



# Abstract Book

# Daily Program

## Day 1, May 17, Rm. 301, 3F

Friday, May 17, 2019	
Rm. 301, 3F	
08:20-08:40	<b>Opening Ceremony</b> <i>Venue: Rm. 401, 4F</i>
08:40-10:00	<b>Symposium 01</b> <b>Epidemiology</b> <i>Moderators:</i> <i>Anna Kam (S021), Hong Kong &amp; Roshni Biswas (S074), Italy</i>
	<b>S01-S1</b> <b>Tinnitus in Adolescents – a Survey of Secondary School Students</b> <i>Speaker: Anna Kam (S021), Hong Kong</i>
	<b>S01-S2</b> <b>Epidemiology of tinnitus: risk factors and findings from a pan-European survey</b> <i>Speaker: Roshni Biswas (S074), Italy</i>
	<b>S01-S3</b> <b>Epidemiology of Clinically Significant Tinnitus: A 10-Year Trend From Nationwide Health Claims Data in South Korea</b> <i>Speaker: Il-Woo Lee (S032), Korea</i>
	<b>S01-O1</b> <b>Noise-induced hearing loss and its individual susceptibility</b> <i>Presenter: Hui Wang (Reg.180085), China</i>
	<b>S01-O2</b> <b>Tinnitus and its associations with general health and hearing loss</b> <i>Presenter: Inge Stegeman (Reg.180173), Netherlands</i>
	<b>S01-O3</b> <b>Tinnitus and mental health of Baby Boomers: a population study</b> <i>Presenter: Inge Stegeman (Reg.180173), Netherlands</i>
	<b>S01-O4</b> <b>The Influences of Personality on Tinnitus Distress: A Longitudinal Study</b> <i>Presenter: Jorge Simoes (Reg.180215), Germany</i>
	<b>S01-O5</b> <b>The effects of Parental Mental Health in childhood in coping with tinnitus and hyperacusis in adulthood</b> <i>Presenter: Ali Danesh (Reg.180048), USA</i>
10:00-10:30	<b>Coffee break</b> <i>Venue: Rm. 402, 4F</i>
10:30-12:00	<b>Symposium 02</b> <b>Animal Models of Tinnitus</b> <i>Moderators:</i> <i>Yun Hoon Choung (S031), Korea &amp; Yen-Fu Cheng (S070), Taiwan</i>
	<b>S02-S1</b> <b>Development of treatment agents for tinnitus using animal models</b> <i>Speaker: Yun Hoon Choung (S031), Korea</i>
	<b>S02-S3</b> <b>Association between Stress and Tinnitus: An experimental study in a rat model of stress-induced tinnitus</b>

<b>Friday, May 17, 2019</b>	
<b>Rm. 301, 3F</b>	
	<i>Speaker: Shi Nae Park(S036), Korea</i>
	<b>S02-O1</b>
	<b>The gap-pre-pulse inhibition of the acoustic startle reflex: statistics, criticism and future applications</b>
	<i>Presenter: Achim Schilling (Reg.180094), Germany</i>
	<b>S02-O2</b>
	<b>Effect of salicylate-induced tinnitus on hearing thresholds</b>
	<i>Presenter: Veralice Lanaia (Reg.180104), Germany</i>
	<b>S02-O3</b>
	<b>Expression of Immediate-Early Genes in Rat with Noise-Induced Tinnitus</b>
	<i>Presenter: Ho Yun Lee (Reg.180119), South Korea</i>
	<b>S02-O4</b>
	<b>Acute time course changes in extracellular amino acids in the cochlear nucleus and inferior colliculus following acoustic trauma in rats</b>
	<i>Presenter: Yiwen Zheng (Reg.180139), New Zealand</i>
	<b>S02-O5</b>
	<b>Effect of noise trauma on the intracortical processing in the auditory cortex</b>
	<i>Presenter: Vinay Parameshwarappa (Reg.180183), France</i>
	<b>S02-O6</b>
	<b>Central tinnitus induced by optogenetic modulation of inhibitory neural circuits in the auditory midbrain</b>
	<i>Presenter: Lin Chen (Reg.180181), China</i>
	<b>S02-O7</b>
	<b>Sound-evoked functional magnetic resonance imaging of hyperacusis in rats</b>
	<i>Presenter: Condon Lau (Reg.180194), Hong Kong</i>
<b>12:00-13:00</b>	<b>Lunch</b>
<b>13:00-15:00</b>	<b>Symposium 03</b>
	<b>Diagnostics</b>
	<i>Moderators:</i>
	<i>Mariko Takahashi (S028), Japan &amp; Richard Tyler (S056), USA</i>
	<b>S03-S1</b>
	<b>An improved system for grading and treating tinnitus</b>
	<i>Speaker: Mariko Takahashi (S028), Japan</i>
	<b>S03-S2</b>
	<b>Guidelines for the diagnosis of chronic tinnitus in Japan.</b>
	<i>Speaker: Hiroaki Sato (S027), Japan</i>
	<b>S03-S3</b>
	<b>乙状窦源性搏动性耳鸣的外科治疗</b>
	<i>Speaker: Shusheng Gong (S006), China</i>
	<b>S03-S4</b>
	<b>Factors influencing severity and prognosis of chronic tinnitus.</b>
	<i>Speaker: Xiangli Zeng (S013), China</i>
	<b>S03-O1</b>
	<b>Stochastic resonance model of tinnitus development: Support from tinnitus patients' data</b>
	<i>Presenter: Konstantin Tziriids (Reg.180102), Germany</i>
	<b>S03-O2</b>
	<b>Clinical characteristics of patients with subjective tinnitus with and without temporomandibular disorders</b>
	<i>Presenter: Annemarie van der Wal (Reg.180131), Belgium</i>

<b>Friday, May 17, 2019</b>	
<b>Rm. 301, 3F</b>	
	<b>S03-O3</b> <b>vHIT results of vestibular schwannoma</b> <i>Presenter: Jingjing Wang (Reg.180133), China</i>
	<b>S03-O4</b> <b>Characteristics and Reproducibility of Residual Inhibition after Repeated Acoustic Stimulation</b> <i>Presenter: Suyi Hu (Reg.180125), Switzerland</i>
	<b>S03-O5</b> <b>Measuring the tinnitus frequency using repetitive recursive matching: Results from three studies using sinusoidal and narrow band noise</b> <i>Presenter: Christian Dobel (Reg.180182), Germany</i>
<b>15:00-15:30</b>	<b>Coffee break</b> <i>Venue: Rm. 402, 4F</i>
<b>16:00-17:30</b>	<b>Symposium 04</b> <b>Electrophysiology</b> <b>Moderators:</b> <i>Ming Lee (S007), China &amp; Hong Ju Park (S037), Korea</i>
	<b>S04-S1</b> <b>Enhanced Central Gain: Neural Basis for Hyperacusis</b> <i>Speaker: Richard Salvi (S055), USA</i>
	<b>S04-S2</b> <b>Tomographic neurofeedback for tinnitus treatment</b> <i>Speaker: Tobias Kleinjung (S016), Switzerland</i>
	<b>S04-S3</b> <b>The Resting-state Bold-fMRI Study on the Idiopathic Tinnitus with and Without Hearing Loss</b> <i>Speaker: Ming Lee (S007), China</i>
	<b>S04-S4</b> <b>The gap-prepulse inhibition deficit of the cortical N1-P2 complex in patients with tinnitus: The effect of gap duration.</b> <i>Speaker: Myung-Whan Suh (S040), Korea</i>
	<b>S04-S5</b> <b>Electrophysiology</b> <i>Speaker: Martin Meyer (S045), Switzerland</i>
	<b>S04-O1</b> <b>Effect of sound therapy on gap detection and speech recognition in patients with sudden sensorineural hearing loss</b> <i>Presenter: Yanmei Feng (Reg.180234), China</i>
	<b>S04-O2</b> <b>Event Related Potentials (P300) to assess the Tinnitus complaint</b> <i>Presenter: Andreia Azevedo (Reg.180188), Brazil</i>

## Day 1, May 17, Rm. 401, 4F

Friday, May 17, 2019	
Rm. 401, 4F	
08:20-08:40	<b>Opening Ceremony</b>
08:40-10:00	<b>3rd Cross-Strait Tinnitus Seminar</b> <b>Keynote Speech</b> <i>Moderators:</i> <i>Tien-Chen Liu (S048), Taiwan &amp; Chuan-Jen Hsu (M004), Taiwan</i> <b>CSK01-1</b> 梅尼埃病诊疗进展 <i>Speaker: Wei Jia Kong (S084), China</i> <b>CSK01-2</b> Inner ear test battery in guinea pig models <i>Speaker: Yi-Ho Young (S050), Taiwan</i> <b>CSK01-3</b> Noise-induced hearing loss and its individual susceptibility <i>Speaker: Shankai Yin (S011), China</i> <b>CSK01-4</b> The impact of impulse noise exposure on hearing: A repeated measures analysis for comparing audiometry and DPOAE <i>Speaker: Chih-Hung Wang (S064), Taiwan</i>
10:00-10:30	<b>Coffee break</b> <i>Venue: Rm. 402, 4F</i>
10:30-11:30	<b>3rd Cross-Strait Tinnitus Seminar</b> <b>Round Table 1 : MD &amp; VM</b> <i>Moderators:</i> <i>Jen-Tsung Lai (S047), Taiwan &amp; Jun Yang (M007), China</i> <i>Panelists:</i> <div> <i>Chia-Huei Chu (180052), Taiwan</i> <i>Xin Ma (S079), China</i>  <i>Che-Ming Wu (S066), Taiwan</i> <i>Xiuli Liu (S081), China</i>  <i>Ting-Hua Yang (S067), Taiwan</i> <i>Jing Wang (S082), China</i>  <i>Ming-Yee Lin (S069), Taiwan</i> <i>Huan Jia (S088), China</i> </div>
11:30-12:30	<b>3rd Cross-Strait Tinnitus Seminar</b> <b>Round Table 2 : SD</b> <i>Moderators:</i> <i>Lisheng Yu (S012), China &amp; Tien-Chen Liu (S048), Taiwan</i> <i>Panelists:</i> <div> <i>Chia-Der Lin (S060), Taiwan</i> <i>Yan Mei Feng (S078), China</i>  <i>Pa-Chun Wang (S061), Taiwan</i> <i>Sulin Zhang (S083), China</i>  <i>Chung-Feng Hwang (S062), Taiwan</i> <i>Yun Li (S085), China</i>  <i>Hung-Ching Lin (S063), Taiwan</i> <i>Zhi-Wu Huang (S089), China</i>  <i>Kuen-Yao Ho (S068), Taiwan</i> </div>
12:30-13:30	<b>Lunch</b>
13:30-15:00	<b>3rd Cross-Strait Tinnitus Seminar</b> <b>Symposium</b> <i>Moderators:</i> <i>Po-Hung Li (M003), Taiwan &amp; Shankai Yin (S011), China</i> <b>CSS01-1</b> Investigation on Sound Characteristics in Tinnitus Patients <i>Speaker: Peng Liu (S008), China</i> <b>CSS01-2</b> 基于「耳鸣中枢化机制」的临床声掩蔽治疗模式 <i>Speaker: Zhi-Wu Huang (S089), China</i> <b>CSS01-3</b> Precision medicine in cochlear implantation: the NTUH experience

Friday, May 17, 2019	
Rm. 401, 4F	
	<p><i>Speaker: Chen-Chi Wu (S049), Taiwan</i></p> <p><b>CSS01-4</b> Recent advances in molecular therapy for inner ear disorders <i>Speaker: Yen-Fu Cheng (S070), Taiwan</i></p> <p><b>CSS01-5</b> 如何成功的进行耳鸣的声治疗 <i>Speaker: Zao Han (S080), China</i></p> <p><b>CSS01-6</b> Application of CRISPR to treat genetic hearing loss <i>Speaker: Yong Tao (S087), China</i></p> <p><b>CSS01-7</b> Functional Mechanisms on The Generation and Perception of Tinnitus <i>Speaker: Tang-Chuan Wang (S071), Taiwan</i></p> <p><b>CSS01-8</b> Altered expression of circadian clock genes in inner ear disorders <i>Speaker: Chao-Hui Yang (S072), Taiwan</i></p>
<b>15:00-15:30</b>	<p><b>Coffee break</b> <i>Venue: Rm. 402, 4F</i></p>
<b>15:30-16:00</b>	<p><b>Keynote Speech 01</b> <i>Moderator: Berthold Langguth (S018), Germany</i></p> <p><b>KS01</b> Brainstem mechanisms in tinnitus <i>Speaker: Susan E. Shore (S058), USA</i></p>
<b>16:00-17:30</b>	<p><b>Symposium 05</b> <b>Brain Stimulation</b> <i>Moderators:</i> <i>Jun Yang (M007), China &amp; Dirk de Ridder (S042), New Zealand</i></p> <p><b>S05-S1</b> Update on Brain Stimulation Approaches for the Teatment of Tinnitus <i>Speaker: Berthold Langguth (S018), Germany</i></p> <p><b>S05-S2</b> Long-Term Effects of Repetitive Transcranial Magnetic Stimulation in Unilateral Tinnitus <i>Speaker: In Seok Moon (S034), Korea</i></p> <p><b>S05-S3</b> Pain and tinnitus in the brain: the same of different? <i>Speaker: Dirk de Ridder (S042), New Zealand</i></p> <p><b>S05-O1</b> RTMS parameters in tinnitus trials: a systematic review <i>Presenter: Stefan Schoisswohl (Reg.180100), Germany</i></p> <p><b>S05-O2</b> Effects of High Definition transcranial Direct Current Stimulation (HD tDCS) in 114 chronic tinnitus patients <i>Presenter: Laure Jacquemin (Reg.180065), Belgium</i></p> <p><b>S05-O3</b> An exploratory study on the use of event-related potentials as an objective measure of auditory processing and therapy effect in patients with tinnitus: a transcranial direct current stimulation study <i>Presenter: Laure Jacquemin (Reg.180065), Belgium</i></p> <p><b>S05-O4</b> Exploring the physiological predictors of subjective tinnitus by the assessments of electrophysiology</p>

---

**Friday, May 17, 2019**

**Rm. 401, 4F**

---

*Presenter: Tang-Chuan Wang (Reg.180149), Taiwan*

**S05-O5**

**Prediction of treatment response to repetitive transcranial magnetic stimulation in tinnitus based on individual brain anatomy**

*Presenter: Timm Poepl (Reg.180226), Germany*

---

**S05-O6**

**Neural activity underlying bothersome and non-bothersome tinnitus with normal hearing documented by EEG**

*Presenter: Haibo Shi (Reg.180217), China*

---



## Day 2, May 18, Rm. 301, 3F

Saturday, May 18, 2019	
Rm. 301, 3F	
08:30-10:00	<p><b>Symposium 06</b>  <b>Clinical Research Methodology</b>  <i>Moderators:</i>  <i>Deborah Ann Hall (S052), Malaysia &amp; Myung-Whan Suh (S040), Korea</i></p> <hr/> <p><b>S06-S1</b>  <b>Clinical Research Methodology</b>  <i>Speaker: Deborah Ann Hall (S052), Malaysia</i></p> <hr/> <p><b>S06-S2</b>  <b>Comparison of Treatment Outcomes Following Either Prefrontal Cortical-only or Dual-site Repetitive Transcranial Magnetic Stimulation in Chronic Tinnitus Patients: A Double-blind Randomized Study.</b>  <i>Speaker: Myung-Whan Suh (S040), Korea</i></p> <hr/> <p><b>S06-S3 (25mins)</b>  <b>Maladaptive alterations of resting state cortical networks in Tinnitus: An effective connectivity analysis of a larger MEG data set</b>  <i>Speaker: Christo Pantev (S073), Germany</i></p> <hr/> <p><b>S06-O1</b>  <b>What would an evidence-based tinnitus patient education program look like? Findings from a systematic review.</b>  <i>Presenter: Tricia Scaglione (Reg.180080), USA</i></p> <hr/> <p><b>S06-O2</b>  <b>Clinical pitfalls of a shared medical appointment approach for tinnitus management in the United States</b>  <i>Presenter: Tricia Scaglione (Reg.180080), USA</i></p> <hr/> <p><b>S06-O3</b>  <b>The hemodynamic study on the different treatment effect after SSCPD resurfacing surgery</b>  <i>Presenter: Zhenxia Mu (Reg.180219), China</i></p>
10:00-10:30	<p><b>Coffee break</b>  <i>Venue: Rm. 402, 4F</i></p>
10:30-12:00	<p><b>Symposium 08</b>  <b>Hearing Aids / CI</b>  <i>Moderators:</i>  <i>Michael Tong (S020), Hong Kong &amp; Eui-Cheol Nam (S035), Korea</i></p> <hr/> <p><b>S08-S1</b>  <b>Hearing aids for relieving tinnitus co-morbid with high-frequency hearing loss</b>  <i>Speaker: Eui-Cheol Nam (S035), Korea</i></p> <hr/> <p><b>S08-S2</b>  <b>Neural substrates of tinnitus in an auditory brainstem implant patient: a preliminary molecular imaging study using H215O-PET including a 5-year follow-up of auditory performance and tinnitus perception</b>  <i>Speaker: Annick Gilles (S003), Belgium</i></p> <hr/> <p><b>S08-S3</b>  <b>Cochlear implant for tinnitus and single sided deafness in Chinese patients</b>  <i>Speaker: Michael Tong (S020), Hong Kong</i></p> <hr/> <p><b>S08-O1</b>  <b>The effects of masking therapy in tinnitus patients are characterized by longitudinally altered local activity and functional connectivity</b></p>



<b>Saturday, May 18, 2019</b>	
<b>Rm. 301, 3F</b>	
	<b>after intervention</b> <i>Presenter: Han Lv (Reg.180017), China</i>
	<b>S08-O2</b> <b>Therapeutic effects of Vibrant Soundbridge on tinnitus accompanied with sensorineural hearing loss</b> <i>Presenter: Jeon Mi Lee (Reg.180081), South Korea</i>
	<b>S08-O3</b> <b>Cochlear implantation in single sided deafness: influence of laterality on audiological, clinical and neuroimaging data</b> <i>Presenter: Nicole Peter (Reg.180146), Switzerland</i>
	<b>S08-O4</b> <b>The Efficacy of Hearing Aids for Tinnitus and Emotional Outcome.</b> <i>Presenter: Jia-Fu Wei (Reg.180126), Taiwan</i>
	<b>S08-O5</b> <b>Effect of sound therapy with hearing aids for treatment of chronic tinnitus in Japan</b> <i>Presenter: Noriomi Suzuki (Reg.180205), Japan</i>
	<b>S08-O6</b> <b>Cochrane review of sound therapy (using amplification devices and/or sound generators) for tinnitus</b> <i>Presenter: Magdalena Sereda (Reg.180123), UK</i>
<b>12:00-13:00</b>	<b>Lunch</b>
<b>13:30-15:00</b>	<b>Symposium 10</b> <b>Hyperacusis / Misophonia</b> <i>Moderators:</i> <i>Tien-Chen Liu (S048), Taiwan &amp; Arnaud Norena (S015), France</i>
	<b>S10-S1</b> <b>Hyperacusis Measurent &amp; Hyperacusis Activities Treatment</b> <i>Speaker: Richard Tyler (S056), USA</i>
	<b>S10-S2</b> <b>Mechanisms of tinnitus/hyperacusis</b> <i>Speaker: Arnaud Norena (S015), France</i>
	<b>S10-S3</b> <b>Sound-based therapies for tinnitus and hyperacusis: rationale and efficacy.</b> <i>Speaker: Martin Pienkowski (S053), USA</i>
	<b>S10-S5</b> <b>Comparison of mechanisms and treatments of tinnitus and misophonia.</b> <i>Speaker: Pawel Jastreboff (S075), UK</i>
	<b>S10-S4</b> <b>Misophonia enforced by strong hyperacusis.</b> <i>Speaker: Margaret Jastreboff (S076), UK</i>
	<b>S10-O1</b> <b>Treatment for oversensitivity to sound</b> <i>Presenter: Peter van Hengel (Reg.180063), Netherlands</i>
	<b>S10-O2</b> <b>Psychometric Properties and Factor Structure of a New Scale to Measure the Impact of Hyperacusis</b> <i>Presenter: Benjamin Greenberg (Reg.180165), USA</i>
<b>15:00-15:30</b>	<b>Group Photo / Coffee break</b> <i>Venue: Rm. 402, 4F</i>
<b>16:00-17:30</b>	<b>Symposium 12</b> <b>Audiology and tinnitus</b>

<b>Saturday, May 18, 2019</b>	
<b>Rm. 301, 3F</b>	
	<p><i>Moderators:</i>  <i>Kammy Ngan-kam Yeung (M002), Hong, Kong &amp; Annick Gilles (S003), Belgium</i></p>
	<p><b>S12-S1</b>  <b>Subjective tinnitus assessment and treatment in clinical practice: the necessity of personalized medicine and counseling of the patient</b>  <i>Speaker: Annick Gilles (S003), Belgium</i></p>
	<p><b>S12-S2</b>  <b>Potential mechanisms for tinnitus with a normal audiogram</b>  <i>Speaker: Hyunjoon Shim (S038), Korea</i></p>
	<p><b>S12-S3</b>  <b>Using Qualitative Data Analysis with Patients in Audiology</b>  <i>Speaker: Nicolas Dauman (S014), France</i></p>
	<p><b>S12-S4</b>  <b>The change of the pitch of tinnitus after TRT therapy</b>  <i>Speaker: Shoko Kato (S022), Japan</i></p>
	<p><b>S12-O1</b>  <b>Analysis of tinnitus occurrence related factors in patients with asymmetric hearing loss</b>  <i>Presenter: Bowen Xue (Reg.180121), China</i></p>
	<p><b>S12-O2</b>  <b>Analysis of the incidence of tinnitus in 135 patients with symmetrical hearing loss</b>  <i>Presenter: Yi-Wen Wei (Reg.180132), China</i></p>
	<p><b>S12-O3</b>  <b>Central Auditory Processing Disorder (CAPD) in Tinnitus and Non-Tinnitus Patients with Normal Hearing</b>  <i>Presenter: Carol Lau (Reg.180019), Canada</i></p>
	<p><b>S12-O4</b>  <b>Analysis of the Precise Audiology Test for the Subjective Tinnitus Patients</b>  <i>Presenter: Binbin Xiong (Reg.180191), China</i></p>
<b>18:30-21:00</b>	<p><b>Networking Dinner</b>  <i>Venue: Int'l Reception Hall, VF, Grand Hotel Taipei</i></p>

## Day 2, May 18, Rm. 401, 4F

Saturday, May 18, 2019	
Rm. 401, 4F	
08:30-10:00	<p><b>Symposium 07</b>  <b>Pathophysiology</b>  <i>Moderators:</i>  <i>Josef Rauschecker (S054), USA &amp; Fan-Gang Zeng (S057), USA</i></p> <hr/> <p><b>S07-S1</b>  <b>Perceptual consequences of tinnitus</b>  <i>Speaker: Fan-Gang Zeng (S057), USA</i></p> <hr/> <p><b>S07-S2</b>  <b>Neuromodulation for tinnitus: does it work? based on recent asian studies</b>  <i>Speaker: Ho Yun Lee (S033), Korea</i></p> <hr/> <p><b>S07-S3</b>  <b>Auditory experience and unsolicited compensation as prerequisites for tinnitus: insights from hearing loss without tinnitus</b>  <i>Speaker: Jae Jin Song (S039), Korea</i></p> <hr/> <p><b>S07-S4</b>  <b>Brain Changes in Tinnitus</b>  <i>Speaker: Josef Rauschecker (S054), USA</i></p> <hr/> <p><b>S07-S5</b>  <b>Frontostriatal Gating of Tinnitus</b>  <i>Speaker: Josef Rauschecker (S054), USA</i></p> <hr/> <p><b>S07-S6</b>  <b>Pathophysiology</b>  <i>Speaker: Kaoru Ogawa (S025), Japan</i></p> <hr/> <p><b>S07-O1</b>  <b>Alterations of the default mode network and cognitive impairment in patients with unilateral chronic tinnitus</b>  <i>Presenter: Yu-Chen Chen (Reg.180068), China</i></p> <hr/> <p><b>S07-O2</b>  <b>Identification of functional biomarkers of tinnitus and tinnitus/hyperacusis in patients</b>  <i>Presenter: Marlies Knipper (Reg.180138), Germany</i></p> <hr/> <p><b>S07-O3</b>  <b>Timing, Tinnitus and Localisation of Sounds</b>  <i>Presenter: Peter J. Hampton (Reg.180237), UK</i></p>
10:00-10:30	<p><b>Coffee break</b>  <i>Venue: Rm. 402, 4F</i></p>
10:30-12:00	<p><b>Symposium 09</b>  <b>Clinical aspects of tinnitus</b>  <i>Moderator: Shi Nae Park (S036), Korea &amp; Hyunjoon Shim(S038), Korea</i></p> <hr/> <p><b>S09-S1</b>  <b>Intratympanic steroid injection in the treatment of acute subjective tinnitus</b>  <i>Speaker: Hyunjoon Shim (S038), Korea</i></p> <hr/> <p><b>S09-S2</b>  <b>Results of Sound Therapy for Tinnitus: from Sound Generator to Cochlear implant</b>  <i>Speaker: Shi Nae Park (S036), Korea</i></p> <hr/> <p><b>S09-S3</b>  <b>A novel diagnostic test for pulsatile tinnitus by sigmoid sinus dehiscence and its clinical application</b>  <i>Speaker: Hong Ju Park (S037), Korea</i></p>

Saturday, May 18, 2019	
Rm. 401, 4F	
	<b>S09-O1</b> <b>The Efficacy of Cochlear Implantation in Subjects with Hearing Loss and Tinnitus.</b> <i>Presenter: David Chen-Yin Wu (Reg.180152), Taiwan</i>
	<b>S09-O2</b> <b>TEES treatment of high jugular bulb in patients with pulsatile tinnitus: case series</b> <i>Presenter: Che-Yang Lin (Reg.180013), Taiwan</i>
	<b>S09-O3</b> <b>Tinnitus in the side with better hearing</b> <i>Presenter: Ho Yun Lee (Reg.180119), South Korea</i>
	<b>S09-O4</b> <b>Evaluation of factors related to sigmoid sinus diverticulum originating pulsatile tinnitus based on CT</b> <i>Presenter: Chenyu Jiang (Reg.180224), China</i>
<b>12:00-13:00</b>	<b>Lunch</b>
<b>13:00-13:30</b>	<b>Keynote Speech 02</b> <i>Moderator: Richard Salvi (S055), USA</i> <b>KS02</b> <b>Tinnitus: Pharmacological Intervention, what should we target?</b> <i>Speaker: Ana Belen Elgoyhen (S001), Argentina</i>
<b>13:30-15:00</b>	<b>Symposium 11</b> <b>Genetics of Tinnitus</b> <i>Moderators:</i> <i>Chuan-Jen Hsu (M004), Taiwan &amp; Winfried Schlee (180227), Germany</i> <b>S11-S1</b> <b>Tinnitus and its Heredity</b> <i>Speaker: Qiuju Wang (S009), China</i> <b>S11-O1</b> <b>Effects of Spirulina on GABA receptor gene expression in salicylate-induced tinnitus.</b> <i>Presenter: Juen-Haur Hwang (Reg.180073), Taiwan</i> <b>S11-O2</b> <b>Characteristic Analysis of Auditory-Vestibular Function in Patients with Vestibular Migraine</b> <i>Presenter: Yilin Hou (Reg.180199), China</i> <b>S11-O3</b> <b>Gender difference in chronic tinnitus</b> <i>Presenter: Winfried Schlee (Reg.180227), Germany</i> <b>S11-O4</b> <b>Risk of cochlear disorders in patients with migraine: a nationwide, population-based cohort study.</b> <i>Presenter: Juen-Haur Hwang (Reg.180073), Taiwan</i>
<b>15:00-15:30</b>	<b>Group Photo / Coffee break</b> <i>Venue: Rm. 402, 4F</i>
<b>15:30-16:00</b>	<b>Keynote Speech 03</b> <i>Moderator: Kaoru Ogawa (S025), Japan</i> <b>KS03</b> <b>Challenges facing tinnitus and sound tolerance disorders care in Asia</b> <i>Speaker: William Martin (S043), Singapore</i>
<b>16:00-17:30</b>	<b>Symposium 13</b> <b>Asian Perspective to Tinnitus</b> <i>Moderators:</i> <i>Hiroaki Sato (S027), Japan &amp; In Seok Moon (S034), Korea</i> <b>S13-S1 New exploration of Tinnitus management based on China's</b>

<b>Saturday, May 18, 2019</b>	
<b>Rm. 401, 4F</b>	
	<b>condition—Tinnitus Combined Management.</b> <i>Speaker: Ming Lee (S007), China</i>
	<b>S13-S2</b> <b>Therapeutic effects of active middle ear implant (Vibrant soundbridge) on tinnitus</b> <i>Speaker: In Seok Moon (S034), Korea</i>
	<b>S13-S3</b> <b>Psychological Factors for Tinnitus and Hyperacusis patients.</b> <i>Speaker: Yoshitaka Takanashi (S029), Japan</i>
	<b>S13-O1</b> <b>Mapping off-on tinnitus related brain activation in tinnitus patients</b> <i>Presenter: Hui Wang (Reg.180085), China</i>
	<b>S13-O2</b> <b>Menopausal Hormone Replacement Therapy for Chronic Tinnitus in Migraine Patients</b> <i>Presenter: Chia-Yi Chen (Reg.180010), Taiwan</i>
	<b>S13-O3</b> <b>Why is Tinnitus a Problem? A Qualitative Cross-cultural Comparison of Problems Reported by Tinnitus Patients in China and England</b> <i>Presenter: Maryam Shabbir (Reg.180168), UK</i>
	<b>S13-O4</b> <b>Cerebral blood flow change in migraine patients with sudden sensorineural hearing loss</b> <i>Presenter: Sheng Kai Huang (Reg.180006), Taiwan</i>
	<b>S13-O5 OP1097</b> <b>The evaluation of brain perfusion SPECT in auditory cortex in rTMS treatment-effective tinnitus patients</b> <i>Presenter: Hsiung-Kwang Chung (Reg.180187), Taiwan</i>
	<b>S13-O6</b> <b>Preliminary exploration of chronic tinnitus in menopausal women</b> <i>Presenter: Ma Xin (Reg.180137), China</i>
<b>18:30-21:00</b>	<b>Networking Dinner</b> <i>Venue: Int'l Reception Hall, VF, Grand Hotel Taipei</i>

## Day 3, May 19, Rm. 301, 3F

Sunday, May 19, 2019	
Rm. 301, 3F	
09:00-10:00	<b>Symposium 14</b> <b>Comorbidities of Tinnitus</b> <i>Moderators:</i> <i>Birgit Mazurek(S019), Germany &amp; Lisheng Yu(S012), China</i>
	<b>S14-S1</b> <b>Tinnitus Following Platinum-based Chemotherapy</b> <i>Speaker: David Baguley (S051), UK</i>
	<b>S14-S2</b> <b>Tinnitus and comorbidities</b> <i>Speaker: Birgit Mazurek (S019), Germany</i>
	<b>S14-S3</b> <b>Analysis of the Natural History and Factors Related to Tinnitus in Patients with Idiopathic Sudden Sensorineural Hearing Loss</b> <i>Speaker: Lisheng Yu (S012), China</i>
	<b>S14-O1</b> <b>Sleep architecture features in adult tinnitus patients with sleep complaints</b> <i>Presenter: Lin Cheng-Yu (Reg.180099), Taiwan</i>
	<b>S14-O2</b> <b>A preliminary study on the correlation between obstructive sleep apnea hypopnea syndrome and chronic tinnitus</b> <i>Presenter: Xiuli Liu (Reg.180120), China</i>
	<b>S14-O3</b> <b>Winning Therapy</b> <i>Presenter: Loredana Bottalico (Reg.180197), Italy</i>
10:00-10:30	<b>Coffee break</b> <i>Venue: Rm. 402, 4F</i>
10:30-12:00	<b>TRI Panel</b> <b>Towards a unified tinnitus model - Panel discussion</b> <i>Moderators:</i> <i>David Baguley (S051), Germany &amp; Marlies Knipper (180138), Germany</i>
12:00-13:00	<b>Lunch</b>
13:30-15:00	<b>Symposium 17</b> <b>Specific Forms of Tinnitus</b> <i>Moderators:</i> <i>Sarah Michiels (S004), Belgium &amp; Wei Jia Kong (S084), China</i>
	<b>S17-S1</b> <b>Somatosensory tinnitus, challenges in diagnosis and treatment</b> <i>Speaker: Sarah Michiels (S004), Belgium</i>
	<b>S17-S2</b> <b>Pulsatile tinnitus update: objective documentation and surgical management</b> <i>Speaker: Jae Jin Song (S039), Korea</i>
	<b>S17-S3</b> <b>Diagnosis and treatment of pulsatile tinnitus associated with sigmoid sinus diverticulum</b> <i>Speaker: Wei Jia Kong (S084), China</i>
	<b>S17-S4</b> <b>Sigmoid sinus constriction on sigmoid sinus associated venous pulsatile tinnitus</b> <i>Speaker: Wuqing Wang (S086), China</i>
	<b>S17-O1</b>

<b>Sunday, May 19, 2019</b>	
<b>Rm. 301, 3F</b>	
	<p><b>Long term reactions to pulsatile tinnitus is featured by weakened short-range functional connectivity within a brain network on the right sided temporal lobe</b>  <i>Presenter: Han Lv (Reg.180017), China</i></p>
	<p><b>S17-O2</b>  <b>Management of Palatal Myoclonic Tinnitus Based on Clinical Characteristics: A Large Case Series Study</b>  <i>Presenter: Jung Mee Park (Reg.180230), Korea</i></p>
<b>15:00-15:30</b>	<p><b>Coffee break</b>  <i>Venue: Rm. 402, 4F</i></p>
<b>16:00-17:30</b>	<p><b>Symposium 19</b>  <b>Behavioral Therapy</b>  <i>Moderators:</i>  <i>Rilana Cima (S041), Netherlands &amp; Iris Hoi-Yee Ng (M001), Hong Kong</i></p>
	<p><b>S19-S1</b>  <b>Specialised CBT for Tinnitus: a dismantling approach: innovative clinical trial methods &amp; assessments</b>  <i>Speaker: Rilana Cima (S041), Netherlands</i></p>
	<p><b>S19-S2</b>  <b>Fearful ears: A fear-learning approach to chronic Tinnitus suffering: preliminary results from an RCT (2-armed, baseline &amp; 4 fu's, daily recordings)</b>  <i>Speaker: Rilana Cima (S041), Netherlands</i></p>
	<p><b>S19-O1</b>  <b>What for Whom? Single-Case Experimental Design as a tool for tailoring CBT for tinnitus</b>  <i>Presenter: Matheus Lourenco (Reg.180107), Netherlands</i></p>
	<p><b>S19-O2</b>  <b>Cognitive performance in chronic tinnitus patients: preliminary results of a cross-sectional study using the RBANS-H</b>  <i>Presenter: Emilie Cardon (Reg.180112), Belgium</i></p>
	<p><b>S19-O3</b>  <b>The effect of Temporomandibular treatment on tinnitus severity and intensity in patients with somatosensory tinnitus: A Pilot Study</b>  <i>Presenter: Annemarie van der Wal (Reg.180131), Belgium</i></p>
<b>17:30-18:00</b>	<p><b>Closing Remarks</b>  <i>Venue: Rm. 401, 4F</i></p>



## Day 3, May 19, Rm. 401, 4F

Sunday, May 19, 2019	
Rm. 401, 4F	
08:30-09:00	<b>Keynote Speech 04</b> <b>Moderator:</b> <i>Shankai Yin (S011), China</i> <b>K04</b> <b>Looking at tinnitus from different angles inferred by nationwide population-based association study of Taiwan</b> <b>Speaker:</b> <i>Tien-Chen Liu (S048), Taiwan</i>
09:00-10:00	<b>Symposium 15</b> <b>Tinnitus and Vertigo</b> <b>Moderator:</b> <i>Jen-Tsung Lai (S047), Taiwan &amp; Meiho Nakayama (S024), Japan</i> <b>S15-S1</b> <b>How do sleep relate to tinnitus and vertigo?</b> <b>Speaker:</b> <i>Meiho Nakayama (S024), Japan</i> <b>S15-S2</b> <b>Cochlear migraine and tinnitus switch</b> <b>Speaker:</b> <i>Jen-Tsung Lai (S047), Taiwan</i> <b>S15-S3</b> <b>Clinical Sound therapy for tinnitus</b> <b>Speaker:</b> <i>Hayato Tsuge (S030), Japan</i> <b>S15-O1</b> <b>Changes in tinnitus after vestibular schwannoma surgery</b> <b>Presenter:</b> <i>Zhengnong Chen (Reg.180082), China</i> <b>S15-O2</b> <b>Mal de débarquement syndrome (MdDs)- Case Report and Review article</b> <b>Presenter:</b> <i>Chih-En Chang (Reg.180115), Taiwan</i> <b>S15-O3</b> <b>Newly Found Clinical Values of VAT in Sudden Deafness with Tinnitus</b> <b>Presenter:</b> <i>Su-Lin Zhang (Reg.180207), China</i>
10:00-10:30	<b>Coffee break</b> <b>Venue:</b> <i>Rm. 402, 4F</i>
10:30-12:00	<b>Symposium 16</b> <b>Psychological View of Tinnitus</b> <b>Moderators:</b> <i>Nicolas Dauman (S014), France &amp; Chii-Yuan Huang (S046), Taiwan</i> <b>S16-S1</b> <b>The Role of Frustration in Tinnitus Suffering and Improved Tolerance</b> <b>Speaker:</b> <i>Nicolas Dauman (S014), France</i> <b>S16-S2</b> <b>Anxiety, Depression and Health-related Quality of Life in Chinese Tinnitus Sufferers with and without Hearing Loss</b> <b>Speaker:</b> <i>Anna Kam (S021), Hong Kong</i> <b>S16-O1</b> <b>Psychological complaints in tinnitus patients with sleep disturbance</b> <b>Presenter:</b> <i>Yi-Lu Li (Reg.180075), Taiwan</i> <b>S16-O2</b> <b>The effects of personality traits and hearing status on the acute tinnitus sensation of idiopathic sudden hearing loss cases</b> <b>Presenter:</b> <i>Jeong Pak In (Reg.180106), Taiwan</i> <b>S16-O3</b> <b>Tinnitus and personality; a systematic review</b>

Sunday, May 19, 2019	
Rm. 401, 4F	
	<i>Presenter: Diane Smit (Reg.180136), Netherlands</i>
	<b>S16-O4</b> <b>The correlation between tinnitus, coping, psychopathology and quality of life</b> <i>Presenter: Diane Smit (Reg.180136), Netherlands</i>
	<b>S16-O5</b> <b>The Effect of Tinnitus on Listening Effort in Patients with Sudden Sensorineural Hearing Loss</b> <i>Presenter: Ming Hsien Tsai (Reg.180071), Taiwan</i>
<b>12:00-13:00</b>	<b>Lunch</b>
<b>13:00-13:30</b>	<b>Keynote Speech 05</b> <i>Moderator:</i> <i>Tobias Kleinjung (S016), Switzerland</i>
	<b>K05</b> <b>Genetics of tinnitus and Meniere disease.</b> <i>Speaker: Jose Antonio Lopez-Escamez (S044), Spain</i>
<b>13:30-15:00</b>	<b>Symposium 18</b> <b>Pharmacotherapy</b> <i>Moderators:</i> <i>An-Suey Shiao (M006), Taiwan &amp; Lieber, Po-Hung Lee (M003), Taiwan</i>
	<b>S18-O1</b> <b>Injections of lidocain in the ganglion oticum for the therapy of tinnitus</b> <i>Presenter: Veronika Vielsmeier (Reg.180214), Germany</i>
	<b>S18-O2</b> <b>Effect of intratympanic steroid injection in acute onset tinnitus</b> <i>Presenter: HeeYoung Kim (Reg.180059), South Korea</i>
	<b>S18-O3</b> <b>Middle ear dexamethasone delivery via ultrasound microbubbles attenuates noise-induced hearing loss</b> <i>Presenter: Cheng-Ping Shih (Reg.180090), Taiwan</i>
	<b>S18-O4</b> <b>Dextromethorphan attenuates hidden hearing loss in military gun-shooting practice</b> <i>Presenter: Hsin-Chien Chen (Reg.180079), Taiwan</i>
<b>15:00-15:30</b>	<b>Coffee break</b> <i>Venue: Rm. 402, 4F</i>
<b>15:30-16:00</b>	<b>Keynote Speech 06</b> <i>Moderator:</i> <i>David Baguley (S051), UK</i>
	<b>K06</b> <b>Enhanced anticipatory predictions in the auditory system of individuals with tinnitus</b> <i>Speaker: Nathan Weisz (S002), Austria</i>
<b>16:00-17:30</b>	<b>Symposium 20</b> <b>Cortical Networks / Neuroplasticity /Imaging Studies</b> <i>Moderators:</i> <i>Shujiro Minami (S023), Japan &amp; Martin Meyer (S045), Switzerland</i>
	<b>S20-S1</b> <b>Age-related change of auditory functional connectivity in Human Connectome Project data and tinnitus patients</b> <i>Speaker: Shujiro Minami (S023), Japan</i>
	<b>S20-S2</b> <b>Cortical Networks / Neuroplasticity /Imaging Studies</b>

<b>Sunday, May 19, 2019</b>	
<b>Rm. 401, 4F</b>	
	<i>Speaker: Martin Meyer (S045), Switzerland</i>
	<b>S20-O1</b>
	<b>Tinnitus distress is associated with enhanced resting-state functional connectivity within the default mode network</b>
	<i>Presenter: Yu-Chen Chen (Reg.180068), China</i>
	<b>S20-O2</b>
	<b>Cross-Modal Stochastic Resonance as a Cause of Subjective Tinnitus</b>
	<i>Presenter: Patrick Krauss (Reg.180086), Germany</i>
	<b>S20-O3</b>
	<b>Are gray matter volume changes in frontal brain regions associated with speech-in-noise performance in tinnitus patients?</b>
	<i>Presenter: Yihsin Tai (Reg.180147), USA</i>
	<b>S20-O4</b>
	<b>Resting-state MEG Functional Connectivity Analysis in Patients with Tinnitus</b>
	<i>Presenter: Po-Yi Lin (Reg.180089), Taiwan</i>
	<b>S20-O5</b>
	<b>Residual Inhibition and Neural Activity in Patients with Tinnitus: Preliminary Results of Within- and Between-Subject Comparison</b>
	<i>Presenter: Suyi Hu (Reg.180125), Switzerland</i>
<b>17:30-18:00</b>	<b>Closing Remarks</b>
	<i>Venue: Rm. 401, 4F</i>

## **CSK01-2**

### **Inner ear test battery in guinea pig models**

*Yi-Ho Young (楊怡和)*

*Department of Otolaryngology, National Taiwan University Hospital, Taipei, Taiwan*

#### **Objective:**

This study reviewed the development of the inner ear test battery comprising auditory brainstem response (ABR), and caloric, ocular vestibular-evoked myogenic potential (oVEMP) and cervical vestibular-evoked myogenic potential (cVEMP) tests in guinea pig models at our laboratory over the last 20 years. Detailed description about the methodology for testing the small animals is also included.

#### **Methods:**

Inner ear disorders i.e. ototoxicity, noise exposure, or perilymph fistula were established in guinea pig models first. One to 4 weeks after operation, each animal underwent ABR, and oVEMP, cVEMP and caloric tests. Then, animals were sacrificed for morphological study in the temporal bones.

#### **Results:**

Inner ear endorgans can be comprehensively evaluated in guinea pig models via an inner ear test battery, which provides thorough information on the cochlea, saccule, utricle and semicircular canal function of guinea pigs. Coupled with morphological study in the temporal bones of the animals may help elucidate the mechanism of inner ear disorders in humans.

#### **Conclusion:**

The inner ear test battery in guinea pig models may encourage young researchers to perform basic study in animals and stimulate the progress of experimental otology which is in evolution.

### **CSS01-3**

#### **Functional Mechanisms on The Generation and Perception of Tinnitus**

*Tang-Chuan Wang*

*Department of Otolaryngology – Head and Neck Surgery*

*China Medical University Hsinchu Hospital, Taiwan*

Tinnitus ("ringing in the ears") is a serious health condition that can negatively affect a patient's quality of life. Though a variety of managements, these all have limited success and effective cure remain missing as its underlying pathophysiology remains poorly understood. Although there is presently no perfect way to cure tinnitus, to figure out the pathophysiological mechanisms of tinnitus generation and to develop a good solution to reliably eliminate the phantom sounds inside the patients becomes an important issue to both auditory neuroscientists and clinicians. Understanding the yet unclear pathophysiological mechanisms can help developing new management for tinnitus. In order to explore the differential changes of auditory pathway on tinnitus, we used the combination of the behavior assessment and electrophysiological studies to compare the tinnitus group and no tinnitus group. We found that the tinnitus related increased neural activities and neural synchrony. Results taken together will suggest that the tinnitus perception is generated by the hyperactive and enhanced synchrony. These might be a good predictor to induce the generation of subject tinnitus. Besides, Further results will be provided for more insights (the functional mechanisms) on tinnitus perception. It is possible that the reorganized auditory circuits and plasticity are related to development of irreversible tinnitus and the glia, especially the astrocyte play a crucial role in the tonotopy reorganization.

#### **CSS01-4**

##### **Circadian clock in the inner ear and related disorders**

*Chao-Hi Yang*

*Department of Otolaryngology, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan*

Circadian rhythm is present in almost all eukaryotes with a 24 hour cycle. Daily rhythmic changes are found in several physiological processes, including sleep, appetite, hormone level, metabolism and gene expression. There are at least nine core circadian clock genes that regulate central and peripheral circadian oscillators using transcriptional-translational feedback loops.

Recently, circadian clock had been found in the cochlea and inferior colliculus by the presentation of circadian oscillation in circadian clock genes expression. The cellular clocks in the cochlea are dynamically regulated and longitudinally distributed. In addition, time-dependent sensitivity to noise was found in the mice, which exposed to noise during the night are more vulnerable than when exposed during the day. In the clinic, we also found the altered expression of circadian clock genes in patients with sudden sensorineural hearing loss. These results imply the circadian regulation plays an important part in the inner and related disorders.

## CSS01-5

### 如何成功的进行耳鸣的声治疗

韩朝 复旦大学附属眼耳鼻喉科医院 耳神经颅底外科

耳鸣的声治疗历史悠久，但是直到 TRT 治疗才被重新重视，大陆 10 年前开始了声治疗，但是效果很差，认知度不高。通过对耳鸣人群，耳鸣患者特征的调查分析，对声治疗依从性的分析，发现声治疗失败的原因和如何能够改善声治疗的效果的方法。通过这种改进，声治疗的有效率得到提供，使得这种良好的几乎没有副作用的物理疗法重新得到认可。声治疗目前成为作者治疗耳鸣患者的必不可少的手段，尤其目前耳鸣发病原因的众多，无法明确的情况下，尤其如此。



## K01

### Brainstem mechanisms in tinnitus

*Susan E. Shore, PhD*

The cochlear nucleus, as the first central processing station in the auditory pathway receives cochlear input from the auditory nerve. Fusiform cells in the dorsal CN (DCN) as well as bushy cells and D-stellate cells in the ventral CN (VCN) integrate the auditory inputs with information from multiple multimodal pathways. Following tinnitus-induction using narrow band noise exposures, we have demonstrated that DCN fusiform cells show BF-specific alterations in stimulus-timing dependent plasticity, increased spontaneous synchronization, and increased spontaneous firing rates (SFR) in animals with behavioral evidence of tinnitus (Wu, Martel et al. 2016, Marks, Martel et al. 2018). Conversely, animals without plasticity-induced changes in fusiform cells, but equivalent degrees of cochlear damage, did not show evidence of tinnitus. New data shows that bushy cells in ventral cochlear nucleus also show BF-restricted increased SFR and cross-unit synchrony that correlate with tinnitus frequency in animals with tinnitus. These correlates are not exhibited in animals without such behavioral evidence, even though ABR thresholds and suprathreshold wave-1 amplitudes were equivalent (Martel and Shore 2019), suggesting similar cochlear damage in the two groups. Changes in glutamatergic and cholinergic transmission also occur in these animals in a tinnitus-specific manner (Heeringa, Wu et al. 2018, Zhang, Wu et al. 2018). Thus, while tinnitus is usually associated with hearing loss, the relationship is not causal as people without audiometric hearing loss can develop tinnitus and not all people with audiometric hearing loss develop tinnitus. Likewise, in animal models, noise exposures that produce only temporary threshold shifts result in behavioral evidence of tinnitus only in about half of the exposed animals. These data suggest that hearing loss, whether visible or 'hidden', is insufficient by itself to produce a tinnitus phenotype. Changes in cochlear output after noise exposure require accompanying plastic changes in recipient neurons in the CNS in order to result in the physiological and behavioral signatures of tinnitus.

### References:

- Heeringa, A. N., C. Wu, C. Chung, M. West, D. Martel, L. Liberman, M. C. Liberman and S. E. Shore (2018). "Glutamatergic Projections to the Cochlear Nucleus are Redistributed in Tinnitus." *Neuroscience*.
- Marks, K. L., D. T. Martel, C. Wu, G. J. Basura, L. E. Roberts, K. C. Schwartz-Leyzac and S. E. Shore (2018). "Auditory-somatosensory bimodal stimulation desynchronizes brain circuitry to reduce tinnitus in guinea pigs and humans." *Sci Transl Med* 10(422).
- Martel, D. and S. Shore (2019). "Ventral cochlear nucleus bushy cells contribute to enhanced auditory brainstem response amplitudes in tinnitus." *ARO*, 2019.
- Wu, C., D. T. Martel and S. E. Shore (2016). "Increased Synchrony and Bursting of Dorsal Cochlear Nucleus Fusiform Cells Correlate with Tinnitus." *J Neurosci* 36(6): 2068-2073.
- Zhang, L., C. Wu, D. T. Martel, M. West, M. A. Sutton and S. E. Shore (2018). "Remodeling of cholinergic input to the hippocampus after noise exposure and tinnitus induction in Guinea pigs." *Hippocampus*.

**K02**

**Tinnitus: Pharmacological Intervention, what should we target?**

*Ana Belén Elgoyhen*

*Instituto de Investigaciones en Ingeniería Genética, CONICET. Buenos Aires,  
Argentina. [abelgoyhen@gmail.com](mailto:abelgoyhen@gmail.com)*

One in 10 adults has clinically significant subjective tinnitus, and for 1 in 100, tinnitus severely affects their quality of life. Despite the significant unmet clinical need for a safe and effective drug targeting tinnitus relief, there is currently not a single FDA-approved drug on the market. Since in some individuals, tinnitus causes irritability, agitation, stress, depression, insomnia and interferes with normal life, even a drug that produces a small but significant effect would have a huge therapeutic impact. The search for drugs that target tinnitus is hampered by the lack of a deep knowledge of the underlying neural substrates of this pathology. Initially considered an inner ear pathology, it is now clear that at least chronic tinnitus is a central nervous system disorder. Based on recent progress in the understanding of tinnitus, I will focus my talk on a brief overview of the pharmacotherapies that have been used, on the challenges faced when designing a tinnitus pharmacotherapy, on potential neural substrates as targets for pharmacological intervention and on the approach followed by the TRI Pharma Workgroup.

### **K03**

#### **Challenges facing tinnitus and sound tolerance disorders care in Asia**

*Abstract: S043-1*

*William Hal Martin<sup>1</sup> Jennifer Ellery Martin<sup>1</sup>*

*<sup>1</sup> Department of Otolaryngology, National University of Singapore*

#### **Introduction:**

Tinnitus and sound tolerance disorders are commonly occurring conditions resulting from a wide range of injuries, diseases and natural aging processes. Tinnitus and sound tolerance care is typically initiated by a physician who rules out or addresses active disease processes using medical or surgical interventions. If the tinnitus and sound tolerance conditions persist, evaluation, management and rehabilitation can be conducted by a team of clinicians from relevant disciplines. Obstacles to appropriate tinnitus and sound tolerance care abound in Asia.

#### **Material & Method:**

In 2013, the authors began the process of establishing a program for evaluation, treatment, management and rehabilitation of individuals with complex and severe tinnitus, sound tolerance disorders and other rare and complex hearing conditions in the National University Hospital of Singapore. They have also worked with other professionals in the region to facilitate tinnitus care. Obstacles to providing adequate care were encountered and attempts to resolve them were made.

#### **Results:**

Obstacles to providing appropriate care for tinnitus and sound tolerance conditions included:

1. Inadequate training of otolaryngologists and audiologists related to these conditions and their management.
2. Lack of administrative process for referrals and billing for services.
3. Patient expectations related to cost of services.
4. Lack of clinicians from other, relevant subspecialties who were willing to engage in interdisciplinary care of these individuals.
5. Lack of tinnitus evaluation tools (questionnaires) in relevant languages.
6. Restricted access to tinnitus and sound tolerance management technologies.
7. Reluctance of the Asian population to seek help for hearing related conditions.
8. Reluctance of the Asian population to seek help for psychiatric/psychological services.
9. Lack of adequate facilities to deliver hearing healthcare services.

#### **Conclusion:**

Clinicians in Asia face significant challenges in providing adequate care for those with tinnitus and sound tolerance conditions that can be overcome with creative and persistent efforts.

## K04

### **Looking at tinnitus from different angles inferred by nationwide population-based association study of Taiwan**

*Tien-Chen Liu*

*Department of Otolaryngology, National Taiwan University Hospital, Taipei, Taiwan*

#### **Background**

Tinnitus baffles patients and clinicians for long. Despite of rigorous research, definite etiology is unknown and effective treatment is lacking now. This report provides a different perspective from the association of tinnitus with other diseases that are uncommonly mentioned before and offers some therapeutic methods that may help certain patients distressed by tinnitus.

#### **Materials and Methods**

Nationwide, population-based, case controlled method was employed to analyze the association of tinnitus with obstructive sleep apnea syndrome, menopausal syndrome in women and patients with history of migraine headache. The selection of this three diseases seemly irrelevant to tinnitus is according to our clinical experience. Specific treatment such as CPAP, hormone replace therapy and migraine prophylactic therapy were used in selective case series and the outcome of tinnitus improvement was evaluated.

#### **Results**

The risk of tinnitus was higher in patients with OSAS (OR=1.36). We further performed PSG for 173 male patients with chronic tinnitus and found the incidence and severity of sleep disorder breathing is much higher (90.6% vs. 27%). Fourteen patients received CPAP as the single treatment for their tinnitus and the improvement rate is 85%. Also, association study demonstrated that menopausal women tend to have higher incidence of tinnitus. Hormone replacement therapy has remarkable tinnitus relieving effects in our preliminary series of 13 patients. Finally, the history of migraine inflict a significant higher risk (OR: 3.30) to develop tinnitus and we proposed that cochlear migraine may be a possible cause of tinnitus in some patients who respond particularly well to anti-migraine therapy.

#### **Conclusions**

The results of our association studies and uncontrolled clinical studies seem to be compatible with two major new concept of tinnitus: 1, tinnitus is heterogenic; 2, a top-down mechanism is a significant etiological contributor. Diversified research and collaborative initiatives are advocated to solve the enigma of tinnitus.

K05

## Genetic of tinnitus and Meniere disease

*Jose Antonio Lopez-Escamez<sup>1, 2</sup>*

*<sup>1</sup> Otology & Neurotology Group, Department of Genomic Medicine, Pfizer -  
Universidad de Granada - Junta de Andalucía Centro de Genómica e Investigación  
Oncológica (GENYO), PTS, Granada, Spain*

*<sup>2</sup> Department of Otolaryngology, Instituto de Investigación Biosanitaria  
ibs.GRANADA, Hospital Universitario Virgen de las Nieves, Granada, Spain*

Persistent tinnitus is a condition associated with different groups of disorders including hearing loss, migraine, sleep disturbances, anxiety and depression. The genetic contribution to tinnitus has been neglected for decades, but recent evidence for Swedish twins and adopted individual studies have this paradigm. Moreover, the prevalence of tinnitus according to the ethnic origin and familial aggregation studies will confirm the suspected tinnitus heritability.

However, tinnitus is clinically heterogeneous and it should be considered as an ensemble of endophenotypes.

We have been investigating the genetic contribution in Meniere disease (MD), a debilitating condition of the inner ear defined by episodes of vertigo associated with tinnitus and hearing loss. Our studies have found a strong familial aggregation and several pathogenic variants in different genes such as FAM136A, DTNA, PRKCB, SEMA3D and DTP in autosomal dominant familial MD. Furthermore, we have found a burden of rare missense variants in certain sensorineural hearing loss genes in sporadic MD, suggesting a multiallelic oligogenic model.

To decipher the genetic underpinnings of tinnitus in MD, we have adopted an extreme phenotype strategy to search for burden of rare variants in tinnitus extreme phenotype individuals with MD. So, by selecting these cases and comparing them with MD patients without persistent tinnitus, we expect to target the driver genes for tinnitus generation in MD.

### Funding

JALE research is partially supported by H2020 ITN-722046 ESIT and GENDER-NET Plus-182 TIGER Grants

**Enhanced anticipatory predictions in the auditory system of individuals with tinnitus**

A prevailing view on tinnitus sees this condition to result from hyperexcitability / -synchrony in subcortical and cortical auditory processing regions resulting from deafferentation due to hearing damage. Despite its merits especially in animal models, there is no strong and consistent evidence base in humans to support this view. Furthermore, this mechanistic account cannot explain several open issues that plague tinnitus research, in particular: Why does only a subset of individuals with hearing loss develop tinnitus? Why is after noise trauma tinnitus transient in most individuals, but becomes chronic in a few? Developing answers to these fundamental questions will be a key in also developing innovative treatments and identifying individuals at risk to develop (chronic) tinnitus. Recently, predictive processing models of tinnitus have been put forward that suggest the default prediction of silence to shift to a prediction of sound. This is an appealing hypothesis, since it does not require any hyperexcitability / -synchrony in the long term and could explain the notorious therapy-resistance of tinnitus. Along these lines we propose that individuals that develop tinnitus may generally rely more strongly on their internal (prediction) models as compared to the actual auditory evidence. This would be a predisposing (for a bolder formulation: trait-like) factor to shift their default prediction towards tinnitus following e.g. a hearing damage. To pursue this idea requires a powerful methodological approach to uncover prediction processes in the auditory system. In the first part of my talk, I will introduce the audience to our recently developed MEG paradigm, that combines a regularity modulation and omission paradigm. Using an MVPA approach, we show that (anticipatory) predictions in the auditory system are tonotopically (i.e. carrier-frequency) specific. In the second part, I will give an overview of our work applying this powerful base paradigm to individuals with tinnitus. Our results show strong differences in anticipatory periods, with activity generated by "tinnitus brains" containing a stronger modulation of carrier-frequency specific information with increasing regularity of the sound sequence. Since no differences between groups were present with regards to the general decoding of carrier-frequency in random sound sequences, our effects point clearly to an altered processing of statistical regularities in tinnitus. Overall, these results support our notion of an increased reliance on internal models in auditory processing of individuals with tinnitus. However, more work will be needed to establish this process as a factor that predisposes tinnitus.

## **S01-O1**

### **Noise-induced hearing loss and its individual susceptibility**

#### **Objective:**

To characterise the effects of noise exposure on hearing damage, the development tendency and identify individual susceptibility of NIHL.

#### **Methods:**

Auditory processing abilities were evaluated and compared between subjects with normal hearing and no history of noise exposure and those with long history of noise exposure but near-normal threshold. The behavioral tests were conducted in all subjects and included speech in noise test, competing sentences test, dichotic listening and gap in noise detection. Objective measurements were performed in selected subjects of different groups, including mismatch negativity and the P3, and molecular magnetic resonance spectroscopy for gamma-aminobutyric acid concentrations.

Results: 5364 workers were comprised in this study included 4554 male and 811 female, age from 20 to 64 years old, duration of employment from 1 to 25 years. The exposed subjects with 8-hour average exposure every day for average 6.88 years in noisy environments showed significantly deteriorated signal processing ability as demonstrated in various behavior tests. Significant MMN maximum intensity difference between the groups is observed at different Brodmann Area. A decreased GABA concentration was seen in the temporal lobe in association with an increased task-evoked activation in this region. Audiology changes of 530 workers within 5 years showed the most susceptible frequencies of NIHL arise in not only 4KHz rather than 12KHz. The best predictive ability of RF achieved an accuracy of 69%.

#### **Conclusion:**

occurrence and development of NIHL have a specific susceptibility frequency, 12kHz may be the most sensitive frequency to noise but 4KHz. Auditory processing abilities can be significantly impaired in the subjects exposing to noise before a significant hearing threshold shift can be identified. Individual susceptibility to NIHL is different, and female is more resistant. Machine learning can be used as a new method to select susceptible individuals.



## S01-O2

### Tinnitus and its associations with general health and hearing loss

*Inge Stegeman<sup>1</sup>, Robert H Eikelboom<sup>2,3,4</sup>, Marcus D Atlas<sup>2,3</sup>, Sandra R Bellekom<sup>2,3</sup>, Rebecca J Bennett<sup>2,3</sup>, David Baguley<sup>5</sup>, Romola S Bucks<sup>6</sup>, Michael Hunter<sup>7,8</sup>, Diane Smit<sup>1</sup>, Susan Tegg-Quinn<sup>2,3</sup>*

<sup>1</sup> Department of Otorhinolaryngology, Head and Neck Surgery, University Medical Center Utrecht, Utrecht, The Netherlands

<sup>2</sup> Ear Science Institute Australia, Subiaco, Australia

<sup>3</sup> Ear Sciences Centre, The University of Western Australia, Nedlands, Australia

<sup>4</sup> Department of Speech Language Pathology and Audiology, University of Pretoria, Pretoria, South Africa

<sup>5</sup> Faculty of Medicine & Health Sciences, University of Nottingham, Nottingham, UK

<sup>6</sup> School of Psychological Science, The University of Western Australia, Nedlands, Australia

<sup>7</sup> Busselton Population Medical Research Institute, Busselton, Australia

<sup>8</sup> School of Population and Global Health, The University of Western Australia, Nedlands, Australia

#### Introduction:

Tinnitus is a heterogeneous condition. Not only can the tinnitus itself be chronic and disabling, but also accompanying general health issues and hearing-related symptoms can have an impact on daily life.

In this study we assessed tinnitus, general health status and hearing status in a large population cohort study.

#### Materials & Methods:

This study uses data from the Busselton Healthy Ageing Study (BHAS), which recruited people in Busselton (Western Australia) born 1946 to 1964. Data were collected between 2010 and 2015.

Logistic regression was used to examine general health (assessed using the SF12PCS) of individuals with and without self-report of tinnitus. Differences in air audiometry at 250 to 8000 Hz were analysed by t-tests.

#### Results:

Of 5107 participants, 1154 (22.6%) experienced tinnitus. Of those, 376 (7.4%) reported that their tinnitus occasionally had an effect on their daily life, whilst a further 104 (2.0%) the effect on their daily life was frequent or constant. Logistic regression showed that the odds ratio for having a lower general health score (SF12PCS) was 0.980 (0.973-0.986); mean (SD) = 48.50 (9.98) versus 50.31 (8.78) for those with and without tinnitus respectively. Individuals who experience their tinnitus as having an effect on their daily life (occasionally, frequently or constantly), have an increased risk of having a lower general health OR 0.96 (0.95-0.97) than those without tinnitus; mean (SD) = 50.07 (8.86) versus 46.22 (11.11) respectively.

There were statistically significant worse hearing thresholds related to the presence of tinnitus, with mean differences increasing from 1.4dB to 12.3dB for 250Hz to 8000 Hz.

#### Conclusion:

The BHAS cohort is the first population study of general health and audiometric data related to tinnitus. Clinicians should consider the general health and hearing level of all of their tinnitus patients, as these comorbidities may interact with tinnitus.

## S01-O3

### Tinnitus and mental health of Baby Boomers: a population study

*Inge Stegeman<sup>1</sup>, Robert H Eikelboom<sup>2,3,4</sup>, Marcus D Atlas<sup>2,3</sup>, Rebecca J Bennett<sup>2,3</sup>, David Baguley<sup>5</sup>, Romola S Bucks<sup>6</sup>, Michael Hunter<sup>7,8</sup>, Dona Jayakody<sup>2,3</sup>, Diane Smit<sup>1</sup>, Susan Tegg-Quinn<sup>2,3</sup>*

<sup>1</sup> Department of Otorhinolaryngology, Head and Neck Surgery, University Medical Center Utrecht, Utrecht, The Netherlands

<sup>3</sup> Ear Sciences Centre, The University of Western Australia, Nedlands, Australia

<sup>4</sup> Department of Speech Language Pathology and Audiology, University of Pretoria

<sup>5</sup> Faculty of Medicine & Health Sciences, University of Nottingham, Nottingham, UK

<sup>6</sup> School of Psychological Science, The University of Western Australia, Nedlands, Australia

<sup>7</sup> Busselton Population Medical Research Institute, Busselton, Australia

<sup>8</sup> School of Population and Global Health, The University of Western Australia, Nedlands, Australia

#### Introduction

Although tinnitus is well known to be chronic and potentially disabling, the accompanying mental wellbeing assessed with markers of depression, anxiety and stress has to date been under-reported, usually only based on clinical samples.

The present study assessed the association between tinnitus and mental health measures in a large population study.

#### Materials & Methods:

This study uses data from the Busselton Healthy Ageing Study (BHAS), which recruited people living in Busselton (Western Australia) born 1946 to 1964. Physical and self-reported data were collected between 2010 and 2015.

We assessed the relationship between mental wellbeing (DASS21: Depression Anxiety and Stress Scale), and tinnitus (self-report) and its effect daily life (as occasional, frequent or constant; i.e. burden). Logistic regression was used to assess differences in mental wellbeing for participants with and without tinnitus (presence and burden).

#### Results:

Of the 5107 participants recruited, 22.6% experienced tinnitus; 46% experienced intermittent tinnitus, and 54% constant tinnitus. Of those with tinnitus, 7.4% participants reported that tinnitus occasionally had an effect on their daily live, and 2.0% reported a frequent or constant effect. The odds ratio for someone with tinnitus classified with Extremely Severe Depression (ESD), stress and anxiety based on the DASS21 sub-scores were 1.61 (95%CI=1.39-2.02), 1.48 (95%CI=1.16-1.89) and 1.52 (95%CI=1.19-1.94) respectively. Participants with tinnitus more often had been diagnosed with depression than participants without tinnitus (OR=1.3;95%CI=1.02-1.68).

Individuals who experience their tinnitus as having an effect on their daily life (occasionally, frequently or constantly), have an increased risk of having depressive symptoms (DASS21 ESD OR=1.79, 95%CI 1.23-2.61).

#### Conclusion:

Individuals with tinnitus have a poorer mental health, which is worse still in those where tinnitus affects their daily lives. This suggests that a multidisciplinary clinical approach involving both audiologists and psychologists may be warranted for patients reporting that tinnitus interferes with their daily lives.

## **S01-O4**

**Jorge Simões, Dr. Martin Schecklmann Prof. Dr. med. Berthold Langguth, Dr.  
Winfried Schlee, Dr. Patrick Neff**

*The Influences of Personality on Tinnitus Distress: A Longitudinal Study*

Tinnitus loudness and hearing loss characteristics cannot fully explain the distressfulness of the condition, suggesting that other characteristics may account for tinnitus perception and intrusiveness. Previous studies investigated the role of personality on tinnitus distress, indicating high neuroticism and low extraversion to be associated with higher scores in the Tinnitus Handicap Inventory (THI) and Tinnitus Questionnaire (TQ). However, little is known about the role of personality on tinnitus distress over time.

388 patients who visited the Tinnitus Clinic Center in Regensburg between 2012 and 2017 received a letter, between March and July of 2018, containing the THI, TQ, and the Big Five Index 2 (BFI-2). Traits and facets of the BFI-2 were used as independent variables in a multiple linear regression setup, and THI and TQ scores were used as dependent variables.

First, we tried to replicate previous results using the big five as independent variables with the THI and the TQ as dependent variables. In both regression setups neuroticism and extraversion were significant predictors of distress. Second, we found that the facets of neuroticism “depression” and “emotional volatility” were positively and negatively associated with distress. Regarding extraversion, the facet “energy” was a statistically significant predictor in the regression setup with the THI as dependent variable. Third, we investigated whether personality traits could explain the difference in the THI and TQ scores over time, but no trait was statistically significant. And fourth, we compared the personality profile patients in three categories: “clinically improved”, “clinically stable”, and “clinically worsened”. Those categories were based on previous literature. Patients in the “clinically improved” and “clinically stable” groups scored lower in neuroticism and higher in extraversion than patients in the group “clinically worsened”.

Personality may be a predictor of tinnitus distress over time. Future studies should address whether personality has an effect on the outcome of clinical treatments.

## **S01-O5**

### **The effects of Parental Mental Health in childhood in coping with tinnitus and hyperacusis in adulthood**

*Ali A. Danesh, PhD<sup>1</sup>, Hashir Aazh, PhD<sup>2</sup>, Langguth Berthold, MD<sup>3</sup> & Brian C. J. Moore, PhD<sup>4</sup>*

<sup>1</sup> Professor, Departments of Communication Sciences & Disorders and Clinical Biomedical Sciences, Florida Atlantic University, Boca Raton, FL, USA

<sup>2</sup> Tinnitus Clinician & Audiologist, Audiology Department, Tinnitus & Hyperacusis Therapy Specialist Clinic, Royal Surrey County Hospital, Guildford, UK

<sup>3</sup> Professor, Department of Psychiatry, Regensburg University, Regensburg, Germany.

<sup>4</sup> Professor, Department of Psychology, University of Cambridge, Cambridge, UK

#### **Introduction:**

This presentation concentrates on parental separation and parental mental health as two key factors that may influence coping with tinnitus and hyperacusis in adulthood. One of the major risk factors in children and adults for mental health disorders is parental mental health and its effects on tinnitus and hyperacusis. This risk has not thoroughly been investigated. Additionally, it is not clear if there is a relationship between parental separation and its impact on perceived disability from tinnitus and hyperacusis in adulthood.

#### **Material & Method:**

Employing a retrospective cross-sectional study with a correlational design, the effects of parental mental health on tinnitus and hyperacusis of a group of sequential patients who attended a clinic in UK were investigated (N=287, Mean Age=52.5 years). The association between mental health and tinnitus/hyperacusis perception was explored by measuring the associated anxiety and depression via the Generalized Anxiety Disorder questionnaire (GAD-7) and the Patient Health questionnaire (PHQ-9). The effects of parental separation also were studied using a retrospective cross-sectional design and the data from 184 consecutive patients.

#### **Results:**

Regression analysis showed that parental mental illness significantly increased the risk of anxiety and depression, with unadjusted odds ratios (ORs) of 2.7 (95% confidence interval [CI]: 1.5-4.9,  $p = 0.001$ ) for the PHQ-9 and 2.6 (95% CI: 1.4-4.8,  $p = 0.002$ ) for the GAD-7. For the second investigation, 14.7% of patients reported that while they were growing up, their parents were separated or divorced. The adjusted OR for a subgroup of patients with a diagnosis of hyperacusis was 6.7 ( $p = .011$ ), indicating a stronger relationship for this subgroup.

#### **Conclusion:**

Clinicians offering tinnitus and hyperacusis rehabilitation should screen patients for parental mental illness in childhood, especially for those with comorbid depression. Future research should analyze the breadth and type of adverse childhood experiences among patients with tinnitus and hyperacusis and their relationship with mental problems and treatment efficacy.

## **S01-S1**

### **Tinnitus in Adolescents – a Survey of Secondary School Students**

*Anna C.S. Kam*

*Department of Special Education and Counselling, The Education University of Hong Kong*

*Integrated Centre of Wellbeing (I-WELL), The Education University of Hong Kong*

#### **Introduction:**

The prevalence and risk factors of tinnitus have been extensively studied in adults but only a few population studies have been performed in children or adolescents. The reported tinnitus prevalence in children and adolescents ranges from 6 to 36%. There is a large inter-study variability due to the difference in study population, definition of tinnitus, and methodologies employed. This study aims to investigate the prevalence and risk factors of tinnitus in a sample of adolescents.

#### **Material & Method:**

In this cross-sectional study, 276 secondary students were surveyed for the presence of tinnitus and its impact, health factor, recreational noise exposure, psychological factor, and socioeconomic status. Tinnitus impact was measured by the Tinnitus Functional Index. All students were screened for possible hearing loss with pure-tone audiometry. Audiological information on pure-tone thresholds, tympanometry, otoacoustic emission and otoscopy were obtained in respondents who have experienced tinnitus that last more than 5 minutes in the past 12 months.

#### **Results:**

91 out of 276 students (33.0%) reported that they have experienced tinnitus. Only 6 of them (2.2% of the total sample) reported that they have experienced tinnitus that last more than 5 minutes in the past 12 months. Recreational noise exposure, ear disease, and family history are significantly associated with tinnitus.

#### **Conclusion:**

The results suggest that the prevalence of tinnitus in adolescents may be over-estimated. Further study in a larger sample size is needed.

## S01-S3

### **Epidemiology of Clinically Significant Tinnitus: A 10-Year Trend From Nationwide Health Claims Data in South Korea.**

*Lee HM1, Han KD2, Kong SK3, Nam EC4, Park SN5, Shim HJ6, Byun JY7, Park HJ8, Im GJ9, Lee IW1.*

- 1. Department of Otorhinolaryngology-Head and Neck Surgery, Pusan National University School of Medicine, Pusan National University Yangsan Hospital, Yangsan.*
- 2. Department of Biostatistics, College of Medicine, The Catholic University of Korea, Seoul.*
- 3. Department of Otorhinolaryngology-Head and Neck Surgery, Pusan National University School of Medicine, Pusan National University Hospital, Busan.*
- 4. Department of Otolaryngology, School of Medicine, Kangwon National University, Chuncheon.*
- 5. Department of Otorhinolaryngology-Head and Neck Surgery, College of Medicine, The Catholic University of Korea.*
- 6. Department of Otorhinolaryngology, Eulji Medical Center, Eulji University School of Medicine.*
- 7. Department of Otorhinolaryngology-Head and Neck Surgery, School of Medicine, Kyung Hee University.*
- 8. Department of Otorhinolaryngology-Head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine.*
- 9. Department of Otorhinolaryngology-Head and Neck Surgery, College of Medicine, Korea University, Seoul, Republic of Korea.*

#### **OBJECTIVES:**

Prevalence of tinnitus has been reported to vary according to the target population and definition of tinnitus. To improve the understanding of tinnitus, authors used the nationwide health claim data to study the tinnitus in the entire population of South Korea.

#### **STUDY DESIGN:**

Retrospective big data review.

#### **SETTING:**

Analysis of big data from the National Health Information Database.

#### **PATIENTS:**

Patients diagnosed with tinnitus according to International Classification of Diseases code 10th edition (ICD-10) and requested to receive National Health Insurance claim at least once from January 2006 to December 2015.

#### **MAIN OUTCOME MEASURE:**

Epidemiologic data, association of tinnitus with the otologic and systemic diseases.

#### **RESULTS:**

The number of patients who received medical care because of tinnitus was 1.44% (0.78 million per 51 million) in 2015. There was a higher prevalence of tinnitus in women, and the overall prevalence increased with increasing age of patients and peaked at patients in their 70s (4.43%). The prevalence of tinnitus among patients aged 10 to 30 years, showed a tendency to increase during study period. In the regional analysis, highest prevalence was observed in Gwangju (2.02%). In comparison with the control group, the patients with tinnitus showed a higher frequency in otologic and systemic disease. Especially, noise induced hearing loss (adjusted odds ratio [AOR]=82.1, 95% confidence interval [95% CI]=74.8-90.2) and sudden sensorineural hearing loss (AOR=49.7, 95% CI=48.4-51.0) showed high frequency in tinnitus patient group.

#### **CONCLUSIONS:**

The prevalence and incidence of tinnitus in this study for entire nation were lower than previously reported studies. These results have limitation because the study only covered patient using the medical service for tinnitus and missed tinnitus sufferers not seeking medical service. However, this study is meaningful in that it was targeting entire nation, reflected the characteristics of clinically significant tinnitus patient enough to visit medical service.

## **S02-O1**

### **The gap-pre-pulse inhibition of the acoustic startle reflex: statistics, criticism and future applications**

*Achim Schilling, Patrick Krauss, Konstantin Tziridis, Holger Schulze*

#### **Introduction**

One central challenge for scientists investigating the neurophysiology of tinnitus in animal models is the fact that a reliable behavioral paradigm for the detection of the presence of a tinnitus percept is needed. When Turner and coworkers introduced the gap-pre-pulse inhibition of the acoustic-startle-reflex (GPIAS), more time-consuming methods based on conditioning of the animals were replaced in many laboratories. The novel paradigm is based on the hypothesis that a tinnitus percept masks a gap of silence in a surrounding band noise of equal spectral composition compared to the tinnitus percept (“filling-in-hypothesis”). The degree of masking is determined by GPIAS.

#### **Materials and Methods**

Although the paradigm resolves the problem of pre-training, the validity of this paradigm is still controversially discussed for several reasons. First, up to now there is no standardized statistical approach for the paradigm and second, the “filling-in-hypothesis” is often criticized. We used our “open-source startle setup” to perform several control experiments to validate the paradigm.

#### **Results**

Here, we present a novel statistical approach to the GPIAS paradigm based on effect size rather than p-values. Furthermore, we provide an experiment based on cortical lesions of the animals indicating that cortical effects can be determined and investigated using the GPIAS paradigm, a major point of criticism. Finally, we extended the paradigm to the detection of Zwicker tone percepts (phantom percept after notched noise presentation) in animals.

#### **Discussion**

We were able to show that the paradigm, though the startle-reflex exclusively involves brainstem regions, is suitable for the detection of tinnitus. Furthermore, our lesion studies demonstrate a cortical influence on GPIAS. Finally, we provide the first indication for the suitability of a modified version of the paradigm for Zwicker tone screening.



## **S02-O2**

### **Effect of salicylate-induced tinnitus on hearing thresholds**

*Veralice Lanaia*<sup>1</sup>, *Konstantin Tziridis*<sup>2</sup>, *Holger Schulze*<sup>3</sup>

<sup>1 2 3</sup> Experimental Otolaryngology, Clinic of Otorhinolaryngology, Friedrich-Alexander University Erlangen-Nürnberg, Erlangen, Germany

#### **Introduction**

A model for tinnitus development based on stochastic resonance that was recently proposed by our laboratory predicts that hearing thresholds should be improved in tinnitus. The main objective of this study therefore was to characterize the effect of the salicylate on Auditory Brainstem Responses (ABR) and the possibly induction of tinnitus as assessed by behavioral testing (gap-prepulse inhibition of the acoustic startle reflex, GPIAS) in Mongolian gerbils.

#### **Material & Method**

So far, a total number of 13 animals were measured using the GPIAS and the ABR paradigms one week before and 20 min after salicylate (S) or saline (control, C) injection, using four different test frequencies (1, 2, 4, and 8 KHz). We analyzed frequency specific differences in the startle reflex after salicylate or saline injection and correlate this data with possible differences in the ABR.

#### **Results**

Preliminary data show a significant linear association between the frequency specific GPIAS effect size and  $\Delta$  hearing threshold, indicating that stronger tinnitus percepts are associated with a higher reduction in hearing threshold. In particular, the control group generally shows a positive effect size, while the salicylate group mostly shows a negative effects size, indicating the presence of a tinnitus percept.

#### **Conclusion**

Salicylate induced tinnitus can be assessed by the GPIAS paradigm. Remarkably, salicylate treated individuals seemed to perceive tinnitus percepts at different frequencies and not only a broadband tinnitus as stated in the literature. In line with our model, the strength of the tinnitus percept (negative effects size) correlated well with the amount of the hearing threshold improvement.

## **S02-O3**

### **Expression of Immediate-Early Genes in Rat with Noise-Induced Tinnitus**

*Ho Yun Lee*<sup>1</sup>, *Yong-Ho Park*<sup>2</sup>, *Sun Ae Shin*,<sup>3,4</sup> *Ah-Ra Lyu*<sup>3,4</sup>

<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, Eulji University, Daejeon, South Korea

<sup>2</sup>Department of Otolaryngology-Head and Neck Surgery, Chungnam National University, Daejeon, South Korea

<sup>3</sup> Department of Medical Science, Chungnam National University, Daejeon, Korea

<sup>4</sup>Brain Korea 21 PLUS Project for Medical Science, Chungnam National University, Daejeon, Korea.

#### **Introduction:**

Various areas of the brain are thought to be involved in the development of tinnitus. We aimed to observe the changes of immediate-early genes (IEGs) in the auditory pathways and limbic system in the noise - induced tinnitus animal model.

#### **Material &Method:**

Rats were exposed to noise only in the left ear. Serial prepulse inhibition of the acoustic startle was evaluated to determine whether the rats had tinnitus. Western blot was performed to measure expression of EGR-1, c-fos in the various brain regions before and after noise exposure.

#### **Results:**

In the cochlear nucleus, the expression of EGR-1 and expression of c-fos differed between time points ( $p < 0.01$ ). Compared with the normal control, increased expression of c-fos on day 14 and the expression of EGR-1 decreased on day 3 and 28 was observed ( $p < 0.05$ ). On day 3 in the auditory cortex, the abrupt decrease and then increase of EGR-1 expression were remarkable. The expression patterns of IEGs in the hippocampus were similar to cochlear nucleus. In the amygdala, changes in the expression of IEGs were not significant ( $p > 0.05$ ). Compared to right side, expression of IEGs on the left side tended to increase in the cochlear nucleus, auditory cortex and hippocampus except amygdala.

#### **Conclusion:**

Sustained neuronal activity in cochlear nucleus may be the main focus that causes tinnitus. In addition, neuronal changes in auditory cortex and hippocampus were also observed to a lesser extent.

## S02-O4

### Acute time course changes in extracellular amino acids in the cochlear nucleus and inferior colliculus following acoustic trauma in rats

Yiwen Zheng<sup>1,2,3</sup>, Huey Tieng Tan<sup>1,2,3</sup>, Julius Bird-Cohen<sup>1,2,3</sup>, Sophie Wong<sup>1,2,3</sup>, Paul F. Smith<sup>1,2,3</sup>

<sup>1</sup> Department of Pharmacology and Toxicology, School of Biomedical Sciences, University of Otago, New Zealand

<sup>2</sup> Brain Research New Zealand

<sup>3</sup> Eisdell Moore Centre for Research on Hearing and Balance Disorders, New Zealand

#### Introduction:

Animals exposed to tinnitus-inducing acoustic trauma have shown increased spontaneous neuronal firing rates, synchronized firing as well as reorganised tonotopic maps in the auditory pathways. An imbalance between inhibitory and excitatory neurotransmission has been suggested as part of the underlying mechanisms. However, the neurochemical basis of tinnitus remains elusive. This study investigated dynamic changes in amino acid concentrations in the extracellular space within both the cochlear nucleus (CN) and the inferior colliculus (IC) of rats following acoustic trauma using *in vivo* microdialysis.

#### Material & Method:

Male Wistar rats (300 - 350 g) were divided into sham and acoustic trauma groups (n = 4 - 5 per group) and anaesthetised with urethane (1.5 g/kg). A microdialysis probe was inserted into either the CN or IC and perfused with artificial cerebrospinal fluid. After 2 h equilibration, samples were collected every 30 min for 1 h to establish the baseline and then every 30 min during and up to 5 h after acoustic trauma. Amino acid concentrations in the microdialysates were analysed using high performance liquid chromatography coupled to an electrochemical detector.

#### Results:

Data were expressed as percentage changes from the baseline concentration and analysed using either a linear mixed model or a generalized estimating equations. Acoustic trauma caused a time-dependent increase in glutamate ( $P \leq 0.0001$ ) in the CN and taurine ( $P \leq 0.05$ ) in the IC. There were no significant changes for other amino acids measured.

#### Conclusion:

Since alterations of extracellular levels of amino acids are likely to reflect functional changes in the brain, our results provide insights into the understanding of the dynamic and location specific neurochemical changes at early time points following acoustic trauma.

## **S02-O5**

### **Effect of noise trauma on the intracortical processing in the auditory cortex**

*<sup>1</sup>Parameshwarappa, V., <sup>2</sup>Pezard, L., <sup>3</sup>Norena, A.*

<sup>1</sup> Aix-Marseille Université and Centre National de la Recherche Scientifique (CNRS)

<sup>2</sup> Aix-Marseille Université

<sup>3</sup> Aix-Marseille Université and Centre National de la Recherche Scientifique (CNRS)

#### **Introduction:**

Noise induced hearing loss has been shown to result in neural hyperexcitability in the central auditory system (AI), including the auditory cortex. Enhanced spontaneous activity may give rise to tinnitus and enhanced sound-induced activity may result in hyperacusis. The mechanisms leading to these neural changes are still unclear, in particular in the auditory cortex which is composed of 6 different layers and where the sensory processing is particularly complex. One notes that cortical recording are usually made in layer III-IV, namely at the depth of the thalamo-cortical inputs. Our study is aimed at assessing the changes in intracortical processing at different cortical layers of the auditory cortex following noise trauma in order to give insights into the mechanisms of tinnitus (and hyperacusis).

#### **Material & Method:**

Experiments were conducted on anesthetized guinea pigs before and after noise trauma (115 dB SPL, 8 kHz continuous tone, 1hour). Local field potentials (LFP) and multi-unit activity (MUA) was recorded from the primary auditory cortex and assessed for both spontaneous and evoked neural activity (pure tones and multi-tones stimulus). Current Source Density (CSD) method was used to analyze changes in auditory cortex microcircuitry. Alterations in multi unity activity, in terms of tuning curve and spontaneous activity are analyzed. Phase Locking Value (PLV) is used to assess changes in temporal coherence between the different cortical depths.

#### **Results:**

After trauma an increase in spontaneous activity was observed at all cortical depths. CSD analysis applied to mean post stimulus LFP demonstrates changes in amplitude and latency of current sinks at different cortical depths after noise trauma compared to before. These changes were observed for both pure tone and multi tone stimulus evoked activity. Also, unmasking of new current sinks in the supragranular (I & II layers) and infragranular (V & VI layers) layers were observed. PLV across the cortical layers with reference to a granular layer (layer IV) showed an increase in temporal coherence between infragranular layers and the granular layer for frequencies above 12 Hz.

#### **Conclusion:**

We conclude that noise trauma alters the intracortical processing in the primary auditory cortex resulting in abnormal neural activity, which may eventually give rise to tinnitus. These findings are pivotal to understanding mechanisms of neural information processing and flow in the auditory cortex circuitry before and after noise trauma.

## **S02-O6**

### **Central tinnitus induced by optogenetic modulation of inhibitory neural circuits in the auditory midbrain**

*Xiao-Peng Liu<sup>1,2</sup>, Fei Li<sup>3</sup>, Guo-Qiang Bi<sup>3</sup>, Pak-Ming Lau<sup>3</sup>, Lin Chen<sup>1</sup>*

<sup>1</sup> Auditory Research Laboratory, University of Science and Technology of China

<sup>2</sup> Center for Hearing and Deafness, State University of New York at Buffalo

<sup>3</sup> Laboratory of Neurophysics and Neurophysiology, University of Science and Technology of China

#### **Introduction:**

Tinnitus is generally believed to stem from negative plastic changes in the central auditory system that are triggered by insult to the auditory periphery. Thus, tinnitus of such a type is actually generated from the auditory center and is called central tinnitus. One problem encountered during research into central tinnitus is that the data are often confounded by the peripheral factors, such as hearing loss. In the present study, we intended to develop an animal model of central tinnitus with an intact auditory periphery using optogenetic approach.

#### **Material & Method :**

In the VGAT-ChR2 transgenic mouse, we implanted a chronic optic fiber to deliver a laser light (wave length: 473 nm) to the inferior colliculus, an important nucleus of the auditory midbrain. The light selectively activated inhibitory neurons, rather than excitatory neurons, for 60 hours. A two-way-choice behavioral protocol was designed to detect any tinnitus-like behavior upon optogenetic stimulation. In some animals, a chronical electrode array were implanted along with the optic fiber for extracellular recordings before and after optogenetic treatment.

#### **Results:**

Two hours following offset of the optogenetic stimulation, a tinnitus-like behavior was observed and lasted up to 24 hours. Extracellular recordings showed an increase in tuning, synchronization and burst firing in neurons of the inferior colliculus. There was no change in auditory sensitivity as indicated by the auditory brainstem response.

#### **Conclusion:**

Optogenetic modulation of neural circuits in the auditory center is a new approach to developing animal models of tinnitus. Using this new model, we have provided a robust support for the central-origin-theory of tinnitus.

## **S02-O7**

### **Sound-evoked functional magnetic resonance imaging of hyperacusis in rats**

*Eddie Wong<sup>1,2</sup>, Kelly Radziwon<sup>3</sup>, Guang-Di Chen<sup>3</sup>, Benjamin Auerbach<sup>3</sup>, Ed Wu<sup>2</sup>, Richard Salvi<sup>3</sup>, Condon Lau<sup>1</sup>*

<sup>1</sup> Department of Physics, City University of Hong Kong, Hong Kong SAR, China

<sup>2</sup> Department of Electrical and Electronic Engineering, University of Hong Kong, Hong Kong SAR, China

<sup>3</sup> Department of Communicative Disorders and Sciences, University at Buffalo, State University of New York, New York, USA

#### **Introduction:**

Functional magnetic resonance imaging (fMRI) with acoustic stimulation has long been used in human subjects. fMRI non-invasively provides a whole-brain view of the physiological response to sounds. Due to limitations in human subjects research, animal models of auditory conditions are important. However, fMRI is less developed for animals, especially rats commonly used in hearing research. In this report, we present sound-evoked fMRI of the rat sodium salicylate tinnitus/hyperacusis model.

#### **Material & Method:**

Animal subjects - Male Sprague-Dawley rats were employed and housed under standard conditions. Subjects behaviorally evaluated for tinnitus and hyperacusis were at the University at Buffalo, State University of New York. Subjects who underwent fMRI were at the City University of Hong Kong.

Tinnitus/hyperacusis induction - Subjects were administered sodium salicylate (Sigma Aldrich) in saline at 250 mg/kg body weight via intraperitoneal injection. Testing was performed 2 hrs after administration. Control measurements were performed on the same subject using an equal volume of saline.

Hyperacusis evaluation - Subjects were behaviorally evaluated for hyperacusis using an operant conditioning paradigm that measured reaction time to broadband noises (see Radziwon, Hearing Research, 2017).

fMRI - Brain responses to high sound pressure level (SPL ~90 dB) tonal sounds (8, 16, 32 kHz) were measured with fMRI (see Yang, JASA, 2018 and Lau, NeuroImage, 2015).

#### **Results:**

Salicylate lengthens reaction time to low SPL sounds (< 50 dB) and shortens reaction time to high SPL sounds ( $\geq$  60 dB). Reduced reaction time to sound has been correlated with increased perceived loudness. Salicylate elevates responses to high SPL sound, starting from the midbrain inferior colliculus and extending up to the cortex.

#### **Conclusion:**

Sound-evoked fMRI is an excellent method for studying auditory conditions in animal models. It can guide further studies with specific methods such as electrophysiological recordings and immuno/genetic assays by providing a "map" of brain responses. fMRI also helps translate animal findings to humans.

## **S02-S1**

### **Development of treatment agents for tinnitus using animal models**

*Yun-Hoon Choung, Oak-Sung Choo*

Department of Otolaryngology, Ajou University School of Medicine, Suwon,  
Republic of Korea

#### **Introduction:**

Tinnitus is a phantom sound without sound stimulus. In the present study, tinnitus animal models were constructed via noise exposure, and the presence of tinnitus was confirmed via Gap Pre-pulse Inhibition of Acoustic Startle (GPIAS). Then, a natural product, *Vitis vinifera* leaves dry extract(VLE) was evaluated for its treatment effects on animal models with tinnitus.

#### **Material &Method:**

Male 8-week-old Sprague Dawley (SD) rats were exposed to narrow-band noise of 112dB SPL (bandwidth 100Hz) at 16kHz for 4 hours and auditory brainstem response test was performed to evaluate hearing loss. Tinnitus was confirmed by GPIAS measuring equipment. Rats were divided into control, noise and VLE groups. The VLE group was sub-classified into the VLE-1w and VLE-2w groups according to the administration period. After VLE administration, ABR and GPIAS were compared among four groups.

#### **Results:**

Hearing loss was not detected after noise exposure in all animals. GPIAS values were significantly higher in the VLE-1w and VLE-2w groups than in the noise group, but GPIAS values from the VLE-1w group decreased after 1 week of VLE discontinuation, showing similar results with the noise group. Hematoxylin and eosin staining showed no differences in number of hair cells among any of the groups, however, structural changes in the nuclei of spiral ganglion neurons were detected in the noise group compared to the other groups.

#### **Conclusion:**

From our study, VLE effectively decreased tinnitus in animal models indicating the potential of VLE as one of the treatment agents for treating tinnitus.

## **S02-S2**

### **Association between Stress and Tinnitus: An experimental study in a rat model of stress-induced tinnitus**

*Shi Nae Park, Min Jung Kim, Jung Mee Park, So Young Park  
Department of Otorhinolaryngology-Head and Neck Surgery, College of Medicine,  
The Catholic University of Korea, Seoul, Republic of Korea*

#### **Background:**

Although there have been many studies showing possible relationship between tinnitus and stress, there was no report which demonstrates a direct causal relationship between stress and tinnitus. We performed this experimental study to prove causal relationship between tinnitus and stress in an animal model of tinnitus.

#### **Methods:**

Male Wistar rats aged 1 month were used and subgrouped according to the single or double stimuli of noise and stress. Noise stimulus was given to noise stress (NS) group by 110 dB SPL, 16 kHz narrow band noise for 1hr. Restraint was given to restraint-induced acute stress (RIAS) group with taped plastic film envelopes for 1hr. ABR thresholds and DPOAEs were recorded before and after the noise and stress stimuli. Tinnitus was assessed by gap-prepulse inhibition of the acoustic startle reflex (GPIAS) by obtaining GN ratios. Stress hormones and relevant neurotransmitter receptors, NMDA and GABA receptors (NMDAr and GABAr) were observed in the cochlea and the brain hippocampal tissues.

#### **Results:**

Not increased ABR thresholds but significantly decreased DPOAE responses were observed after 1 hr noise stimuli in NS groups. RIAS only group, without changes in hearing level, showed increased GN ratio compared to the control group ( $P<0.05$ ), which indicates that stress alone can cause tinnitus. Dual stimuli of noise and stress groups showed more significantly increased GN ratios than control group. In western blot of whole hippocampus, GABAr was significantly decreased in RIAS +NS group ( $P<0.05$ ). Immunofluorescence staining of CA3 area of hippocampus showed increased expression of NMDAr in the experimental groups and decreased expression of GABAr compared to the control group ( $P<0.05$ ).

#### **Conclusion:**

Tinnitus was obviously generated after noise and/or restraint stress. Even restraint stress alone caused tinnitus, which is a novel and interesting finding showing a direct causal relationship between stress and tinnitus. The result of this study, the imbalance of the excitatory and inhibitory neurotransmitters in the hippocampus of the rats with tinnitus following noise and/or restraint stress, is the first evidence demonstrating tinnitus-related changes of neuronal activity in the nonauditory brain area.



### **S03-O1**

#### **Stochastic resonance model of tinnitus development: Support from tinnitus patients' data**

Tinnitus affects 10 to 15% of the population. Consensus exists on hearing loss as a primary cause of it. The exact mechanism of development is still under debate.

Recently, we proposed a new model of tinnitus development in which information transmission into the hearing system is constantly optimized by physiological neuronal processes (stochastic resonance, SR), thereby reducing hearing loss<sup>1</sup>. In this view, tinnitus develops as a side effect of SR, in the frequency range of the hearing impairment. This hypothesis is supported by animal model data and data from a collective of more than 40.000 patients with and without tinnitus. As the human data in that collective show large variability, we here analyzed the anamnesis of the tinnitus patients and distinguished between patients with tinnitus as the explicit reason for ENT-consultation (Te) and those that came for another reason (Ta).

In this study, anamnesis of 575 tinnitus patients (48.3% women, 1150 ears) of different ages (ranging from 19 to 90 years) have been investigated (Te: n=132, Ta: n=443). Multifactorial ANOVAs revealed - independent of age – that the hearing thresholds of Te patients were significantly better than those of Ta patients and that their tinnitus loudness was significantly higher. Additionally, the tinnitus frequencies match the range of the worst hearing thresholds. These results are perfectly in line with the predictions of our SR model.

In conclusion, analyzing human patient data we could demonstrate that tinnitus severeness positively correlates with the beneficial effect on hearing thresholds, hence supporting our hypothesis of an SR-based physiological mechanism that aims to improve hearing thresholds after hearing loss and produces tinnitus as a side product.

<sup>1</sup> Krauss et al., 2016. Stochastic resonance controlled upregulation of internal noise after hearing loss as a putative cause of tinnitus-related neuronal hyperactivity. Front. Neurosci.

## **S03-O2**

### **Clinical characteristics of patients with subjective tinnitus with and without temporomandibular disorders**

*A. van der Wal, S. Michiels, P. van de Heyning, M. Braem, A. Gilles, V. Topsakal, C. Visscher, W. De Hertogh*

#### **Background**

Subjective tinnitus can be influenced by the temporomandibular somatosensory system, then called temporomandibular somatic or somatosensory tinnitus (TST). TST can be explained via existing connections between the dorsal cochlear nucleus (DCN) and the medullary somatosensory nuclei. The higher prevalence of tinnitus in patients with temporomandibular disorders (TMD) (30.4% to 64%), compared to general population (10% to 15%) illustrates this neurophysiological model. Treating TMD to decrease tinnitus severity has been described. Information about the type of masticatory dysfunctions in patients with TST and non-TST is currently lacking. This is however mandatory to guide appropriate treatment.

The purpose of this study is to compare the clinical characteristics of both tinnitus and TMD in patients with only tinnitus and in patients with tinnitus and TMD.

#### **Methods**

Patients were recruited by otolaryngologists at a tertiary tinnitus clinic. All patients were assessed based on medical history, Ear-Nose-Throat (ENT) examination with audiometry and brain MRI (Magnetic Resonance Imaging) to exclude any objective case of tinnitus. Based on the subsequent ENT diagnoses two groups were created: one group with TST (according to the diagnostic criteria for ST of Michiels et al. 2018) and a second group with other types of subjective tinnitus (non-TST group). Tinnitus and TMD characteristics were compared.

#### **Results**

In total 47 patients with TST and 99 patients with non-TST were included. No significant differences in tinnitus characteristics were found.

In comparison with the non-TST group, patients with TST presented more frequently with bruxism (87% versus 12%), jaw myalgia (87% versus 12%) and jaw arthralgia (16% versus 0%).

#### **Conclusions**

Bruxism and jaw myalgia appear be the most frequent dysfunctions in patients with TST. Both dysfunctions can be targeted with non-invasive treatment. The effect hereof on tinnitus remains to be determined.

### **S03-O3**

#### **vHIT results of vestibular schwannoma**

*Jingjing Wang<sup>1</sup>, Zhengnong Chen<sup>1</sup>, Shan-Kai Yin<sup>1</sup>*

1Otolaryngology Institute, Affiliated Sixth People's Hospital, Shanghai Jiao Tong University

#### **Introduction**

Because of slow tumor growth and central compensation, vestibular symptoms such as vertigo and nystagmus in vestibular schwannoma(VS) patients are often mild. However, 40% to 75% of the patients present vestibular symptoms at the time of diagnosis. Previous studies presented that vertigo can reduce the quality of life and is a risk factor for future work disability in VS patients. VS management has traditionally focused on tumor growth, facial nerve function, and hearing function, whereas outcomes related to vertigo and dizziness are rarely reported. The objective of this study was to evaluate vestibular function in VS patients.

#### **Material &Method**

Subjects included 32 patients who were definitively diagnosed with VS between August 2017 and January 2019, the vHIT was performed in all patients and the value of vestibulo-ocular reflex (VOR) gains (vHIT-G) were compared. The purpose is to evaluate the severity and extent of canals affected in VS.

#### **Results**

The mean value of vHIT-G of the anterior semicircular canal(AC), horizontal semicircular cana(HC) and posterior semicircular canal(PC) of affected side were  $0.58 \pm 0.18$ ,  $0.94 \pm 0.36$  and  $0.65 \pm 0.31$  respectively in VS patients, differences were significantly( $p = 0.01$ ). 50% patients had normal vHIT. 66.7% patients might have superior vestibular nerve (AC, HC) dysfunction, and 66.7% patients might have inferior vestibular nerve (PC) dysfunction. Tumor size was not correlated with the values of three semicircular canals of affected side.

#### **Conclusion**

vHIT is an effective tool in measuring all three canals function in VS patients. The anterior semicircular canal and horizontal semicircular canal was mostly affected in VS patients.

## S03-O4

### Characteristics and Reproducibility of Residual Inhibition after Repeated Acoustic Stimulation

Hu S<sup>1,2</sup>, Anschuetz L<sup>1,2</sup>, Huth M<sup>1</sup>, Kompis M<sup>1</sup>, Hall D<sup>3,4</sup>, Caversaccio M<sup>1,2</sup>, Wimmer W<sup>1,2</sup>

<sup>1</sup>Department of Otorhinolaryngology, Head & Neck Surgery, Inselspital, Bern University Hospital, Bern, CH

<sup>2</sup>Hearing Research Laboratory, ARTORG Center, University of Bern, Bern, CH

<sup>3</sup>NIHR Nottingham Biomedical Research Centre, Nottingham, UK

<sup>4</sup>Hearing Sciences, Division of Clinical Neuroscience, University of Nottingham, Nottingham, UK

#### Introduction

The aim of this ongoing study is to characterize temporal features of residual inhibition (RI) and to investigate RI reproducibility after repeated acoustic stimulation in subjects with subjective, single tinnitus.

#### Method

Audiometry (up to 13 kHz) and tinnitometry (tinnitus intensity, pitch and minimum masking level, MML) were performed in 45 subjects (18 female, 27 male; average age: 46 years). RI was assessed in 10 consecutive trials (stimulation with 60 s, narrow-band noise centered at the tinnitus frequency, 20 dB louder than MML). The subjects were asked to indicate change in tinnitus loudness (RI depth; -5 complete suppression, 0 no change, +5 enhancement) continuously, until the loudness returned to the previous level. In subjects with RI, the effect of repeated stimulation on RI depth was analyzed using a cumulative link mixed model. In addition, for each RI repetition, tinnitus recovery curves were modelled as exponential decay. The effect of repetitions on maximum RI depth and RI duration (time after 80% tinnitus loudness recovery, in seconds) was analyzed using a linear mixed effects model.

#### Results

Tinnitus suppression through RI was observed in 82% of subjects. The average maximum RI depth and RI time ( $\pm$ SD) obtained from exponential curve fitting were  $-4.8 \pm 0.5$  and  $64s \pm 27s$ , respectively. With each repeated stimulation, the odds ratio for stronger RI depth is increased by a factor of 1.06 ( $p < .005$ ) and the RI duration (80% of tinnitus recovering time) is extended by 1.3 seconds ( $p = 0.017$ ).

#### Conclusion

Our results show a small increase of RI depth and RI duration after repeated acoustic stimulation, indicating that RI is a reproducible mechanism to generate repeated states with and without tinnitus as required for within-subject comparison studies (e.g. [1]).

[1] Hu S et al. Association Between Residual Inhibition and Neural Activity in Patients with Tinnitus: Protocol for a Controlled Within- and Between-Subject Comparison Study. *JMIR Res Protoc* 2019. 8:e12270; doi: 10.2196/12270.

## **S03-O5**

### **Measuring the tinnitus frequency using repetitive recursive matching: Results from three studies using sinusoidal and narrow band noise**

*Christian Dobel<sup>1</sup>, Andreas Wollbrink<sup>2</sup>, Christo Pantev<sup>2</sup>*

<sup>1</sup> *Department of Otorhinolaryngology, University Hospital Jena, Germany*

<sup>2</sup> *Institute for Biomagnetism and Biosignalanalysis, University of Münster, Germany*

#### **Introduction:**

Determining the tinnitus frequency is in many clinical settings a routine procedure for diagnosis, but it is also required for therapeutic approaches. With tinnitus being a phantom sound, this is not a straightforward procedure. We will report the results from three studies in which we used recursive matching with sinusoidal and narrow band noise (NBN).

#### **Material & Method:**

Study 1: 117 patients suffering from chronic tonal tinnitus measured their tinnitus pitch in ten sessions.

Study 2: 30 persons not suffering from Tinnitus were asked to match the pitch of two sounds, one being the target sound and the other a test sound. NBNs and pure tones were used both as target and as test stimuli.

Study 3: 20 patients suffering from tonal, chronic tinnitus matched the pitch of sinusoidal sounds and NBN repeatedly six times to their tinnitus sound.

All measures were performed with automated procedures.

#### **Results:**

Study 1: Mean, median and modus across measures led to highly similar results. The internal consistency calculated with Cronbach's alpha was very high (e.g. seven pitch matches: 0.93)

Study 2: The best match with smallest errors was achieved matching sinus with sinus sounds, but the worst result was matching sinus to an NBN target.

Study 3: As in study 1 the internal consistency was for sinus sounds (0.91) and NBNs (0.93) very high with a better result for NBN across measures. When asked to match their tinnitus sound to a narrow band noise, no patient chose consistently a sinusoidal tone.

#### **Conclusion:**

We demonstrated that recursive matching is a promising method to measure tinnitus pitch. It can be administered and analyzed in a standardized manner. The reliability across sessions is very high. Using NBN instead of sinusoidal tones seems to correspond more to the subjective tinnitus perception and is thus recommended.

### **S03-S1**

#### **An improved system for grading and treating tinnitus**

*Mariko Takahashi<sup>1</sup>, Kayoko Kabaya<sup>1</sup>, Kenichi Sekiya<sup>2</sup>, Futoshi Matsuda<sup>3</sup>, Yoshimasa Sekiya<sup>4</sup>, Meiho Nakayama<sup>1</sup>, Shingo Murakami<sup>1</sup>*

*1) Department of Otolaryngology, Head and Neck Surgery, Nagoya City University Medical School*

*2) Department of Otolaryngology, Anjo Kosei Hospital*

*3) Otolaryngological Matsuda Clinic*

*4) Sekiya Otolaryngological Clinic*

#### **Abstract**

Tinnitus is a condition in which patients have continuous sensation of sound in the ears or head although there is no external sound. At least 10% of the population are have experienced tinnitus and 1-3% of these cases are severe. Prevalence of tinnitus in Japan is relatively high; nonetheless, systematic treatment protocol has not been proposed. Therefore, the patients are often kept away in outpatient clinics without adequate treatment.

Tinnitus Retraining Therapy (TRT) has recently been introduced. TRT is a therapeutic method based on the neurophysiological model of tinnitus designed by Jastreboff, which consists of sound therapy and directive counseling. However, tinnitus patients often suffer from depression, anxiety and/or insomnia, who need drug treatment, psychotherapy and psychiatry treatment with the exception of TRT. In practice, we have treated patients with severe tinnitus using antidepressants and/or psychotherapy. Hence, we have been proposing a new grading system for tinnitus and protocol of systematic treatment considering tinnitus severity and psychological condition.

We classified tinnitus severity by 3 items: tinnitus state, mental state and catastrophic state. Tinnitus severity was evaluated by Tinnitus Handicap Inventory (THI), mental state was evaluated by Hospital Anxiety and Depression Scale (HADS), catastrophic state was evaluated by the items in accordance with major depression criteria and catastrophic episode in Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV. We analyzed 82 cases of tinnitus patients who were treated using new grading system of tinnitus over 6 months at the Department of otolaryngology, Nagoya city university hospital. We observed improvement in THI scores  $50.3 \pm 22.5$  points before treatment and  $40.5 \pm 20.0$  after treatment, average of HADS score is  $12.9 \pm 6.9$  points before treatment and  $11.3 \pm 6.9$  after treatment. We hope that this proposal of the tinnitus grading system and management would be helpful for tinnitus treatment in clinics.

## **S03-S2**

### **Guideline for the diagnosis of chronic tinnitus in Japan**

*Department of Otolaryngology-Head and Neck Surgery*

*Iwate Medical University*

*Hiroaki Sato MD*

In Japan, the Standardized Tinnitus Test was developed by Japanese Tinnitus Study Group in 1984 and was revised in 1993. It consists of medical questionnaires including verbal rating scales and onomatopoetic expressions, and audiologic testing specific to evaluation of chronic tinnitus such as loudness and pitch matching and minimal masking. However, no clinical practice guideline for assessment and treatment of chronic (lasting more than 3 month) subjective tinnitus has been developed in Japan. In 2017, Japanese Tinnitus Study Group has started to develop clinical practice guideline in response to the grant of research fund from Japan Agency for Medical Research and Development (AMED) following "Minds (Medical Information Network Distribution Service) Manual for Clinical Practice Guideline Development. Ver.2.0" released in 2016. We extracted the examinations necessary for the diagnosis and assessment of chronic tinnitus by the following two ways; one is a systematic review searching keywords "Tinnitus, Treatment" from the past 36 years English literature (Cochrane Review 32, Cochrane trial 695, PubMed 468) and another is the utilization of existing systematic review assessed by AGREE II (Fuller TE, et al, 2017). Among the extracted examinations from the above two systematic reviews, we selected the followings as recommendation: Tinnitus Sample Case History (TSCHQ), Tinnitus Handicap Inventory (THI and THI-12), Tinnitus Rating Scale (TRS), Tinnitus Severity Scale (TSS), Tinnitus Functional Index (TFI), Visual Analogue Scale (VAS), Hospital Anxiety & Depression Scale (HADS), Audiological assessment (pure tone audiometry, loudness and pitch matching, minimal masking), and Imaging study if necessary. The final version of "Clinical Practice Guideline for Chronic Tinnitus in Japan" has been completed and will be published in 2019.

## S04-O1

### Effect of sound therapy on gap detection and speech recognition in patients with sudden sensorineural hearing loss

*Yuanyuan Sun, MD; Liang Xia, MD; Zhong Zheng, MD; Xulan Tang, MD; Hongmin Wu, MD; Huiqun Zhou, PhD; Yanmei Feng, PhD\*; Zhengnong Chen, PhD; Haibo Shi, PhD; Shankai Yin, PhD*  
*Department of Otolaryngology, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, No. 600, Yishan Road, Xuhui District, 200233 Shanghai, China*  
*Correspondence should be addressed to Yanmei Feng: feng.yanmei@126.com*

#### **Objective:**

To investigate the effect of sound therapy combined with traditional drug therapy (SDT) on gap detection threshold and speech recognition scores in patients with sudden sensorineural hearing loss (SSNHL).

#### **Methods:**

Patients with SSNHL were grouped randomly into SDT and drug therapy (DT) groups. All patients with SSNHL received standard drug treatment and patients in the SDT group additionally received sound stimulation for the affected ears for 6 days. We compared the pure tone audiogram, speech recognition scores at normal and time compressed rates (70%, 60%, and 50%) under quiet and noisy conditions, and the gap detection threshold of the SDT and DT groups before treatment and on days 6 and 30 after treatment.

#### **Results:**

There were 20 patients in the SDT group and 24 in the DT group. No significant differences were observed in the baseline conditions between the two groups. The pure tone thresholds of affected ears were significantly lower in the SDT group on day 6 after treatment than those in the DT group at 125 and 250 Hz ( $p < 0.05$ ), but not at 500–8,000 Hz (all  $p > 0.05$ ). No significant difference was observed in terms of pure tone threshold between the SDT and DT groups across 125–8,000 Hz on day 30 after treatment (all  $p > 0.05$ ). Significantly lower gap detection thresholds and higher speech recognition scores under the noisy condition were observed at the normal and time compressed rates (70%, 60%, and 50%) in the SDT group than those in the DT group on days 6 and 30 after treatment (all  $p < 0.05$ ). No significant difference in speech recognition was observed in the quiet at normal and time compressed rates (70%, 60%, and 50%) between the two groups on days 6 and 30 after treatment (all  $p > 0.05$ ). Significant correlations were observed between the gap thresholds and speech recognition scores in a noisy environment at normal and time compressed rates (70%, 60%, and 50%) on day 6 ( $r = -0.44$ ,  $p < 0.05$ ;  $r = -0.41$ ,  $p < 0.05$ ;  $r = -0.39$ ,  $p < 0.05$ ; and  $r = -0.40$ ,  $p < 0.05$ ; respectively). Significant correlations were also observed between the gap thresholds and speech recognition scores in the noisy environment at normal and time compressed rates (70% and 60%) on day 30 ( $r = -0.42$ ,  $p < 0.05$ ;  $r = -0.41$ ,  $p < 0.05$ ; and  $r = -0.39$ ,  $p < 0.05$ ; respectively).

#### **Conclusions:**

SDT may be beneficial to improve gap detection thresholds and speech recognition scores in noisy environments for patients with SSNHL.



## **S04-O2**

### **Event Related Potentials (P300) to assess the Tinnitus complaint**

#### **Introduction:**

Tinnitus is a phantom auditory sensation for which no objective measurement is available, as yet. Event Related Potentials are an electrophysiological tool used to evaluate attention related events. Changes in latency and amplitude patterns have been previously reported in tinnitus patients

#### **Method:**

Eighty-eight patients complaining of Tinnitus were randomly placed into two drug groups: Drugs that act upon the Central Nervous System (CNS) that have different action mechanisms on the neurotransmitters involved in the auditory pathways, and also Drugs having an effect upon the peripheral auditory system. Their effects upon the negative aspects caused by Tinnitus symptoms were evaluated by the ERPs during three periods: Premedication (T1), at Termination of the drug treatment (T2), and following the Washout period (T3), and then compared with the results from the THI questionnaire and VAS.

#### **Results:**

The measurement of ERP waves using either the medications of central, CNS, action or those of peripheral action did not demonstrate significant differences during the three evaluated periods ( $p = 0.53$ ), despite the significant improvement seen through the evaluation by the THI questionnaire and VAS for tinnitus annoyance and intensity ( $p < 0.0001$ ).

#### **Conclusion:**

The use of ERPs with patients of chronic tinnitus who have been submitted to treatment using drugs having actions on both the CNS and peripheral auditory system did not present changes in either latency or amplitude of the N1, P2, N2 and P3 waves throughout the treatment, especially when compared to the THI questionnaire and VAS. The amplitude and latency parameters of ERPs cannot be considered as criterion to evaluate the evolution of drug treatment in patients complaining of tinnitus.

Key words: tinnitus, P300, Event Related Potentials, Drug Therapy, Attention

**S04-S1**

**Name: Richard Salvi**

**Affiliation: Center for Hearing and Deafness, University at Buffalo**

**Presentation Title: Is Enhanced Central Gain the Neural Basis for Hyperacusis?**

**Abstract**

Many tinnitus patients suffer from hyperacusis, a debilitating condition in which normal sounds are perceived as extremely loud and sometimes painful. The neural bases for hyperacusis are poorly understood, but may be linked to sound-evoked hyperactivity within the central nervous system. To test this hypothesis, we developed an animal model in which the growth of loudness was assessed by measuring a rat's reaction time to sounds presented over a large intensity range (RT-I). In Experiment 1, we administered sodium salicylate, an ototoxic drug that induces tinnitus. Salicylate made RT-I functions steeper and RTs shorter than normal, behaviors consistent with loudness hyperacusis. We tested the central gain model of salicylate-induced hyperacusis by measuring sound-evoked neural activity before and after salicylate treatment. Salicylate reduced the sound-evoked neural output of the cochlea, but paradoxically, sound-evoked neural responses progressively increased along the central auditory pathway resulting in suprathreshold responses 50-100% larger than normal in the auditory cortex and amygdala, an emotional processing area. In Experiment 2, we measured RT-I functions at different frequencies before and after inducing a high-frequency hearing loss. RT-I functions measured at frequencies below the hearing loss were steeper than normal and RTs were significantly shorter than normal, behaviors indicative of low-frequency hyperacusis. We carried out electrophysiological measurements to test the central gain model of noise-induced hyperacusis. Sound-evoked neural response in the cochlea were significantly reduced. In contrast, sound-evoked neural response in the auditory cortex and amygdala were proportionately larger than those from cochlea. However, the neural responses in auditory cortex and amygdala were smaller in the Noise group with hyperacusis than in Normal controls. Thus, the amount of central gain enhancement was not large enough to account for noise-induced hyperacusis.

## **S04-S3**

### **The Resting-state Bold-fMRI Study on the Idiopathic Tinnitus with and Without Hearing Loss**

*Zhang Jianning*

#### **Background:**

Hearing loss is regarded as one of the most common risk factors of tinnitus. However, still some tinnitus presents with normal hearing. Blood oxygenation level-dependent functional magnetic resonance imaging (Bold-fMRI) was used to show changes in central nervous system of tinnitus. Few studies focus on the Bold-fMRI difference between tinnitus with and without hearing loss.

#### **Objective:**

To explore the brain activity difference between tinnitus patients with and without hearing loss.

#### **Methods:**

12 idiopathic tinnitus patients with hearing loss, 15 without hearing loss and 12 normal controls were enrolled. BOLD-fMRI results were analyzed based on MATLAB platform combined DPARSF, REST, and low frequency amplitude analysis.

#### **Results:**

Compared with normal controls, 63.0%, 40.7% and 37% of tinnitus patients have a higher activity in frontal lobe, limbic system and temporal lobe, respectively. In 12 tinnitus patients with hearing loss, 25% has a higher activity in temporal lobe. In 15 tinnitus patients without hearing loss, 46.7% has a higher activity in temporal lobe. In tinnitus patients with hearing loss, 25% has a higher activity in limbic system, 2 cases in cingulate gyrus and 1 in hippocampus. In 15 cases without hearing loss, 60% showed a higher activity in limbic system, with 5 cases in cingulate gyrus. In total 27 tinnitus patients, cases with less than 3 higher activity areas (includes 3 areas) have an average THI value of  $44.00 \pm 12.71$ , whereas cases with more than 3 higher activity areas have an average THI value of  $62.13 \pm 21.19$ . The difference is significant ( $P=0.015$ ).

#### **Conclusion:**

A higher activity of frontal lobe and limbic system were found in tinnitus patients without hearing.

#### **Key words:**

Tinnitus; Functional magnetic resonance imaging; Resting-state

#### **S04-S4**

##### **The gap-prepulse inhibition deficit of the cortical N1-P2 complex in patients with tinnitus: The effect of gap duration.**

*Suh MW, Ku Y, Ahn JW, Kwon C, Kim DY, Park MK, Lee JH, Oh SH, Kim HC.*

##### **Abstract**

The present study aimed to investigate whether gap-prepulse inhibition (GPI) deficit in patients with tinnitus occurred in the N1-P2 complex of the cortical auditory evoked potential. Auditory late responses to the intense sound of the GPI paradigm were obtained from 16 patients with tinnitus and 18 age- and hearing loss-matched controls without tinnitus. The inhibition degrees of the N1-P2 complex were assessed at 100-, 50-, and 20-ms gap durations with tinnitus-pitch-matched and non-matched frequency background noises. At the 20-ms gap condition with the tinnitus-pitch-matched frequency background noise, only the tinnitus group showed an inhibition deficit of the N1-P2 complex. The inhibition deficits were absent in both groups with longer gap durations. These findings suggested that the effect of tinnitus emerged depending on the cue onset timing and duration of the gap-prepulse. Since inhibition deficits were observed in both groups at the same 20-ms gap condition, but with the tinnitus-pitch-non-matched frequency background noise, the present study did not offer proof of concept for tinnitus filling in the gap. Additional studies on the intrinsic effects of different background frequencies on the gap processing are required in the future.

## **S04-S5**

### **Tomographic neurofeedback for tinnitus treatment**

*Tobias Kleinjung<sup>1</sup>, Dominik Guentensperger<sup>2</sup>, Christian Thuerling<sup>1</sup>, Patrick Neff<sup>2, 3</sup>, Martin Meyer<sup>2</sup>*

<sup>1</sup> University Hospital of Zurich, Department of Otorhinolaryngology, Zurich, Switzerland

<sup>2</sup> Department of Psychology, University of Zurich, Zurich, Switzerland

<sup>3</sup> Department of Psychiatry and Psychotherapy, University of Regensburg, Regensburg, Germany

#### **Introduction:**

Alpha/delta neurofeedback has been shown to be a potential treatment option for chronic subjective tinnitus. Traditional neurofeedback approaches working with a handful of surface electrodes have been criticized, however, due to their low spatial specificity. The purpose of this study was to evaluate a tomographic neurofeedback protocol that combines activity measured across the whole scalp with sLORETA source estimation.

#### **Material & Method:**

Forty-eight chronic tinnitus patients participated in 15 weekly neurofeedback training sessions and extensive pre and post measurements, as well as follow-up testing (3 and 6 months after the training). Patients were randomly assigned to a tomographic (ToNF) group or a traditional electrode-based neurofeedback (NTNF) group. The main outcome measures of this study consisted of tinnitus-related distress measured with the Tinnitus Handicap Inventory (THI) and Tinnitus Questionnaire (TQ), tinnitus loudness, and pre- and post-training resting-state EEG activity in trained frequency bands.

#### **Results:**

For both groups a significant reduction of tinnitus-related distress and tinnitus loudness was found. While distress changes seemed to persist, loudness levels returned to baseline in the follow-up period. No between-group differences between the 2 neurofeedback applications (ToNF or NTNF) were found, which suggests a similar contribution to symptom improvement. The trained alpha/delta ratio increased significantly over the course of the training and remained stable in the follow-up period. This effect was found for both groups on surface and source levels with no meaningful differences between the 2 groups.

#### **Conclusion:**

This study shows that a tomographic alpha/delta protocol should be considered a valuable addition to tinnitus treatment with neurofeedback. More knowledge about distinct tinnitus subtypes and their manifestation in respective brain activity patterns is necessary in order to develop more individually specific neurofeedback approaches.

## **S05-O1**

### **RTMS parameters in tinnitus trials: a systematic review**

*Stefan Schoisswohl<sup>1,4</sup>, Kushal Agrawal<sup>2,4</sup>, Jorge Simoes<sup>1,4</sup>, Patrick Neff<sup>1,3</sup>, Winfried Schlee<sup>1,4</sup>, Berthold Langguth<sup>1,4</sup>, Martin Schecklmann<sup>1,4</sup>*

<sup>1</sup>*Department of Psychiatry and Psychotherapy, University of Regensburg, Regensburg, Germany*

<sup>2</sup>*Institute of Databases and Information Systems, University of Ulm, Ulm, Germany*

<sup>3</sup>*Neuroplasticity and Learning in the Healthy Aging Brain (HAB LAB), Department of Psychology, University of Zurich, Zurich, Switzerland*

<sup>4</sup>*European School for Interdisciplinary Tinnitus Research (ESIT), Regensburg, Germany*

#### **Introduction:**

Over the past few years extensive body of research was produced investigating the effects of repetitive transcranial magnetic stimulation (rTMS) for the treatment of chronic tinnitus with heterogeneous results. This heterogeneity is exemplified by two recently published large-scale, randomized, sham-controlled clinical trials reporting different outcomes. Investigation of reasons for this incongruency suspected a number of technical aspects of rTMS, with its large parameter space, as a potential source. The aim of this systematic review is to examine the overall efficacy of rTMS in chronic tinnitus and to identify possible technical factors relevant for the effectiveness of rTMS trials.

#### **Methods:**

A literature search was conducted using the keywords “tinnitus” and “transcranial”. From identified appropriate original research papers, rTMS parameters were extracted from each study arm for subsequent statistical analysis with respect to observed effects (significant vs. not significant pre to post rTMS effects).

#### **Results:**

Our findings indicate that verum rTMS is superior to sham rTMS as indicated by the proportion of significant pre-post contrasts. Some relevant rTMS parameters (e.g., pulse waveform) are not reported. Lower stimulation intensity of rTMS was associated with significant effects in verum rTMS arms. An additional stimulation of the DLPFC to the temporal cortex was not found to promote efficacy.

#### **Conclusion:**

Future research should consider differential effects of rTMS induced by technical parameters and strive for an exhaustive reporting of relevant rTMS parameters.

## **S05-O2**

### **Effects of High Definition transcranial Direct Current Stimulation (HD tDCS) in 114 chronic tinnitus patients**

*Jacquemin L.<sup>1,2</sup>, Mertens G.<sup>1,2</sup>, Van de Heyning P.<sup>1,2</sup>, Vanderveken O.<sup>1,2</sup>, Topsakal V.<sup>1,2</sup>, De Hertogh W.<sup>3</sup>, Michiels S.<sup>1,2,3</sup>, Beyers J.<sup>1,2</sup>, Moyaert J.<sup>1</sup>, Van Rompaey V.<sup>1,2</sup>, Gilles A.<sup>1,2,4</sup>*

<sup>1</sup> *University Department of otorhinolaryngology and Head & Neck surgery, Antwerp University Hospital, Edegem, Belgium*

<sup>2</sup> *Dept. of Translational Neurosciences, Faculty of Medicine and Health Sciences, Antwerp University, Wilrijk, Belgium*

<sup>3</sup> *Dept. of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, Antwerp University, Wilrijk, Belgium*

<sup>4</sup> *Department of Education, Health & Social Work, University College Ghent, Ghent, Belgium*

#### **Introduction:**

Transcranial direct current stimulation (tDCS) is a well-known tinnitus treatment inducing cortical plasticity and modulating the activity of brain structures. The broad stimulation pattern, which is one of the main limitations of tDCS, can be overcome with the recently developed technique called high-definition tDCS (HD tDCS). The results with HD tDCS are promising. The present study investigated the effect of HD tDCS on the reported tinnitus complaints in an extensive study.

#### **Material & Method:**

The current prospective study included 114 chronic, subjective, non-pulsatile tinnitus patients who received HD tDCS of the right dorsolateral prefrontal cortex (DLPFC). Therapy effects were assessed by use of the tinnitus functional index (TFI), visual analogue scale (VAS), hyperacusis questionnaire (HQ), tinnitus questionnaire (TQ) and hospital anxiety and depression scale (HADS) filled out at the pre-therapy, post-therapy and follow-up visit.

#### **Results:**

TFI and TQ total scores improved significantly over time ( $p_{TFI} = .030$ ;  $p_{TQ} = .034$ ), with a significant improvement between post-therapy and follow-up visit ( $p_{TFI} = .037$ ;  $p_{TQ} = .032$ ). The percentage of patients reporting an improvement of their tinnitus at follow-up visit was 34 %. There was no significant change on the other questionnaires.

#### **Conclusion:**

The current study reported on the effects of HD tDCS in a large tinnitus population. HD tDCS of the right DLPFC resulted in a significant improvement of the tinnitus perception. Future studies should elaborate on this data by including a placebo group and investigating the effectiveness of sequential or simultaneous electrical stimulation.

## S05-O3

### **An exploratory study on the use of event-related potentials as an objective measure of auditory processing and therapy effect in patients with tinnitus: a transcranial direct current stimulation study**

*Jacquemin L.<sup>1,2</sup>, Mertens G.<sup>1,2</sup>, Van de Heyning P.<sup>1,2</sup>, Vanderveken O.<sup>1,2</sup>, Topsakal V.<sup>1,2</sup>, De Hertogh W.<sup>3</sup>, Michiels S.<sup>1,2,3</sup>, Beyers J.<sup>1,2</sup>, Moyaert J.<sup>1</sup>, Van Rompaey V.<sup>1,2</sup>, Gilles A.<sup>1,2,4</sup>*

<sup>1</sup> University Department of otorhinolaryngology and Head & Neck surgery, Antwerp University Hospital, Edegem, Belgium

<sup>2</sup> Dept. of Translational Neurosciences, Faculty of Medicine and Health Sciences, Antwerp University, Wilrijk, Belgium

<sup>3</sup> Dept. of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, Antwerp University, Wilrijk, Belgium

<sup>4</sup> Department of Education, Health & Social Work, University College Ghent, Ghent, Belgium

#### **Introduction:**

Therapy effect in tinnitus research is usually evaluated by use of questionnaires. As this is a solely subjective assessment method, the need for additional objective measurements arises in order to genuinely evaluate the effects of therapeutic interventions. The current study explored the value of event-related potentials (ERPs) in the evaluation of high-definition transcranial direct current stimulation (HD-tDCS) for tinnitus treatment.

#### **Material & Method:**

This study compared ERPs before and after HD tDCS treatment of the right dorsolateral prefrontal cortex (DLPFC) in 22 tinnitus patients. In addition to this objective measurement, the therapy effects were assessed by use of the tinnitus functional index (TFI) and the hospital anxiety and depression scale (HADS).

#### **Results:**

The results showed a significant shortening of the N1, P2, N2 and P3 latencies after HD-tDCS treatment. Moreover, the increased amplitude of the P2 and N2 peaks resulted in more salient and clear peaks after HD-tDCS, with the amplitude of N2 being significantly larger after HD-tDCS. However, the ERP change was not significantly correlated with the change in TFI total score.

#### **Conclusion:**

The current study showed that adding ERPs to the outcome measures in tinnitus research can be valuable. The shortening of ERP latencies may reflect a more effective sound processing after HD-tDCS in tinnitus patients. The increased amplitude of the P2 and N2 peaks after HD-tDCS may indicate an increase in the recruitment of neurons in the auditory cortex to analyze sound. Moreover, it may also imply a better synchronization in neuronal firing. Future studies should elaborate on these promising data to provide a better insight in the underlying mechanism of these ERP changes.

To explore and compare the differential changes of central auditory relays in overdose-SS and loud sound exposure induced tinnitus rats by using the combination of the behavior assessment, behaving electrophysiological studies and Microarray assay would reveal the key factors or differential mechanisms in the development of reversible or irreversible tinnitus.



## S05-O5

### Prediction of treatment response to repetitive transcranial magnetic stimulation in tinnitus based on individual brain anatomy

Timm B. Poepl<sup>1,2</sup>, Martin Schecklmann<sup>1</sup>, Michael Landgrebe<sup>3</sup>, Berthold Langguth<sup>1</sup>, Simon B. Eickhoff<sup>4,5</sup>

1. Department of Psychiatry and Psychotherapy, University of Regensburg, Regensburg, Germany
2. Department of Psychiatry, Psychotherapy and Psychosomatics, RWTH Aachen University, Aachen, Germany
3. Department of Psychiatry, Psychotherapy and Psychosomatics, kbo-Lech-Mangfall-Klinik Agatharied, Hausham, Germany
4. Institute for Systems Neuroscience, Heinrich Heine University, Düsseldorf, Germany
5. Institute of Neuroscience and Medicine, Brain and Behaviour (INM-7), Research Centre Jülich, Jülich, Germany

#### Introduction:

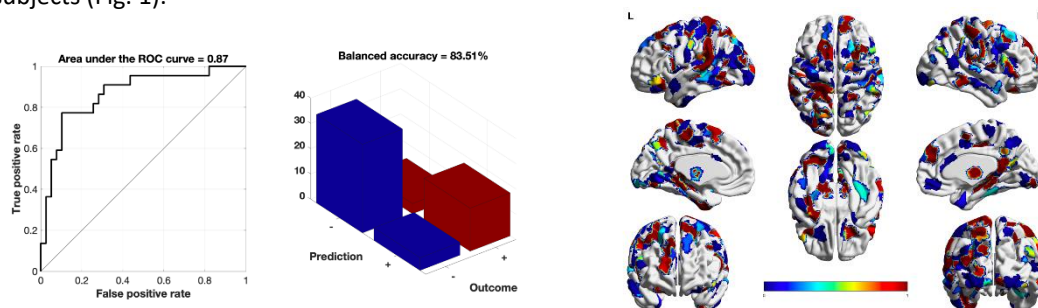
Noninvasive brain stimulation can modify phantom sounds for longer periods by modulating neural activity and inducing regional neuroplastic changes (Poepl et al. 2018). However, treatment response is limited and there are no good demographic or clinical predictors for treatment outcome (Lehner et al. 2012). We used multivariate pattern analysis (MVPA) to investigate whether brain anatomy as assessed by structural magnetic resonance imaging (sMRI) can predict therapeutic outcome.

#### Material & Method:

Sixty subjects chronically experiencing phantom sounds (i.e., tinnitus) received repetitive transcranial magnetic stimulation (rTMS) of left dorsolateral prefrontal and temporal cortex according to a protocol that has been shown to yield a significantly higher number of treatment responders than sham stimulation and previous stimulation protocols. Before rTMS, a structural magnetic resonance image in high resolution was obtained from all patients. The prediction target was nonresponse vs. response defined by a reduction of at least 5 points on the Tinnitus Questionnaire (Adamchic et al., 2012). In order to predict treatment effects, we employed a support-vector machine (SVM) ensemble.

#### Results:

In the cross-validation, the SVM ensemble based on stratified subsampling and feature selection yielded an area under the curve (AUC) of 0.87 for the prediction of therapy success in new, previously unseen subjects (Fig. 1).



This corresponded to a balanced accuracy of 83.3%, a sensitivity of 77.2% and a specificity of 87.2%. Finally, the F1-score (harmonic mean of sensitivity and positive predictive value) was .77. Investigating the most frequently selected regions (Fig. 2) showed the involvement of auditory but also a widespread network of nonauditory brain areas.

#### Conclusion:

Individual responses to rTMS in patients experiencing phantom sounds may be accurately predicted using biomarkers based on structural neuroimaging. Although further larger studies are needed to validate the proposed response classifier, our results provide a robust basis for the development of personalized rTMS interventions taking into account individual neurobiology.

## **S05-O6**

### **Neural activity underlying bothersome and non-bothersome tinnitus with normal hearing documented by EEG**

#### **Objectives:**

The physiopathological mechanism underlying the tinnitus is still ongoing debate. We aimed to explore the evidence of tinnitus-related brain regions between bothersome and non-bothersome tinnitus with normal hearing documented by EEG.

#### **Methods:**

Brain responses from 15 healthy right-handed tonal tinnitus patients and 20 matched controls with normal audiometry (0.125 to 8 kHz) were recorded with a 256-channel high-density electroencephalogram (HD-EEG). All subjects passed the test of middle-ear function and distortion product otoacoustic emission (DPOAE). Electrocochleogram (ECoChG), event-related potential of generator localization, mismatch negativity (MMN) and resting state EEG were performed in all the subjects. The differences between the neural networks involved in bothersome and non-bothersome tinnitus were recorded by conducting sLORETA based source analysis of resting state EEG. Source analysis of MMN according to different tinnitus frequency was performed.

#### **Results:**

A marked shift of the cortical representation of the tinnitus frequency into an area adjacent to the expected tonotopic location was observed after source analysis. Resting-state EEG measurements from the temporal cortex of individuals with tinnitus reveal a reduction of alpha power and increases in delta and theta power. An increase in gamma-band connectivity between the left primary and secondary auditory cortex and the left insula, and between the auditory cortices and the right prefrontal cortex was seen in bothersome tinnitus patients compared with non-bothersome tinnitus patients. A significantly reduced amplitude of the wave AP in ECoChG was shown in tinnitus patients with normal hearing.

#### **Conclusions:**

This provides evidence of “hidden hearing loss” that manifests as reduced neural output from the cochlea in the absence of elevated hearing thresholds, and consequent cortical reorganization. And the amount of bothersome is related to the brain responses in prefrontal cortex.

## **S06-O1**

### **What would an evidence-based tinnitus patient education program look like?**

#### **Findings from a systematic review.**

*Aurora Occa<sup>1</sup>, Susan Morgan<sup>2</sup>, Tricia Scaglione<sup>3</sup>, Brianna Kuzbyt<sup>4</sup>, Richard Bookman<sup>5</sup>*

*<sup>1</sup> University of Kentucky*

*<sup>2-5</sup> University of Miami*

#### **Introduction:**

According to the United States Center for Disease Prevention, tinnitus affects approximately 50 million individuals nationwide. It is critical that health care providers offer patients an appropriate basis of fundamental knowledge regarding tinnitus causes, perceptions, and management techniques. The purpose of this project was to identify the strategies available to educate patients about tinnitus and to provide guidelines and instructions on how to develop better tinnitus education intervention.

#### **Material & Method:**

A systematic review of peer-reviewed published articles about tinnitus education was conducted. After an initial review of 306 articles, 18 were included in the final review. The information extracted included data on the content conveyed to patients about tinnitus, the format employed, the process used to develop the educational materials, and patients' outcomes linked to tinnitus education.

#### **Results:**

A limited amount of evidence exists for the education of tinnitus management and education. Based on the available articles, the outcomes provided by the interventions were perceptual, behavioral, and clinical in nature. The format and the content provided by the interventions were heterogeneous. Effective tinnitus education interventions were patient-centered and provided specific coping strategies in their curriculum.

#### **Conclusion:**

Educating patients about tinnitus is important to improving their perceptions of the condition and their management behaviors. Healthcare providers and patients need to collaborate to create patient-centered, ad hoc plans. It is important to identify patients' expectations about the outcomes and shared goals. Further studies are needed to identify effective education techniques for this underserved population.

## **S06-O2**

### **The clinical pitfalls of a shared medical appointment approach for tinnitus management in the United States**

*Tricia L. Scaglione<sup>1</sup>, Brianna Kuzbyt<sup>2</sup>*

*<sup>1,2</sup> University of Miami Hospital, Miami, FL, USA*

#### **Introduction:**

Standard medical work-up of the tinnitus patient typically includes an interdisciplinary approach that is timely and costly. Additionally, the paucity of health care providers specializing in tinnitus care and management results in extensive wait-times for consultations, delaying critical care for patients in need. This issue is common among chronic health conditions.

The Shared Medical Appointment (SMA) approach has been introduced to address above-mentioned concerns. SMAs increase patient access to care, reduce wait times, increase cost-effectiveness, and result in overall satisfaction for patients and providers alike. SMAs for the purpose of tinnitus management is currently under-utilized in the United States.

The University of Miami implemented a SMA approach to assess whether the group approach was of greater value than traditional management of the tinnitus patient. While this novel approach is beneficial to patient care, numerous obstacles were identified which may limit the feasibility of implementing this approach in non-government funded facilities.

#### **Materials & Methods:**

A retrospective review was conducted on tinnitus patients evaluated at the University of Miami Tinnitus Clinic. Metrics regarding wait times, no show/cancellations, revenue generation, and patient satisfaction were assessed for the traditional approach and the implemented SMA model.

#### **Results:**

Patients were highly satisfied with the SMA approach. Due to the novelty of this approach, wait times, cancellations, and no shows varied as delivery methods were modified to address identified obstacles. Despite this variability, the no show and cancellation rates had far less negative impact on clinical productivity and efficiency.

#### **Conclusion:**

The SMA approach provides benefit to the patient; however, feasibility is heavily reliant on structure. To promote sustainability, clinical pitfalls must be identified prior to implementing an SMA.

## **S06-O3**

### **The hemodynamic study on the different treatment effect after SSCPD resurfacing surgery**

*Zhenxia Mu<sup>1</sup>, Xiaoyu Qiu<sup>2</sup>, Bin Gao<sup>1</sup>, Xiaofei Xue<sup>1</sup>, Xiaoshuai Li<sup>2</sup>, Zhenghan Yang<sup>2</sup>,*

*Yu Chang<sup>1\*</sup>, Pengfei Zhao<sup>2\*</sup>, Zhenchang Wang<sup>2\*</sup>*

*<sup>1</sup> School of Life Science and Bioengineering, Beijing University of Technology, Beijing 100124, China*

*<sup>2</sup> Department of Radiology, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China*

#### **Introduction**

Sigmoid sinus cortical plate dehiscence (SSCPD) is a common malady in patients with pulsatile tinnitus (PT) and usually treated by SSCPD resurfacing surgery in clinic. However, the treatment effects are significantly different. The purpose of this study is to illuminate the causes of different treatment effects after SSCPD resurfacing surgery from the perspective of biomechanics and to provide a theoretical basis for clinical treatment.

#### **Material & Method**

Six patients-specific SSCPD geometric models were reconstructed based on computed tomography (CT) data, including 3 health cases and 3 unhealth cases after SSCPD resurfacing surgery. Computational fluid dynamics simulation was used to compare the flow velocity, flow rate, pressure, and wall shear stress of the affected side sigmoid sinuses and transverse, before and after SSCPD resurfacing surgery.

#### **Results**

Compared with the preoperative health cases, the postoperative health cases results indicated that the SSCPD area was loaded with lower pressure (reduced 21Pa) and higher WSS (increased  $7.147 \times 10^{-2}$  Pa). However, the unhealth cases results showed that the pressure (1367Pa), flow velocity and WSS at preoperative and postoperative were similar. Compared with the unhealth cases, the blood flow pattern of the health cases became smoother and more regular. The pressure was evenly distributed in the overall model.

#### **Conclusion**

On the one hand, SSCPD is the key factor in the process of transmitting noise to the inner ear. On the other hand, the abnormal hemodynamic state in SS is the fundamental reasons of PT. Therefore, the treatment of PT patients should not only resurface the missing bone wall, but also need to improve the abnormal blood flow.

## S06-S1

### The COMiT'ID study: Intervention-specific outcome domains provide an important starting point for standardised measures

Hall DA<sup>1,2,3</sup>, on behalf of the COMiT initiative

<sup>1</sup> NIHR Nottingham Biomedical Research Centre, Nottingham, UK

<sup>2</sup> Hearing Sciences, Division of Clinical Neuroscience, University of Nottingham, Nottingham, UK

<sup>3</sup> University of Nottingham Malaysia, Malaysia.

#### Introduction

Over the past four years, the Core Outcomes in Tinnitus (COMiT) initiative has been conducting the first of two steps to establish a common standard. This first step identifies what specific tinnitus-related complaints (*outcome domains*) are critical and important to assess in all clinical trials to determine whether an intervention has worked<sup>1,2</sup>. The work has focused on sound-, psychology-, and pharmacology-based interventions for chronic subjective tinnitus in adults. These are in common practice, and they each have a different therapeutic rationale so clinical outcomes might reasonably differ across interventions according to how each intervention is supposed to be working.

#### Method

The COMiT'ID study used an online three-round Delphi method with three separate surveys for sound-, psychology- and pharmacology-based interventions, followed by face-to-face and online discussions. We engaged English-speaking participants from across the world.

#### Results

Viewpoints and votes involved all major stakeholder groups, with approximately a 1:1 ratio of health-care users to professionals. *Tinnitus intrusiveness* was voted in for all three interventions. For sound-based interventions, the minimum set included *ability to ignore, concentration, quality of sleep, and sense of control*. For psychology-based interventions, the minimum set included *acceptance of tinnitus, mood, negative thoughts and beliefs, and sense of control*. For pharmacology-based interventions, *tinnitus loudness* was the only additional core outcome domain. Results will highlight recent progress in defining what these concepts mean to health-care users to professionals alike.

#### Conclusion

The intervention-specific differences in the consensus-based decisions illustrate how the tinnitus community recognises a need to tailor outcome domains to the specific intervention being evaluated in the design of future clinical trials of chronic subjective tinnitus in adults. Defining what these concepts mean to the tinnitus experts is an important precursor to recommending standards for how they should be measured. These recommendations are intended to provide a framework for greater compatibility across clinical trials, not to stifle individual preferences.

<sup>1</sup> Hall DA, Smith H, Hibbert A, et al. Developing core outcome domains sets for clinical trials of sound-, psychology-, and pharmacology-based interventions for chronic subjective tinnitus in adults. *Trends Hear*. 2018; 22: 2331216518814384. doi: 10.1177/2331216518814384.

<sup>2</sup> Hall DA, Hibbert A, Smith H, et al. One size does not fit all: developing common standards for outcomes in early-phase clinical trials of sound-, psychology-, and pharmacology-based interventions for chronic subjective tinnitus in adults. *Trends Hear*. 2019 in press.

## **S06-S2**

### **Comparison of Treatment Outcomes Following Either Prefrontal Cortical-only or Dual-site Repetitive Transcranial Magnetic Stimulation in Chronic Tinnitus Patients: A Double-blind Randomized Study.**

*Suh MW, Noh TS, Kyong JS, Chang MY, Park MK, Lee JH, Oh SH, Kim JS, Chung CK.*

#### **OBJECTIVES:**

We evaluated treatment outcomes following single-site repetitive transcranial magnetic stimulation (rTMS) in the dorsolateral prefrontal cortex (DLPFC) and dual-site rTMS in the auditory cortex (AC) and DLPFC (AC+FC).

#### **STUDY DESIGN AND PATIENTS:**

This prospective randomized double-blind trial initially included 19 patients with chronic tinnitus and 17 of these patients received rTMS on the left AC and left DLPFC or only the left DLPFC. The subjects were randomly allocated to either the dual-site rTMS (AC+FC) protocol (Group 1, n=9) or the singlesite rTMS (DLPFC) protocol (Group 2, n=8). Group 1 received daily treatments with 2,000 pulses applied to the AC and 1,000 pulses applied to the DLPFC for 4 days (total of 12,000 pulses) and Group 2 received daily treatments with 3,000 pulses applied the DLPFC for 4 days (total of 12,000 pulses).

#### **MAIN OUTCOME MEASURES:**

The severity of tinnitus was assessed before rTMS treatment using the Tinnitus Handicap Inventory (THI) and the self-rated Visual Analog Scale. These measures were used to determine the awareness, loudness, annoyance, and effects of tinnitus on daily life at 1, 2, 4, and 12 weeks after treatment.

#### **RESULTS:**

The improvement in THI score was significantly better in Group 1 than in Group 2, even after controlling for the between-group differences in pretreatment THI score. In terms of psychological factors, Group 1 exhibited significant improvements in scores on the State-Trait Anxiety Inventory (STAI) for both state anxiety (STAI-X1) and trait anxiety (STAI-X2) at 12 weeks posttreatment and scores on the Pittsburgh Sleep Quality Index at 4 weeks posttreatment. Group 2 showed an improvement in only the STAI-X2 score at 12 weeks posttreatment.

#### **CONCLUSIONS:**

The rTMS protocol effectively suppressed tinnitus in the dual-site rTMS (AC+FC) group but not in the single-site rTMS (DLPFC) group. Although recent evidence has shown that non-auditory cortices in the tinnitus network play an important role in the generation of tinnitus, our findings indicate that rTMS on non-auditory cortical sites alone may not be sufficient for treatment. Thus, dual-site rTMS in the AC and DLPFC may be preferable for controlling this condition.

## **S06-S3**

### **Maladaptive alterations of resting state cortical networks in Tinnitus:**

#### **An effective connectivity analysis of a larger MEG data set**

*Christo Pantev<sup>1</sup>, Evangelos Paraskevopoulos<sup>1,2</sup>, Christian Dobel<sup>3</sup>*

<sup>1</sup> Institute for Biomagnetism and Biosignalanalysis, University of Münster, P.C. D-48149, Germany

<sup>2</sup> School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, PO Box 376, P.C. 54124, Thessaloniki, Greece

<sup>3</sup> Department of Otorhinolaryngology, University Hospital Jena, Friedrich-Schiller-University of Jena, P.C. D-07740 Jena, Germany

#### **Introduction:**

Recent tinnitus research suggests that the cortical reorganization underlying tinnitus involves a widespread network of cortical sources. The goal of the study is to investigate cortical connectivity underpinning tinnitus using a novel, whole head, node-to-node approach that does not a-priori define the corresponding networks, but instead, quantifies the amount of shared information within distributed cortical regions.

#### **Material & Method:**

The resting state MEG activity of 40 chronic tinnitus patients and 40 matched controls was compared. Effective connectivity of the resting brain, at a whole cortex level, was estimated by means of a statistical comparison of the estimated phase Transfer Entropy (pTE) between the time-series of cortical activations, as reconstructed by LORETA. As pTE identifies the direction of the information flow, a detailed analysis of the connectivity differences between tinnitus patients and controls was possible.

#### **Results:**

Results indicate that the group of tinnitus patients show increased connectivity between the right dorsal prefrontal and right medial temporal areas. Our results go beyond previous findings by indicating that the role of the left para-hippocampal area is dictated by a modulation from dmPFC; a region that is part of the dorsal attention network (DAN), as well as implicated in the regulation of emotional processing. Additionally, this whole cortex analysis showed a crucial role of the left inferior parietal cortex, which modulated the activity of the right superior temporal gyrus, bilateral middle temporal and left visual association areas, providing new hypotheses for the role of this area within the context of current tinnitus models.

#### **Conclusion:**

The maladaptive alterations of the structure of intrinsic cortical networks show a decrease in efficiency and information processing performed by the resting state network of tinnitus patients.



## **S06-S4**

### **Investigation on Sound Characteristics in Tinnitus Patients**

*LIU Peng DING Ran-Ran LU Jing-Zhe, ZHENG Jian-Long, LIU Ying, GUO En-Qin , CAO Lin*

*Department of Otolaryngology, The First Affiliated Hospital of Guangzhou University of TCM, Guangzhou*

#### **Objective**

To investigate the characteristics of tinnitus sounds in order to provide clinical epidemiological evidence for exploring etiology of tinnitus.

#### **Methods**

Clinical investigation of 346 patients was conducted. In addition to recording demographic information, the investigation focused on sound location, tone, and loudness of tinnitus. Pure tone audiometry, tinnitus pitch and loudness match were also conducted.

#### **Results**

- ① Tinnitus can occur in the ear, brain, skull, and air. 69.7% tinnitus was located in the ear while 30.3% not in the ear. There was no significant difference in the proportion of hearing loss between patients with two tinnitus locations ( $P>0.05$ ). There were only 35% patients in which the location of hearing loss and that of tinnitus was related.
- ② 75.1% of tinnitus sounded was described as cicada chirp. There was no significant difference in the ratio of high-, middle-, and low-tone tinnitus between the two groups with cicada chirp tinnitus and non-cicada chirp tinnitus ( $P>0.05$ ).
- ③ The loudness-match  $\leq 6$  dB SL accounted for 83.2% tinnitus patients. There was no significant difference in the loudness-match in tinnitus patients who could perceive their tinnitus in the quiet environment, general environment and any environment ( $P>0.05$ ). However, the proportion of hearing loss of in patients who could only perceive their tinnitus in the quiet environment was significantly lower than that in patients who could perceive tinnitus in general environment and any environment ( $P<0.05$ ).

#### **Conclusion**

There is no scientific evidence to estimate the lesion location based on tinnitus sound location and the tone of tinnitus. The true cause of tinnitus may not be the same as that of hearing loss.

**Key words:** tinnitus; tinnitus sound characteristics; cicada chirp; hearing loss

## S07-O1

### Alterations of the default mode network and cognitive impairment in patients with unilateral chronic tinnitus

Yu-Chen Chen<sup>1</sup>, Richard Salvi<sup>2</sup>, Xindao Yin<sup>1\*</sup>

<sup>1</sup>Department of Radiology, Nanjing First Hospital, Nanjing Medical University, Nanjing, China;

<sup>2</sup>Center for Hearing and Deafness, University at Buffalo, State University of New York, Buffalo, NY 14214, USA.

\*Corresponding author: Xindao Yin

Address Correspondence to:

\* Xindao Yin, MD, Ph.D., Department of Radiology, Nanjing First Hospital, Nanjing Medical University, No.68, Changle Road, Nanjing 210006, China, Tel: +862587726268, Fax: +862552236361, E-mail: y.163yy@163.com

#### Background:

Previous studies have demonstrated that cognitive impairment is linked with neurophysiological alterations in chronic tinnitus. This study aimed to investigate the intrinsic functional connectivity (FC) pattern within the default mode network, (DMN) and its associations with cognitive impairment in tinnitus patients using a resting-state functional magnetic resonance imaging (rs-fMRI).

#### Methods:

Thirty-five chronic unilateral tinnitus patients, and 50 healthy controls were recruited for rsfMRI scanning. Both groups were age, gender and education level well-matched. The posterior cingulate cortex (PCC) was chosen as the region of interest (ROI) for detecting the FC changes, and determining if these abnormalities were related to a specific cognitive performance and tinnitus characteristic.

#### Results:

Relative to the healthy controls, tinnitus patients showed increased FC between the PCC and the right medial prefrontal cortex (mPFC). Moreover, the enhanced FC between the PCC and right mPFC was correlated with the poorer TMT-B scores ( $r=0.474$ ,  $p=0.008$ ). These correlations were adjusted by age, gender, education level, GM volume, and mean hearing thresholds. The enhanced FC was not correlated with other tinnitus characteristics or cognitive performances.

#### Conclusions:

The enhanced FC pattern of the PCC that is correlated with cognitive impairment in chronic tinnitus patients, especially the executive dysfunction. Enhanced connectivity pattern within the DMN may play a crucial role in neurophysiological mechanism in tinnitus patients with cognitive dysfunction.

**Keywords:** chronic tinnitus; functional connectivity; resting-state fMRI; default mode network; posterior cingulate cortex.

## **S07-O2**

### **Identification of functional biomarkers of tinnitus and tinnitus/hyperacusis in patients**

*Marlies Knipper<sup>1</sup>, Benedikt Hofmeier<sup>1</sup>, Stephan Wolpert<sup>1</sup>, Lukas Rüttiger<sup>1</sup>, Uwe Klose<sup>2</sup>*

*<sup>1</sup>University of Tübingen, Dept. of Otorlaryngology, Hearing Research Centre Tübingen, Molecular Physiology of Hearing, Elfriede-Aulhorn-Str. 5, 72076 Tübingen, Germany*

*<sup>2</sup>Department of Neuroradiology, Eberhard Karls University, Tübingen, Germany.*

#### **Introduction**

Tinnitus is as a symptomatic malfunction of our hearing system, where phantom sounds are perceived without acoustic stimulation.

#### **Material & Method**

In recent years, we have developed a fingerprint for tinnitus and recently hyperacusis using a combination of behavior animal models for tinnitus/hyperacusis and electrophysiological as well as molecular approaches in the peripheral and central auditory system. The characteristic features that distinguished equally hearing impaired animals with and without tinnitus or hyperacusis are described (Möhrle et al., 2019, Hofmeier et al., 2018, Knipper et al 2013; Rüttiger et al 2013, Singer et al 2013). We aimed to test the knowledge for patients with tinnitus only and tinnitus with co-occurrence of hyperacusis.

#### **Results**

Here we present a clinical pilot studies in hearing-impaired subjects with and without tinnitus in comparison to tinnitus with co-occurrence of hyperacusis. We use audiometric measurements, the analysis of body fluids, and functional magnetic resonance tomography (fMRI) analyzing evoked BOLD fMRI and resting state r-fcMRI.

#### **Conclusion**

The results in defined patient groups are discussed in the context of previous findings gained in animals.

This work was supported by the Deutsche Forschungsgemeinschaft DFG KN 316/10-1; RU 713/3-2 (FOR 2060; RU 316/12-1, KN 316/12-1 (SPP 1608); KN 316/13-1.

## S07-O3

### Abstract Title : Timing, Tinnitus and Localisation of Sounds

Peter J. Hampton

*Institution of Engineering and Technology (IET), UK*

#### Introduction

Tinnitus is usually attributed to spontaneous firing of neurons within the brain. However it could also be that tinnitus is a manifestation of a fast body clock that could be used for localization of sounds as well as having other auditory functions.

This 'clock must have its source within the brain and be applied to both cochleas simultaneously.

If we consider the cochlea as a sampling audio to temporal code converter then a sampling signal,  $F_s$ , of at least twice the highest incoming audio frequency would be required to be applied to the outer hair cells (OHCs). Whilst this would be inaudible in normally hearing subjects, damage to the rows of OHCs could cause the sampling signal to 'change down' to a subharmonic of the normal sampling frequency and be audible as tinnitus. Auditory function and localization of sound sources would still be maintained but at a lower resolution. This talk builds on presentations given by the author at previous conferences over the last few years.

#### Material & Method

1. Attendance at TRI and ITS tinnitus conferences since 2008 and asking questions about the physiology of the cochlea and the nature of the impulses or spikes that must be driving the OHCs.
2. Reading of the available literature on the subjects of tinnitus, localization of sounds, hair cell organization and motility and the physiology of the cochlea.
3. Building up a model for transduction of sounds to neuronal impulses that shows the cochlea may be an up-converting array of parametric amplifiers.  
This gives high gain and good selectivity with minimum of distortion whilst redundancy in the rows of OHCs enables continued cochlear function in the event of single or multiple OHC damage. Such damage may result in remaining OHCs needing to fire at a lower rate than normal – hence giving rise to tinnitus.
4. Comparing prior models with that given in this work shows a better agreement with effects observed in practice and gives a rational explanation for the *function* of tinnitus which is even lacking in current models.
5. Otoacoustic emissions (OAEs) and tinnitus. A test that needs to be done is to find out whether and by how much tinnitus precludes OAE production. OAEs may be produced in 'perfect ears' by the intermodulation of two test tones and the  $F_s$  signal. If the  $F_s$  signal is degraded to a half or third its original frequency the OAEs may still be produced but will not be so easy to discriminate from other intermodulation products within the ear.

#### Results

As a retired physics teacher and electronics engineer the necessity for a fast bodily clock seems to be a fundamental requirement for auditory function and spatial localization of sounds. Tinnitus could be an obvious candidate for a periodic signal capable of timing the arrival of sounds at each cochlea to give us our auditory spatial awareness. Hearing the tinnitus would be an indicator of the fact that damage has been done to the OHCs and the angular resolution of sound sources would be degraded as compared to the normal hearing sampling signal  $F_s$  which is likely to be of the order of 20-24 kHz. There are many experiments that can be done to verify parts of this model and collaboration with interested teams is most welcome. The tinnitus sampling signal will be generated within the brain and applied to both cochleas simultaneously.

#### Conclusion

This idea of tinnitus being a sub-harmonic of an internal sampling signal generated by the brain needs to be investigated further. It overlays a functional requirement for tinnitus on current models and fits in well with observed results from many experiments and studies. Converting sounds within the cochlea to a higher frequency band by adding the sampling frequency should result in reduced distortion as harmonic distortion products will be easily filtered out at the higher frequencies. I very much hope that this talk will generate collaborative work in this area.

## **S07-S1**

### **Perceptual consequences of tinnitus**

*Fan-Gang Zeng, University of California, Irvine, CA, USA*

Tinnitus is auditory perception in the absence of apparent auditory stimulation. Tinnitus affects ~20% of the general population and is increasingly prevalent with age, hearing loss, noise exposure and ototoxicity. Several neural codes have been suggested to correlate with tinnitus, ranging from central hyperactivity to maladaptive plasticity and network abnormality. Despite extensive tinnitus research, few studies have focused on perceptual consequences of tinnitus, resulting in many claims such as tinnitus filling in the gap or impairing speech perception that lack solid experimental support. Here I present systematic psychophysical data from gap detection to discrimination of intensity and frequency as well as masking, modulation detection and speech perception in noise. A unique feature of the present study was that the carrier intensity and frequency were matched to tinnitus loudness and pitch on an individual basis in these basic psychophysical tests. Surprisingly under these carefully controlled conditions, tinnitus subjects produced equal, or even sometimes slightly better performance than the non-tinnitus control subjects. The present result suggests that tinnitus has minimal impact on normal auditory perception. A computation model treating tinnitus as central noise with increased attentional gain can account for not only the lack of perceptual consequences of tinnitus but also several mysteries in tinnitus perception. For example, the discrepancy between high tinnitus loudness rating and low-level match to an external tone can be readily explained by the increased attentional gain in the rating task and the decreased gain in the matching task. The present study has also implications for tinnitus diagnosis and treatment.

## **S07-S2**

This presentation concerns neuromodulation studies performed in Asia. Common features and regional characteristics of these different from other continents will be reviewed and discussed. In Asia, various neuromodulation studies also have been performed for treatment of tinnitus. These include rTMS, tDCS, and tVNS. For rTMS, it was reported to safe but not long-lasting treatment and it can alleviate patients with catastrophic tinnitus. In order to increase the treatment effect, combination of stimulation sites such as prefrontal cortex – auditory cortex, change in stimulation target or frequencies, numbers of stimuli have been currently studied. For tDCS, combination of tailor-made notched music therapy was studies. Last, Asian is more familiar with tVNS because it is similar to acupuncture and various studies on diverse diseases have widely studied.

## **S07-S3**

### **Auditory experience and unsolicited compensation for hearing loss as prerequisites for the perception of tinnitus: insights from hearing loss without tinnitus**

*Jae-Jin Song*

Recent studies have suggested that, as the human brain works in a Bayesian manner to reduce environmental uncertainty, missing auditory information due to hearing loss may cause auditory phantom percepts. This type of deafferentation-induced auditory phantom percept should be preceded by auditory experience because the fill-in phenomenon is based upon auditory prediction and the resultant prediction error. Also, although most people develop some degree of hearing loss, only some of them suffer from tinnitus while others do not perceive tinnitus. Based on these premises, 4 studies will be delivered in this talk to explore the prerequisites for tinnitus: 1) a comparison between 20 subjects with congenital single-sided deafness (SSD) and 44 subjects with acquired SSD with regard to the presence and characteristics of tinnitus; 2) a comparison between 15 subjects with unilateral better-ear tinnitus and 20 subjects with unilateral worse-ear tinnitus with regard to the characteristics of tinnitus and the duration of hearing loss; 3) a comparison between 61 subjects with HL with tinnitus (HL-T) and 61 subjects without tinnitus (HL-NT) with regard to resting-state quantitative electroencephalography (rs-qEEG) findings to reveal cortical activity differences between the two groups; and 4) a comparison between 61 HL-T subjects and 61 HL-NT subjects with regard to volume entropy and inflow differences based on rs-qEEG data. By delivering these 4 studies, I would conclude that auditory experience and unsolicited cortical compensation for hearing loss are prerequisites for the perception of tinnitus

## **S07-S4**

### **TINNITUS IN THE BRAIN**

*Josef P. Rauschecker*

*Georgetown University Medical Center*

*Washington, DC, USA*

The opinion that tinnitus is a purely auditory disorder has long been discarded. The suffering caused by tinnitus in many patients, which ends in suicide in a large number of cases (22 per day in US veterans according to estimates by the Washington Post!), is conveyed by brain structures outside the auditory system. The limbic system, consisting of a number of cortical and subcortical brain regions, has long been considered a likely site for the emotional corollaries of tinnitus. Neuroimaging has provided hard evidence for an involvement of limbic structures in tinnitus, such as the limbic part of the prefrontal cortex and the ventral striatum (n. accumbens). Connectivity studies have revealed changes in the connections between the auditory and limbic systems in tinnitus sufferers. Nevertheless, the overwhelming majority of tinnitus studies still concentrates on changes in the auditory system, hoping that relief of the auditory symptoms would also relieve what are commonly considered as emotional “reactions” to tinnitus. This view assumes that changes in the auditory system are the only cause of tinnitus, and the emotional problems are a consequence of it. However, given that stress and insomnia can modulate and exacerbate existing tinnitus, causality may go in the opposite direction: According to this “frontostriatal gating” theory, frontal cortex and the striatum together form a system for executive control of sensory-perceptual events. A broken frontostriatal gating system would no longer suppress or attenuate the tinnitus signal. If this theory is correct, it would appear promising to work on fixing the broken limbic structures, either by brain stimulation or by researching pharmacological treatments.



**S07-S6**

Tinnitus is the perception of a phantom sound in the absence of sound. Chronic tinnitus is experienced by approximately 10% of adults in various countries. Patients often suffer from a drop in the quality of life caused by insomnia, lack of concentration, and excess of anxiety and depression. Previous studies have reported the relationship between tinnitus and distress. The analysis in the total 1424 patients who consulted our institute for treatment of tinnitus also showed the significant positive correlation between THI scores and SDS and STAI (state) scores. In addition, antidepressants such as tricyclic antidepressant and selective serotonin reuptake inhibitors (SSRIs) have been reported to be effective in treating patients with severe tinnitus. It is recently reported that the gene polymorphism may contribute to depression, anxiety disorder and the response to antidepressant drugs. In this study we would like to present the gene-related characteristics of tinnitus and the annoyance of tinnitus.

## S08-O1

### The effects of masking therapy in tinnitus patients are characterized by longitudinally altered local activity and functional connectivity after intervention

Lv Han<sup>1</sup>, Zhao Pengfei<sup>1</sup>, Liu Chunli<sup>2</sup>, Yang Zhenghan<sup>1</sup>, Gong Shusheng<sup>2\*</sup>, Wang Zhenchang<sup>1\*</sup>

<sup>1</sup>Department of Radiology, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

<sup>2</sup>Department of Otolaryngology Head and Neck Surgery, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

#### Introduction:

Masking therapy serves as an effective way to induce relief of adverse tinnitus sensations. However, the neural modulation of tinnitus-related synchronous activity after effective masking therapy with potential therapeutic benefit remains unclear.

#### Material &Method:

In this study, we recruited 30 tinnitus patients and performed resting-state functional magnetic resonance imaging scans at baseline and after 12 weeks of masking therapy intervention. Thirty age- and gender-matched healthy controls were also longitudinally scanned twice over a 12 week interval. Data were analyzed by via ALFF (amplitude of low-frequency fluctuation) and seed-based functional connectivity (FC) to measure significantly altered local brain spontaneous activity and its connections. Correlation analyses were performed on changes observed in the Tinnitus Handicap Inventory (THI) score and on altered functional activity measurements (i.e., ALFF and seed-based FC).

#### Results:

Treatment-related changes in local neural activity assessed by ALFF values were observed in the left parahippocampal gyrus and right superior temporal gyrus (STG), the hub region belonging to the primary auditory cortex). Importantly, local functional activity in the left parahippocampal gyrus approached normal levels, but activity in the right STG extended beyond a relatively normal range after masking intervention. These changes were found to be positively correlated with changes in the THI score after treatment. Significant group-by-time interaction effects on the FC were observed between the left parahippocampal gyrus and the left right anterior cingulate cortex and left middle cingulate cortex.

#### Conclusion:

We prove our hypothesis that abnormal local neural activity is altered longitudinally in tinnitus patients after masking therapy, suggesting the presence of a compensation mechanism after intervention. Such an understanding could benefit from the elucidation of treatment effects on neural activity, which would be crucial to identifying biomarkers for monitoring the treatment efficacy of tinnitus masking therapy.

#### Key Words:

Tinnitus; Masking therapy; fMRI; ALFF; Functional connectivity; Neural biomarker

#### Reference:

1. Bauer, C.A., Tinnitus. New England Journal of Medicine, 2018. 378(13): p. 1224-1231.
2. Husain, F.T. and S.A. Schmidt, Using resting state functional connectivity to unravel networks of tinnitus. Hear Res, 2014. 307: p. 153-62.
3. Lv, H., et al., Resting-State Functional MRI: Everything That Nonexperts Have Always Wanted to Know. AJNR Am J Neuroradiol, 2018. 39(8): p. 1390-1399.
4. Ueyama, T., et al., Alterations of Regional Cerebral Blood Flow in Tinnitus Patients as Assessed Using Single-Photon Emission Computed Tomography. Plos One, 2015. 10(9): p. e0137291.
5. Maudoux, A., et al., Auditory resting-state network connectivity in tinnitus: a functional MRI study. PLoS One, 2012. 7(5): p. e36222.

## **S08-O2**

### **Therapeutic effects of Vibrant Soundbridge on tinnitus accompanied with sensorineural hearing loss**

*Yong Seok Jo<sup>1</sup>, Hyun Jin Lee<sup>2</sup>, Jeon Mi Lee<sup>1</sup>, In Seok Moon<sup>3</sup>*

*<sup>1</sup> Department of Otorhinolaryngology, Ilsan Paik Hospital, Inje University College of Medicine*

*<sup>2</sup> Department of Otorhinolaryngology, Incheon St.Mary's Hospital, College of Medicine, The Catholic University of Korea*

*<sup>3</sup> Department of Otorhinolaryngology, Yonsei University College of Medicine*

#### **Introduction**

Tinnitus is a common symptom in patients with hearing loss, and few studies have reported successful tinnitus suppression with hearing devices. Active middle ear implantation using Vibrant Soundbridge (VSB) is a good alternative to existing hearing devices. The aims of this study are to evaluate the effects of VSB on tinnitus and to identify the main factor that affects tinnitus suppression.

#### **Material & Method**

The study participants were 16 adults who have tinnitus with sensorineural hearing loss, and who underwent VSB implantations. Pure-tone audiometry; word recognition test; tinnitus handicap inventory (THI); and visual analog scale (VAS) for loudness, awareness, and annoyance were measured before and 12 months after surgery. Changes in hearing threshold, word recognition scores (WRSs), THI scores, and VAS scores were analyzed.

#### **Results**

VAS scores showed significant improvements from pre-operation to 12 months postoperatively in loudness ( $p = 0.005$ ), in awareness ( $p = 0.011$ ), and in annoyance ( $p = 0.004$ ). THI scores also showed a significant decrease ( $p = 0.017$ ). Average hearing threshold level, WRS, and most comfortable levels (MCL) showed significant improvements at 12 months post-operatively ( $p < 0.001$ ,  $0.048$ , and  $0.001$ , respectively). Among the aforementioned factors, changes in MCL were best correlated with those in THI scores ( $p = 0.002$ ).

#### **Conclusion**

VSB implantation is beneficial in subjects with tinnitus and concomitant sensorineural hearing loss. The changes in THI scores best correlated with those in MCL. This improvement may represent a masking effect that contributes to tinnitus suppression in patients with VSB implantation.

## **S08-O3**

### **Cochlear implantation in single sided deafness: influence of laterality on audiological, clinical and neuroimaging data**

*Nicole Peter<sup>1</sup>, Colette Hemsley<sup>1</sup>, Rudolf Probst<sup>1</sup>, Georgios Mantokoudis<sup>2</sup>, Pascal Senn<sup>3</sup>, Wilhelm Wimmer<sup>4</sup> Tobias Kleinjung<sup>1</sup>*

<sup>1</sup> *Universitätsspital Zürich, ORL-Klinik, Zürich, Schweiz*

<sup>2</sup> *Inselspital Bern, ORL-Klinik, Bern, Schweiz*

<sup>3</sup> *Hôpitaux Universitaires de Genève, ORL Département, Genève, Suisse*

<sup>4</sup> *Universität Bern, ARTORG Center for Biomedical Engineering, Bern, Schweiz*

#### **Introduction:**

The study investigated the influence of laterality in single sided deafness on audiological, clinical and neuroimaging data before and after cochlear implantation (CI). The goal was to investigate if the side of deafness had an impact on clinical improvement and if any differences could be related to functional neuroimaging data.

#### **Material & Method:**

In a prospective, multicenter study, 10 patients with unilateral deafness (5 right, 5 left) were treated with a cochlear implant during the period from 2013 to 2016 in Bern and Zurich. Pre- and 12 months postoperatively directional hearing, speech understanding in noise and various questionnaires (Tinnitus Handicap Inventory (THI), General Health Status (WHOQOL-BREF), Speech, Spatial Listening and Hearing Quality (SSQ), Bern Benefit in Single Sided Deafness Questionnaire (BBSS)). A H2O PET measurement with an auditory task was performed before and 9 months after implantation. In addition, the population was compared to a healthy control group.

#### **Results:**

Patients with right-sided deafness demonstrated a more pronounced improvement of speech comprehension in noise as well as improved spatial hearing abilities compared to the left-sided deaf subjects after CI-implantation. The questionnaires SSQ and BBSS confirmed the audiological collected data. Basically, all patients showed a significant reduction in tinnitus impairment (THI) and a significant improvement in quality of life (WHOQOL-BREF) after CI implantation. The left-sided deaf subjects revealed a higher tinnitus burden preoperatively and demonstrated a clearer improvement after cochlear implantation. The clinical improvement could be substantiated by functional neuroimaging data.

#### **Conclusion:**

In our small group CI implantation revealed a clinical improvement of the hearing and tinnitus situation in all patients. Right-sided deaf subjects showed a clearer improvement of speech understanding in noise and directional hearing after CI implantation, whereas left-sided deaf patients showed a clearer tinnitus improvement.

## **S08-O4**

### **The Efficacy of Hearing Aids for Tinnitus and Emotional Outcome.**

#### **Introduction**

The use of hearing aids has been well-documented to reduce tinnitus perception and improve patient's quality of life. But there is little evidence for its serial treatment effect in previous study. This study demonstrated the serial hearing aid treatment outcome for tinnitus and related psychological problem.

#### **Material &Method**

This study is a longitudinal study. We collected 219 users of unilateral or bilateral hearing aids who had tinnitus problem. All the patients must wear unilateral or bilateral hearing aides at least for 2 months. All participants have to complete questionnaires of THI(Tinnitus Handicap Inventory), HADS ( Hospital Anxiety and Depression Scale), HADS-B and reported VAS ( visual analog scale) of tinnitus. We used THI ( Tinnitus Handicap Inventory) and VAS ( visual analog scale) to evaluate the subjective treatment outcome of tinnitus. HADS and HADS-B were used for emotional outcome, including anxiety and depression assessment.

#### **Results**

The result showed a longitudinal outcome of tinnitus condition and related anxiety and depression outcome. We found the significant difference in tinnitus VAS( visual analog scale), THI(Tinnitus Handicap Inventory) score and HADS( Hospital Anxiety and Depression Scale) before the use of unilateral or bilateral hearing aids and after fitting the hearing aids. The hearing aids provides persisted improvements for tinnitus, anxiety and depression related to tinnitus.

#### **Conclusion**

Analysis of the results evidences that the use of unilateral or bilateral hearing aids reduce tinnitus perception and tinnitus related anxiety and depression. Based to our data and research, hearing aids provides persisted effect for tinnitus and related emotional outcome.

## **S08-O5**

### **Effect of sound therapy with hearing aids for treatment of chronic tinnitus in Japan**

Noriomi Suzuki<sup>1)2)</sup>, Naoki Oishi<sup>1)</sup>, Seiichi Shinden<sup>1)3)</sup>, Kaoru Ogawa<sup>1)</sup>

*1) Department of Otolaryngology, Head and Neck Surgery, Keio University School of Medicine*

*2) Department of Otolaryngology, National Hospital Organization Tochigi Medical Center*

*3) Department of Otolaryngology, Saiseikai Utsunomiya Hospital*

#### **Introduction**

In Japan, the treatment of chronic subjective tinnitus using sound therapy with hearing aids has become the standard practice. This study aimed to evaluate the effect of this therapy on patients with chronic tinnitus associated with hearing loss.

#### **Material & Method**

The study included 418 individuals with bilateral mild to severe hearing loss who received sound therapy with hearing aids for three months at the Department of Otolaryngology in Saiseikai Utsunomiya Hospital.

To determine the impact of tinnitus on the patients' quality of life, the subjects completed a series of questionnaires including the Tinnitus Handicap Inventory (THI), Visual Analogue Scale (VAS), and the questionnaire of subjective symptom improvement.

Data were collected at entry and three months after the beginning of treatment.

#### **Results**

The average THI score of these patients before treatment was  $53 \pm 25$ . The average score significantly decreased to  $9 \pm 13$  after treatment.

The average VAS scores for tinnitus loudness and annoyance before the treatment were  $70 \pm 22$  and  $75 \pm 26$ , respectively. These scores also decreased significantly to  $23 \pm 26$  and  $18 \pm 24$ , respectively.

Over 85% of the patients claimed an improvement in tinnitus on their response to the questionnaire of subjective symptom improvement.

#### **Conclusion**

This study revealed that sound therapy with appropriate hearing aids fitting could reduce the psychological distress in patients with chronic tinnitus associated with hearing loss and improve their quality of life.

## S08-O6

### **Cochrane review of sound therapy (using amplification devices and/or sound generators) for tinnitus**

Magdalena Sereda<sup>1,2</sup>, Jun Xia<sup>3</sup>, Amr El Refaie<sup>4</sup>, Deborah A Hall<sup>1</sup>, Derek J Hoare<sup>1,2</sup>

<sup>1</sup> Hearing Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, UK

<sup>2</sup> NIHR Nottingham Biomedical Research Centre, Nottingham, UK

<sup>3</sup> Cochrane Schizophrenia Group, University of Nottingham, Nottingham, UK

<sup>4</sup> Department of Speech and Hearing Sciences, University College Cork, Cork, Ireland

#### **Introduction**

In a recent scoping review to define priority topics for new Cochrane systematic reviews, a review on sound therapy was identified as a high priority (interventions are used in clinical practice, there is 'no recommendation' for tinnitus in current management guidelines, published randomised controlled trials are available). We therefore conducted a systematic review asking whether sound therapy (using amplification devices, sound generators or both) is effective for tinnitus in adults.

#### **Material and Method**

Electronic database searches for randomised controlled trials recruiting adults with acute or chronic subjective tinnitus were performed. The primary outcomes of interest were tinnitus symptom severity and severe adverse effect. We followed current Cochrane methodological procedures for quality assessment and data analysis.

#### **Results**

Eight studies were included (with a total of 590 participants). No data for our outcomes of interest were available for comparison of interventions (hearing aids, sound generators or combination devices) to controls (waiting list group, placebo or education/information only). Limited data directly comparing devices were available. Only one comparison (hearing aids versus sound generators) was suitable for meta-analysis (three studies, 114 participants). This meta-analysis demonstrated an equivalence of the two interventions in terms of change in tinnitus symptom severity (standardised mean difference -0.15, 95% confidence interval -0.52 to 0.22). Adverse effects were not assessed in any of the included studies. In general, risk of bias was unclear due to lack of detail about sequence generation and allocation concealment, and little use of blinding.

#### **Conclusion**

Further research should establish the effectiveness of sound therapy options for tinnitus compared to controls. One such trial (HUSH, trial ID: ISRCTN14218416) is now ongoing in the UK; a multicentre randomised controlled feasibility trial comparing hearing aids to education/information only.

## **S08-S1**

### **Hearing aids for relieving tinnitus co-morbid with high-frequency hearing loss**

*Eui-Cheol Nam<sup>1</sup>*

*<sup>1</sup>Department of Otolaryngology, Kangwon National University, School of Medicine, Chuncheon, Republic of Korea*

#### **Introduction:**

Hearing aids (HA) with frequency-lowering strategy have been used for high-frequency hearing loss (HFHL), but their effectivity on tinnitus relief has not been studied extensively. We investigated and compared tinnitus suppression effect of conventional type HA (using wide dynamic range compression) and frequency-lowering HA in patients with HFHL through a randomized double-blind clinical trial following CONSORT (consolidated standards of reporting trials) guidelines.

#### **Material & Method:**

94 chronic tinnitus patients with HFHL were randomized into three groups (A: conventional HA, B: HA with frequency translation, C: HA with linear frequency transposition). Participants were asked to wear HA for 3 months and then discontinue. The final follow-up was 3 months after cessation of wearing HA. Tinnitus Handicap Inventory (THI) score and additional variables such as matched tinnitus loudness and visual analogue scale of subjectively perceived tinnitus loudness, daily duration and annoyance were measured at initial visit, and 3 and 6 months follow-ups.

#### **Results:**

There was no differences in initial demographic, hearing or tinnitus characteristics between the three groups. THI score and most of the additional outcomes were significantly improved at both 3 and 6 months compared to their initial values in all three groups. Incidence of patients who improved THI score at least 20% was 71.0, 72.7, and 74.3% at 3 months, and 54.8, 51.6, and 59.4% at 6 months for A, B, and C group, respectively. However, no significant difference was observed between HA groups at either 3 or 6 months for either variable.

#### **Conclusion:**

Our study demonstrated tinnitus-suppression effect of HA alone without accompanying counselling or other treatments. Regardless of amplification strategy types, wearing HA was effective for relieving tinnitus in patients with HFHL and the effect seemed to last at least 3 months after removing HA.



## S08-S2

### **Neural substrates of tinnitus in an auditory brainstem implant patient: a preliminary molecular imaging study using H<sub>2</sub><sup>15</sup>O-PET including a 5-year follow-up of auditory performance and tinnitus perception**

*Annick Gilles, Jae-Jin Song, Anouk Hofkens, Griet Mertens, Cordula Matthies, Steven Staelens, Sigrid Stroobants, Olivier Vanderveken, Vedat Topsakal, Paul Van de Heyning, Vincent Van Rompaey*

#### **Introduction:**

It was previously demonstrated that tinnitus due to profound unilateral hearing loss can be treated by use of electrical stimulation via a cochlear implant (CI) with long-lasting positive effects. In cases where patients are not suitable for cochlear implantation due to aplasia/hypoplasia, cochlear malformations etc. an auditory brainstem implant (ABI) may be a solution. While auditory performance with ABI is well-investigated, it is currently unknown whether stimulation through ABI also renders tinnitus reduction in patients with incapacitating tinnitus. The current case study reports on the subjective tinnitus perception during a five-year follow-up period. In addition, a first H<sub>2</sub><sup>15</sup>O PET imaging study in an ABI patient is carried out revealing underlying neural substrates of tinnitus.

#### **Methods:**

A 56-year old male single-sided deaf patient with incapacitating tinnitus received an ABI after insufficient auditory performances and only minor tinnitus reduction with CI. Audiological follow-up was carried out during a five-year follow-up period comprising pure tone audiometry, speech-in-quiet testing, speech-in-noise testing, tinnitus questionnaires (Tinnitus Questionnaire (TQ) and Numeric Rating Scale (NRS)) and the HISQUI19 questionnaire. In order to investigate the neural substrates of tinnitus in this subject, H<sub>2</sub><sup>15</sup>O PET tomography scans were acquired in three different conditions: 1) ABI switched off which was considered as the resting-state measurement rendering the loudest possible tinnitus for the patient (ABI OFF); 2) ABI switched on causing a small suppression of tinnitus due to electrical stimulation (ABI ON); 3) ABI switched on and 70 dB SPL white noise presented directly to the external audio processor through a direct audio cable providing the maximum tinnitus suppression for the patient (NOISE).

#### **Results:**

Subjectively the patient reported a significant tinnitus reduction after implantation which remained stable over time with a decrease on TQ from grade 4 to grade 2 and a 50% reduction on the NRS (from 8 to 4) during the five-year period. Comparing the ABI OFF and ABI ON condition, significant increase of rCBF was observed in brain areas involved in the salience network showing already suppression of tinnitus only by electrical stimulation in the absence of auditory stimuli. The NOISE condition showed relatively decreased rCBF in the insula (as well as in the orbitofrontal cortex) as compared with the ABI OFF condition. Abnormally activated areas comprising the salience network may have been significantly suppressed by the NOISE condition both by acoustic and electrical stimulations of the auditory pathway. Moreover, the NOISE condition showed significantly decreased rCBF in the parahippocampus (PHC) as compared with the ABI OFF condition. This finding supports the idea of distinct tinnitus generators depending on the amount of hearing loss.

#### **Conclusion:**

The reduction of tinnitus in the current ABI subject may be attributable to partial peripheral reafferentation-induced deactivation of the PHC-based tinnitus generator as well as the salience network. Further validation is required by use of a follow-up study with a larger number of subjects.

## **S08-S3**

### **Cochlear implant for tinnitus and Single Sided Deafness in Chinese patients**

*TONG Michael Chi-Fai, YEUNG Kammy Ngan-kam*

*Department of Otorhinolaryngology, Head and Neck Surgery and Institute of Human Communicative Research, The Chinese University of Hong Kong*

#### **Objective:**

To evaluate the benefit and efficacy of cochlear implantation in patients with acquired unilateral severe-to-profound hearing loss and in combination with severe tinnitus.

#### **Methods:**

Nine adult patients (4 males and 5 females) aged 27 to 65 years (mean 46.4 years of age), who has unilateral severe-to-profound deafness and complaints of severe tinnitus, received cochlear implantation. Word and sentence recognition scores in quiet and in noise in the implanted ear 24 months after device activation were compared with pre-implant scores. Tinnitus pitch and loudness were measured with Vernon and Meikle's procedure and Visual Analog Scale. Tinnitus distress was measured with Tinnitus questionnaire (TQ). All outcome measures were measured pre-operatively, and at 1, 3, 6, 12 and 24 months post-operatively.

#### **Results:**

There was no significant improvement in 3 patients whose unilateral deafness was over 10 years in word and sentence recognition tests at six time points. ANOVA within-subject factor suggested a significant improvement in other 6 patients, suggested duration of deafness influenced the outcomes significantly. Tinnitus loudness reduced significantly across time (mean $\pm$ SD; pre-op, 6.8 $\pm$ 10.7; post 1 month, 4.9 $\pm$ 8.1; post 3 months, 3.8 $\pm$ 7.9; post 6 months, 3.4 $\pm$ 6.0; post 12 months, 3.4 $\pm$ 6.0; post 24 months, 2.6 $\pm$ 6.9), which demonstrated a positive effect of CI stimulation.

#### **Conclusions:**

The preliminary results suggested that cochlear implantation can improve hearing in patients suffering from unilateral severe to profound deafness. The outcomes of this study demonstrated that cochlear implant may be an effective treatment for unilateral tinnitus in this population.

## **S09-O1**

### **The Efficacy of Cochlear Implantation in Subjects with Hearing Loss and Tinnitus.**

*David Chen-Yin Wu<sup>1</sup>, Lieber Po-Hung Li<sup>1,2</sup>*

*Department of Otolaryngology, Cheng Hsin General Hospital, Taipei, Taiwan<sup>1</sup>*

*Faculty of Medicine, School of Medicine, National Yang Ming University, Taipei, Taiwan<sup>2</sup>*

#### **Introduction**

Cochlear implants (CIs) have become a standard method to rehabilitate severe-to-profound sensorineural hearing loss. In some cases, cochlear implantation has also reduced reported tinnitus. The aim of this presentation is to share the experience of tinnitus management by using cochlear implantation in patients suffering from hearing loss and accompanied by tinnitus and the treatment and psychological outcomes of cochlear implants (CIs) as a treatment for tinnitus.

#### **Material & Method**

Subjects with profound hearing impairment with tinnitus were recruited in this study. All subjects underwent implantation of a multichannel CI. The device was switched on within 24 hours after cochlear implantation. A visual analog scale (VAS), The Hospital Anxiety and Depression Scale (HADS) and the Tinnitus Questionnaire (Tinnitus Handicap Inventory, THI) were used for evaluation before and after the operation in specific time periods. The differences scores of the questionnaires were compared and analyzed.

#### **Results**

The collected data demonstrated a consistent reduction in tinnitus loudness with electrical stimulation in CI subjects. These findings are consistent with our other recent study findings, and the THI, VAS, HADS scores all showed improvement after the operation.

#### **Conclusion**

Analysis of the results evidences that the use of Cochlear implants (CIs) improves tinnitus and improved the patients' emotional state. Significant reduction in severity of tinnitus was noted after the initial fitting and remained stable.

## **S09-O2**

### **Abstract Title (Times New Roman, 14pt, Bold)**

*Che-yang Lin<sup>1</sup>, Che-Yang Lin<sup>2</sup>, Chang-Wei Huang<sup>3</sup>*

*<sup>1</sup>.Department of Otolaryngology, Kuang-Tien General Hospital, Taichung, Taiwan*

*<sup>2</sup> Department of Otolaryngology, Kuang-Tien General Hospital, Taichung, Taiwan*

*<sup>3</sup> Department of Otolaryngology, Kuang-Tien General Hospital, Taichung, Taiwan*

### **Introduction (Times New Roman, 12pt, Bold):**

The cure for tinnitus is an ever-changing technology, there has been a theory for pulsatile tinnitus about high riding jugular bulb with dehiscence, involving microscope for surgery(post-aural /endaural),using self tissue or bone cement to repair. Even though there has been different opinion for this treatment, but studies have shown it has brought some effects.

Our ENT department has brought a new way: using endoscopic for surgery to treat HJB that causes pulsatile tinnitus

### **Material &Method (Times New Roman, 12pt, Bold):**

A brief Methods section with enough detail to ensure reproducibility of the research (Times New Roman, 12pt).

We collected 4 patients (all female), three of which is right sided and one left.

Through the endoscopic surgery, putting bone scraps from the ear canal in the HJB, then covering up with tragus perichondrium

### **Results (Times New Roman, 12pt, Bold):**

Three out of four had immediate improvement. And the last one after 6 months of check ups, all her symptoms has slowly disappeared. It has a minimal invasive wound ,endoscopic surgery has given good results.

### **Conclusion (Times New Roman, 12pt, Bold):**

By using surgically repairing the HJB to treat pusatile tinnitus has given the opportunity to treat tinnitus with surgery. We try using endoscopic surgery to fix the HJB is a whole new way, and gives good outcome.

## **S09-O3**

### **Tinnitus in the side with better hearing**

*Ho Yun Lee<sup>1</sup>*

*<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, Eulji University, Daejeon, South Korea*

#### **Introduction:**

We aimed to confirm the characteristics of patients with tinnitus in the better-hearing side.

#### **Material &Method:**

Among the 778 patients who visited the tinnitus clinic complaining of unilateral tinnitus at a local university hospital between March 2014 and December 2017, we recruited 62 patients who showed tinnitus in the better-hearing side on pure-tone audiometry. The mean hearing threshold was calculated using the arithmetic mean of the pure tone thresholds at 1, 2, 3, and 4 kHz. In addition, patients' medical history, tinnitus questionnaires, and other audiologic test results were thoroughly analyzed together for diagnosis.

#### **Results:**

Fluctuating hearing loss without vertigo or Ménière's disease were the most common etiologies (n = 16, 25.8%), followed by high-frequency hearing loss (n = 13, 21.0%), sudden idiopathic hearing loss (n = 6, 9.7%), and presbycusis (n = 6, 9.7%). Somatosensory tinnitus was also observed in seven patients. Neck pain was associated with tinnitus in five patients (8.1%), and two other patients (3.2%) experienced temporomandibular disorder in the same side as the tinnitus.

#### **Conclusion:**

Tinnitus was associated with deterioration of hearing even when it occurred in the better-hearing side. Among the possible etiologies, fluctuating hearing loss in the tinnitus side was the most common audiologic finding. Assessment of hearing level at each frequency was more effective in detecting high-frequency hearing loss rather than the use of the mean hearing level. In addition, somatosensory tinnitus should not be ignored.

## **S09-O4**

### **Evaluation of factors related to sigmoid sinus diverticulum originating pulsatile tinnitus based on CT**

Chenyu Jiang<sup>1</sup>, Pengfei Zhao<sup>1</sup>, Chihang Dai<sup>1</sup>, Xuxu Meng<sup>1</sup>, Heyu Ding<sup>1</sup>, Zhenchang Wang<sup>1</sup>

<sup>1</sup> Beijing Friendship Hospital, Capital Medical University

#### **Introduction:**

To evaluate the factors related to sigmoid sinus diverticulum (SSD) originating pulsatile tinnitus (PT) based on CT

#### **Material &Method:**

Fifteen unilateral PT patients who were treated successfully by surgical reconstruction of SSD were retrospectively enrolled as the PT group. Thirty asymptomatic subjects with SSD and gender and age matching (1:2) were included as the control group. The characteristics of SSD and accompanying signs about sinuses, sigmoid sinus wall dehiscence, the degree of mastoid pneumatization and sella turcica were evaluated. The prevalence of these signs were compared statistically and the differences were discussed.

#### **Results:**

Compared with the control group, the mean width, depth, height of SSD was all significantly larger in PT group; the angle formed by the major axis of SSD and the middle line of cerebrum was smaller (31 degrees vs 49 degrees); the prevalence of either ipsilateral transverse sinus stenosis (93% vs 17%) or contralateral transverse sinus stenosis / hypoplasia (93% vs 20%) was much higher and the mean total score of bilateral transverse sinus stenosis was also much larger (7.0 points vs 0.8 points). The prevalence of ipsilateral venous outflow dominance was 60% in both groups. The prevalence of sigmoid sinus wall dehiscence was 100% in the PT group while 73% in the control group; the mean area was larger in former group (13.2 mm<sup>2</sup> vs 8.5 mm<sup>2</sup>). Besides, the prevalence of empty sella (47% vs 17%), high jugular bulb (53% vs 20%) and well pneumatized mastoid bone (67% vs 17%) were also significantly higher in PT group.

#### **Conclusion:**

The hemodynamic partly formed by the diverticulum, bilateral transverse sinus stenosis, intracranial pressure, ipsilateral venous outflow and high jugular bulb may be the root cause of SSD-originating PT; the sigmoid sinus wall dehiscence may be the requirement for PT transmitting to the inner ear.

## **S09-S1**

### **Intratympanic steroid injection in the treatment of acute subjective tinnitus**

*Hyun Joon Shim, Hyeon Sik Oh, Eun Sub Lee, Yong-Hwi An*

*Department of Otorhinolaryngology-Head and Neck Surgery, Eulji University School of Medicine, Eulji Medical Center, Seoul, Korea*

Although the therapeutic effect of ITD for acute subjective tinnitus (AST) is still controversial, we believe that ITD is therapeutic in the early stage of tinnitus based on the rationale given below. First, the majority of tinnitus is triggered by cochlear damage, and there is a time window in which this damage can be reversed. Second, we surmise that in many cases, the etiology and cochlear pathology of acute idiopathic tinnitus are the same as those of sudden SNHL, including viral infection and microvascular obstruction. Third, steroid injected into the middle ear cavity can penetrate the round window membrane and many steroid receptors have been found in the inner ear structures. Forth, ITD is a relatively safe treatment, with few potential complications. We previously reported a randomized controlled trial study of the feasibility of ITD therapy for the treatment of AST within 3 months of its onset; the overall improvement rate, including “cured” cases, achieved with ITD was greater than that of alprazolam (75.8% vs 40.3%, respectively), and the cure rate achieved with ITD was also greater than that achieved with alprazolam (25.8% vs 9.8%, respectively). Our retrospective study to investigate the outcome of treating AST with ITD in 114 subjects indicated that only factor affecting the cure rate of ITD for AST was symptom duration, and unilateral tinnitus was associated with better improvements in symptoms than bilateral tinnitus. Another retrospective study which compared the clinical characteristics and audiological data of wholly cured patients and wholly nonresponsive patients after ITD treatment for AST demonstrated that a short duration of tinnitus, low hearing threshold, female, short tinnitus-awareness time, and no history of immediate noise exposure might be favorable prognostic factors for AST treated with ITD injection.

**S09-S2**

**Results of Sound Therapy for Tinnitus: from Sound Generator to Implantable Hearing Devices**

*Shi Nae Park, MD, PhD*

*Department of Otorhinolaryngology-Head and Neck Surgery, Seoul St. Mary's Hospital,  
College of Medicine, The Catholic University of Korea*

Hyperactivity of the auditory central nervous system caused by the decreased auditory input as a homeostatic response has been known to be a major mechanism of tinnitus generation in hearing impaired patients with tinnitus. Based on this scientific background, sound therapy with various sound therapeutic modalities such as sound generator, hearing aid or even implantable hearing devices could be effective in managing tinnitus.

In this talk, our several clinical study results, showing the good therapeutic effects of directive counseling and two sound therapeutic modalities of hearing aids or sound generator on tinnitus will be introduced. Interesting cases and the scientific evidence showing the effects of various implantable hearing devices, i.e. bone bridge, middle ear implant and cochlear implant on tinnitus will be also presented.

Based on my 20 year experience at specialized tinnitus clinic, I would propose that practical application of a customized sound therapy from sound generator to various implantable hearing device followed by directive counseling is a promising clinical solution for the patient with problematic tinnitus.



## **A novel water occlusion test for the diagnosis of pulsatile tinnitus: Possible pathophysiology and its clinical implications**

<sup>1</sup>Jin Taek Park, <sup>2</sup>Shi Nae Park, <sup>2</sup>Ho Jun Jin, <sup>1</sup>Ja Yoon Koo, <sup>1</sup>Yehree Kim, <sup>1</sup>Min Young Kwak, <sup>3</sup>Ji Won Seo, <sup>4</sup>Chan Il Song, <sup>1</sup>Hong Ju Park

<sup>1</sup>Department of Otorhinolaryngology-Head and Neck Surgery, Asan Medical Center, University of Ulsan, College of Medicine, Seoul, Korea

<sup>2</sup>Department of Otolaryngology-Head and Neck Surgery, The Catholic University of Korea College of Medicine, Seoul, Korea

<sup>3</sup>Department of Otorhinolaryngology-Head and Neck Surgery, Samsung Changwon Hospital, Sungkyunkwan University College of Medicine, Changwon, Korea

<sup>4</sup>Department of Otorhinolaryngology, Yonsei University College of Medicine, Seoul, Korea

### **Introduction:**

The exact pathophysiology of pulsating tinnitus is still unclear. We wanted to describe the results of a novel test which can be done easily in a clinic, water occlusion test, in patients with pulsatile tinnitus related to identifiable radiologic abnormality and to pursue its clinical implications.

### **Material & Method:**

Retrospective analysis of 25 patients with pulsatile tinnitus with identifiable radiologic abnormality. Water occlusion test was performed by filling the external auditory canal with water and the patients were asked whether the pulsatile tinnitus disappeared, decreased or increased. The results of water occlusion test were characterized by the identified radiologic abnormalities and posttreatment results.

### **Results:**

For 20 patients with venous sinus dehiscence (VSD), dehiscence of sigmoid sinus was identified in 16 (80%) and jugular bulb in 5 (25%). Water occlusion test made the pulsatile tinnitus to disappear in 15 (75%), decrease in 3 (15%), and persist in 2 (10%). Ipsilateral neck was compressed in 12 patients and the pulsatile tinnitus disappeared in 10, decreased in 1 and persisted in 1. The sigmoid sinus dehiscence was resurfaced in 4 patients and the pulsatile tinnitus disappeared postoperatively. For 4 patients with arteriovenous fistula (AVF), the pulsatile tinnitus could be heard through a stethoscope and ipsilateral neck compression did not make any change of the tinnitus. The water occlusion test increased the pulsatile tinnitus. They were treated with transarterial embolization. In one patient with superior canal dehiscence, water occlusion test increased the pulsatile tinnitus.

### **Conclusion:**

Our findings showed that sigmoid sinus was the most common site of venous sinus dehiscence which could be identifiable by imaging study and suggested that the pulsation of the venous membrane at the dehiscence site could be transmitted through aeration to the tympanic membrane, causing pulsatile tinnitus, which is different from AVF where the turbulent blood flow caused tinnitus. Our novel diagnostic test might provide a logical insight helping with the choice of an effective diagnostic and treatment option.

## **S10-O1**

### **Treatment for oversensitivity to sound**

*P.W.J. van Hengel<sup>1</sup>, M.E. van Thiel-Eilert<sup>1</sup>, M. van Dijk<sup>1</sup>, A.O.T. Dijkstra<sup>2</sup>*

*<sup>1</sup> Pento Audiologisch Centrum Apeldoorn, Albert Schweitzerlaan 31, 7334 DZ Apeldoorn*

*<sup>2</sup> Praktijk voor Medische Psychologie, Geerdinksweg 139-21, 7555 DL Hengelo*

#### **Introduction:**

Pento Audiological Center Twente started to evaluate the effect of their tinnitus treatment in 2017. One of the outcomes was that some patients did not show improvement, due to problems adapting to hearing aids. This led to the idea that a treatment for oversensitivity to sound before introducing hearing aids might pave the way for effective tinnitus treatment. A simple exposure-based protocol was devised and tested at AC Apeldoorn. Although effective, the protocol needed to be extended, and over the course of a 6-month pilot it developed into a tailor-made treatment for various kinds of oversensitivity to sound. Over the last months, the effectiveness of this treatment has been evaluated.

#### **Material & Method:**

After an intake including standard audiometry and a test to determine which sounds were causing problems and at what exposure level, patients were treated in an average of 6 sessions by a specialized social worker. These sessions consisted of exposure in combination with CGT-based methods to decrease the emotional response to specific sounds.

Severity of the oversensitivity was measured using the HQ before intake, at the last session and 6 months after intake. Exposure levels used in the sessions and annoyance scores were recorded.

#### **Results:**

At the time of submission, data collection is underway. First results indicate a significant effect of treatment on all measured parameters.

#### **Conclusion:**

Based on first results we conclude that exposure-based treatment of oversensitivity to sound is very effective.

## **S10-O2**

### **Psychometric Properties and Factor Structure of a New Scale to Measure the Impact of Hyperacusis**

*Benjamin Greenberg, Psy.D.,<sup>1</sup> Megan Carlos, PhD<sup>2</sup>*

<sup>1</sup> *Boston College, Chestnut Hill, MA*

<sup>2</sup> *American School of Professional Psychology, Alameda, CA*

#### **Introduction:**

Despite increasing interest in hyperacusis and other disorders of auditory sensitivity, there is still a lack of valid, standardized assessment tools to measure symptom severity, treatment outcomes, and diagnostic differentiation. Accordingly, this study sought to create a new scale that is reliable, valid, brief, and easy to score with the purpose of filling this gap.

#### **Material & Method:**

Original items were constructed through review of currently existing models of hyperacusis measurement, as well as qualitative data collected from professional audiologists and individuals reporting heightened audiological sensitivity with tinnitus. An initial 26-item scale yielded sound reliability and validity properties. Refinement based on review of initial data resulted in a 25-question second version with a maximum score of 100. A total of 450 completed survey protocols were analyzed from 469 refined Inventory of Hyperacusis Symptoms (IHS) administrations collected online, representing individuals from 37 countries with a mean age of 34.8 years.

#### **Results:**

Internal consistency reliability analysis yielded a Cronbach's  $\alpha$  of 0.93, indicating excellent reliability. Furthermore, the IHS showed sound convergent validity with established measures of quality of life, anxiety, and depression in bivariate correlation analysis of Pearson's  $r$ . Factor analysis revealed a five-factor dimensional structure, labeled: psychosocial impact, emotional arousal, functional impact, general loudness, and communication. Analysis of variance between perceived global hyperacusis severity categories provided a preliminary framework for scoring thresholds. Although the level of hearing loss did not correlate with IHS scores, increased tinnitus symptoms were a significant factor in predicting hyperacusis distress and severity.

#### **Conclusion:**

Initial results demonstrated sound statistical properties of the IHS, suggesting usefulness as a hyperacusis measurement tool in research and clinical practice. Furthermore, factor structure and scale dimensions allow for differentiation between subtypes of loudness, annoyance, fear, and pain based on responses to specific item clusters within the scale's dimensional factor structure.

## **S10-S1**

### **"Hyperacusis Measurement & Hyperacusis Activities Treatment"**

*Richard S. Tyler, PhD*

*The University of Iowa, Dept of Otolaryngology-Head and Neck Surgery and  
Communication Sciences and Disorders, Iowa City, IA*

#### **Abstract**

Hyperacusis can be measured with loudness estimates and questionnaires. First we determine the Type; Loudness, Annoyance, Fear or Pain Hyperacusis. Patients are different, but the primary functions affected include 1) Thoughts and Emotions, 2) Hearing, 3) Sleep and 4) Concentration. In our Hyperacusis Activities Treatment, we use low-level sound therapy and successive approximations with recorded and real sounds that the patient has identified. Hearing aids can be fit with closed earmolds and lowered maximum output. The maximum output can be gradually increased over several months. With the successive approximations, we begin with recorded sounds at low levels that the patient controls. Over time, the patient can be exposed gradually to the sounds in the particular environment that are troublesome. Initially, the patient has control over the production, level and duration of the exposure. This progresses to the realistic situations.

## **S10-S2**

### **Molecular mechanisms of homeostatic plasticity after noise trauma**

Homeostatic plasticity is aimed at preserving the averaged neural activity roughly constant around a set point value. In case of sensory deprivation, due to hearing loss for instance, the neural excitability is increased to compensate for the decrease in sensory inputs associated to hearing loss. Homeostatic plasticity may contribute to the mechanisms of tinnitus generation through its role in enhancing neural spontaneous activity in auditory centers. The repertoire of the molecular mechanisms involved in homeostatic plasticity is plethoric. The goal of our study was to investigate further these mechanisms with a specific focus on central inhibition and inflammation. We quantified, in the cochlear nucleus and inferior colliculus (IC), the  $\beta 2,3$  sub-units of GABA receptors (GABA<sub>r</sub>), the co-transporters of ion chloride NKCC1 and KCC2 (permits an inflow or outflow of ion chloride, respectively), and microglia (IBA1), in control animals and animals exposed to a noise trauma (at 3 and 30 days after the trauma, d3 and d30, respectively). The effects of noise trauma were different in the ventral cochlear nucleus and dorsal cochlear nucleus. The GABA<sub>r</sub> were reduced in the ventral cochlear nucleus (VCN) but it was increased in the dorsal cochlear nucleus (DCN) at d3. The KCC2 was dramatically reduced in VCN, DCN and IC at d3 and d30, except for VCN at which the level of KCC2 was restored at d30. The number of microglial cells was enhanced at d3 and d30 in VCN and DCN, but was unchanged in IC. The NKCC1 was not expressed neither in control animals nor in animals exposed to noise trauma. Our results show that noise trauma triggers dramatic molecular changes in the cochlear nuclei and inflammation. These changes may contribute to neural hyperactivity after noise trauma and therefore to tinnitus. These results may have clinical implications for a putative pharmacological treatment of tinnitus.

## **S10-S3**

### **Sound-based therapies for tinnitus and hyperacusis**

*Martin Pienkowski, PhD*

Tinnitus (T) and “loudness hyperacusis” (H) are thought to be triggered by hyperactive neurons in the auditory brainstem and cortex. The hyperactivity appears to be a byproduct of central compensation to peripheral hearing loss, and likely involves the potentiation of excitatory neurotransmission and the depression of inhibitory transmission. Successful treatment of hearing loss with surgery, hearing aids, or cochlear implants typically leads to a partial or even complete remission of T and H, presumably by reducing or reversing the hyperactivity. However, not all hearing loss is treatable, and sound therapies have long been a popular additional or alternative treatment for T and H.

The first widely used sound therapy was broadband noise, which was typically filtered only by the frequency response of the sound generator, and enhanced at around 3 kHz by ear canal resonance. Many individuals with T and H reported benefits, but placebo-controlled trials have shown modest efficacy at best. One hypothesis is that the individuals with good outcomes had a hearing loss and/or tinnitus pitch that aligned more closely with the real-ear broadband noise spectrum. Such “targeted” stimulation (even if unintentional) might be more effective in reducing the hyperactivity underlying T and H.

This possibility has led to the recent emergence of a large number of sound therapies (narrowband noises, tone ensembles, music, etc.) that have been filtered in relation to the individual’s hearing loss and tinnitus qualities. Sounds have also been paired with electrical stimulation of the vagus and trigeminal nerves, and have been tried in the context of perceptual and cognitive training (as opposed to “passive” sound therapy), sometimes in video game format. This presentation will summarize these developments, and address topics for future work, expanding on my recent review published in a Neuroscience special issue on T and H (doi: [10.1016/j.neuroscience.2018.09.012](https://doi.org/10.1016/j.neuroscience.2018.09.012)).

## **S10-S4**

### **A Comparison of mechanisms and treatments of tinnitus and misophonia**

*Pawel J. Jastreboff, Ph.D., Sc.D., M.B.A.<sup>1,2</sup>, Margaret M. Jastreboff, Ph.D.,<sup>2</sup>*

*<sup>1</sup>Department of Otolaryngology, Emory University School of Medicine, Atlanta, Georgia, USA*

*<sup>2</sup>JHDF, Inc., Ellicott City, Maryland, USA.*

It is proposed that the neuronal networks involved in tinnitus and misophonia are the same. The difference between these phenomena is that tinnitus-related neuronal activity is generated within the auditory pathways, while in misophonia neuronal activity is evoked by external, bothersome sounds. Mechanisms of both involve pattern recognition, with a crucial role played by subconscious conditioned reflexes linking the auditory system with other systems in the brain, particularly, while not exclusively, with the limbic and autonomic nervous systems.

For both, tinnitus and misophonia, a modified version of passive extinction of conditioned reflexes is implemented in treatment. Specifically, the strength of negative reactions is decreased by removing contribution of cognitive processing (achieved by counseling), while at the same time decreasing the strength of tinnitus- / misophonia-related neuronal activity by increasing the level of stimulation by sounds (sound therapy).

Additionally, for misophonia it is possible to implement the method of active extinction of conditioned reflexes by associating external sound with positive reinforcement during specific exercises which the patient is asked to do. In all protocols a common goal exists to create positive associations with a sound. The most advanced protocol is based on the concept of complex conditioned stimulus. Specifically, the bothersome misophonic triggers are encapsulated in positive sounds and other positive stimuli of various sensory modalities, the patient is exposed to this new stimulus, which induces weaker reactions as compared to when the bothersome sound is presented in isolation. These positive elements are gradually decreased, slowly changing the composition of this complex stimulus.

Results obtained utilizing treatments based on proposed mechanisms from over 2000 tinnitus patients, and about 1000 misophonic patients show the effectiveness of achieving clinically significant improvements in over 80% of patients with tinnitus and / or misophonia.

## **S10-S5**

### **Misophonia enforced by strong hyperacusis**

*Margaret M. Jastreboff, Ph.D.,<sup>1</sup> Pawel J. Jastreboff, Ph.D., Sc.D., M.B.A.<sup>1,2</sup>,*

*<sup>1</sup>JHDF, Inc., Ellicott City, Maryland, USA.*

*<sup>2</sup>Department of Otolaryngology, Emory University School of Medicine, Atlanta, Georgia, USA*

It is very common to find problems with sound tolerance in patients with tinnitus as the primary complaint. Two main distinctly different situations can be identified when decreased sound tolerance is reported. First, when patients react negatively to all sounds louder than a certain level of sound, disregarding meaning of the sound and context in which sound occurs. Second, when patients react negatively only to specific patterns of sound, frequently, but not always, associated with a specific situation / place / person, while being able to tolerate other much louder sounds. These patients can be classified as having hyperacusis and misophonia, respectively.

Interestingly, it is difficult to find patients with strong hyperacusis but without misophonia. The question arises what are the potential mechanisms underlining this observation. Misophonia results from enhanced functional connections between the auditory system and other systems in the brain which are governed by principles of pattern recognition and of conditioned reflexes. Hyperacusis results from increased amplification of sound-evoked activity within subconscious auditory pathways which in turn activate the limbic and autonomic nervous systems. Stronger hyperacusis will always evoke strong negative reactions of these systems which will act as negative reinforcement, and consequently result in creating a conditioned reflex. Therefore, strong hyperacusis will yield misophonia. In case of mild hyperacusis, which induces only mild negative reactions there is a smaller chance of creating conditioned reflexes and therefore mild hyperacusis can exist alone, without misophonia.

On the other hand, misophonia can exist alone without coexisting hyperacusis as an accidental association of a sound with a strong negative emotional state can occur to a sound of any strength, without the need for amplification of the sound-evoked signal within the auditory pathways. Detailed studies correlating the strength of hyperacusis with the prevalence of misophonia are needed to validate this postulate.



## **S11-O1**

### **Effects of Spirulina on GABA receptor gene expression in salicylate-induced tinnitus**

Juen-Haur Hwang<sup>1,2</sup>, Yin-Ching Chan<sup>3</sup>

<sup>1</sup>*Department of Otolaryngology-Head and Neck Surgery, Dalin Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Chiayi, Taiwan.*

<sup>2</sup>*School of Medicine, Tzu Chi University, Hualien, Taiwan.*

<sup>3</sup>*Department of Food and Nutrition, Providence University, Taichung, Taiwan.*

#### **Introduction:**

The function of  $\gamma$ -amino butyric acid receptor (GR) was related with tinnitus. But, the effects of *Spirulina platensis* water extract (SP) on the mRNA expression of GR  $\alpha\beta 3$  (GRA $\beta 3$ ) in mice with tinnitus were still unclear.

#### **Materials and Methods:**

Eighteen SAMP8 mice were divided into the control group (intraperitoneal injection of saline, once per day), the tinnitus group (intraperitoneal injection of salicylate, 300mg/kg body weight once per day), and the spirulina group [intraperitoneal injection of salicylate, 300mg/kg body weight and oral SP supplementation (1000 mg/kg body weight) once per day]. Effects of SP on the mRNA expression of GRA $\beta 3$  in the cochlea and brain of mice were studied for 4 days.

#### **Results:**

Compared to the control group, the tinnitus group had significantly higher tinnitus scores and lower mRNA expression of GRA $\beta 3$  gene in the cochlear, brainstem, hippocampus and parahippocampus, temporal lobes, and the frontal lobes. On the other hand, the spirulina group had significantly lower tinnitus scores and higher GRA $\beta 3$  gene expression than the tinnitus group in all tested areas.

#### **Conclusion:**

SP could reduce salicylate-induced tinnitus possibly via increasing the salicylate-induced down-regulation of GRA $\beta 3$  gene expression.

## S11-O2

### Scope of the Abstract: 04.Clinical Research Methodology , 18.Tinnitus and Vertigo .

*Presentation Type: Oral Presentation*

*Characteristic Analysis of Auditory-Vestibular Function in Patients with Vestibular Migraine*

*Yilin Hou Xiuli LIU*

*Department of Otolaryngology,the First Affiliated Hospital of Dalian Medical University*

#### **Objective:**

The objective of this study was to investigate the hearing and vestibular function of patients with vestibular migraine (VM).

#### **Methods:**

80 patients with confirmed VM were collected from clinical vertigo diagnosis and treatment center which is the first affiliated Hospital of Dalian Medical University. All the patients were examined with detailed medical history inquiry:physical examination of the ears, pure-tone audiometry test(PTA), caloric test and video head pulse test(vHIT). Simultaneously,53 patients with possible vestibular migraine (PVM) were examined with the same test as those with confirmed VM.The differences of auditory function and vestibular function between VM and PVM were analyzed statistically.There was no significant difference in age between the two groups after the balance test between the two groups.

#### **Results:**

There are four types : (1)General status: the ratio of male to female in confirmed VM was 1: 3.44.The age of female patients ranged from 18 to 75 years old and the average age of female patients was  $50.47 \pm 13.02$  years old ; the positive rate of systemic disease was 57.5% and 24 patients with chronic tinnitus symptoms(30%,24/80 ).(2)Characteristics of auditory function in patients with confirmed VM:①30 of 80 patients with abnormal PTA (the abnormal rate is 37.5% , 30/80) , 17 of 30 patients with abnormal PTA value had bilateral ear abnormalities(the abnormal rate is 56.7% , 17 / 30) ; ②Abnormal degree of PTA in 80 cases (160 ears) : 40 ears with mild hearing loss ( 25% , 40/160 ) , 5 ears with moderate hearing loss ( 3.1% , 5/160 ) , 2 ears with severe hearing loss (1.3% , 2/160) , No patients with severe hearing loss.Mild hearing loss was predominant in patients with confirmed VM.③Hearing loss types in 80 cases (160 ears) : The hearing loss rates of 160 ears at high frequency, low frequency, middle frequency and full-frequency were 33.8%,1.9%,6.3% and 6.3%, respectively.(3)Vestibular function in patients with confirmed VM : ①Of the 80 patients with confirmed VM, 4 were abnormal in the saccade test (the abnormal rate is 5%,4/80),1 was abnormal in the tracking test (the abnormal rate is 1.25%,1/80),and 6 were abnormal in the optokinetic test (the abnormal rate is 7.5%,6/80);②The abnormal rate of CP in caloric test is 32.5%(26/80),the abnormal rate of bilateral semicircular canal dysfunction was 16.3%(13/80);③The abnormal rate of vHIT test was 31.3% , another 31 cases (38.8% , 31/80) vHIT value was high gain.(4)Similarities and differences between confirmed VM patients and PVM patients:After statistical analysis, there was no statistical difference between the two groups in the abnormal rate of PTA , CP value in caloric test and vHIT test( $P = 0.760, 0.202, 0.717$ , respectively);While,there was a statistical difference in hearing loss between the two groups( $P < 0.05$ ),the types of hearing loss were also statistically different ( $P < 0.05$ ).

#### **Conclusions:**

High frequency hearing loss is predominant in patients with confirmed VM;A third of confirmed VM patients have chronic tinnitus symptoms;A third of confirmed VM patients had vestibular dysfunction;No significant difference in audio-vestibular function between VM and PVM.

**Key words** : Vestibularmigraine ;probable vestibular migraine ;Pure tone audiometry ;Caloric test ;vHIT.

## **S11-O3**

### **Gender difference in chronic tinnitus**

Winfried Schlee<sup>1</sup>, Berthold Langguth<sup>1</sup>, Jorge Simoes<sup>1</sup>, Stefan Schoisswohl<sup>1</sup>, Patrick Neff<sup>1</sup>

<sup>1</sup> Department of Psychiatry and Psychotherapy, University of Regensburg, Regensburg, Germany

#### **Introduction:**

Tinnitus is an auditory disorder that is characterized by the conscious perception of a phantom sound in the absence of a corresponding sound source. Chronic tinnitus is the perception of a tinnitus sound for more than six months and can be very debilitating to the patient.

Here we present several studies showing marked sex-based differences in the epidemiology of tinnitus and the response to sound stimulation treatment.

#### **Material & Method:**

*Epidemiological:* Three large samples of tinnitus patients were recruited at the TinnitusCenter Regensburg (n=3'786), via the online patient forum TinnitusTalk (n=5'017) and with the TrackYourTinnitus App (n=867) and analyzed with respect to gender distribution.

*Long-term suppression:* The treatment response to four different sound stimulation treatments (hearing aids, masker, notched music and self-applied sound stimulation) were assessed retrospectively with an online survey (n=5'017).

*Short-term suppression:* The short-term tinnitus suppression as a result to three minutes of sound stimulation with 10Hz amplitude-modulated sounds was investigated in three experiments in our laboratory (n1=30, n2=29, n3=29).

#### **Results:**

*Epidemiological:* In all three data sets, we observed a much higher representation of male compared to female patients. (TinnitusCenter Regensburg: 64.9%, TinnitusTalk: 57.2%, TrackYourTinnitus: 72.9% male).

*Long-term suppression:* An ANOVA analysis revealed a significant main effect for gender ( $F=15.8$ ,  $p<0.001$ ) demonstrating better treatment outcome for women compared with men. Such a difference was not found for other, non-auditory treatments.

*Short-term suppression:* Inspired by these results, gender differences were analyzed also on three smaller-sized laboratory experiments with the hypothesis of better tinnitus suppression in women. In two of three studies, we found a tendency for this advantage of female patients

#### **Conclusion:**

Epidemiological data as well as treatment responses to sound stimulation from different studies demonstrate differences between male and female tinnitus patients. Women have a lower prevalence of tinnitus and higher chances of tinnitus suppression through auditory stimulation.

## S11-O4

### **Risk of cochlear disorders in patients with migraine: a nationwide, population-based cohort study**

Juen-Haur Hwang<sup>1,2</sup>, Yi-Chun Chen<sup>2,3</sup>, Shiang-Jiun Tsai<sup>4</sup>, Jen-Tsung Lai<sup>5</sup>, Tien-Chen Liu<sup>6</sup>

Departments of <sup>1</sup>Otolaryngology-Head and Neck Surgery, <sup>3</sup>Nephrology, and <sup>4</sup>Medical Research, Dalin Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Dalin, Chiayi, Taiwan.

<sup>2</sup>School of Medicine, Tzu Chi University, Hualien, Taiwan.

<sup>5</sup>Department of Otolaryngology, Kuang-Tien General Hospital, Shalu, Taichung, Taiwan.

<sup>6</sup>Department of Otolaryngology, National Taiwan University Hospital, Taipei, Taiwan.

#### **Introduction:**

It is still unclear whether migraine might increase the risk of cochlear disorders in a period of time, even though migraine does not attack concurrently. We aimed to investigate the risk of cochlear disorders (tinnitus, sensorineural hearing impairment and/or sudden deafness) in patients with migraine.

#### **Materials and Methods:**

We identified 1056 patients with migraine diagnosed between 1996 and 2012 from the Longitudinal Health Insurance Database 2005 of the Taiwan National Health Insurance Research Database. A total of 4224 controls were also identified from the same database. We

compared the incidence rate of cochlear disorders (tinnitus, sensorineural hearing impairment

and/or sudden deafness) by use of the Kaplan-Meier method. Cox proportional hazard model

was also used to examine the association of cochlear disorders with migraine, with adjustment for all covariates.

#### **Results:**

The mean age of the migraine cohort was 36.7±15.3 years old and 36.4 % of them were males. Compared to non-migraine cohort, the crude and adjusted hazard ratios

(HRs) for cochlear disorders in migraine cohort were 2.83 [95% confident interval (CI)= 2.01-3.99,  $p<0.001$ ] and 2.71 (95% CI= 1.86-3.93,  $p<0.001$ ), respectively. In details, compared to non-migraine cohort, the aHRs were 3.30 (95% CI= 2.17-5.00,  $p<0.001$ ) for

tinnitus, 1.03 (95% CI= 0.17-6.41,  $p=0.97$ ) for sensorineural hearing impairment, and 1.22

(95% CI= 0.53-2.83,  $p=0.65$ ) for sudden deafness in migraine cohort, respectively.

The incidence rates of cochlear disorders were 81.4 per 10<sup>6</sup> person-years for migraine cohort

and 29.4 per 10<sup>6</sup> person-years for non-migraine cohort ( $p<0.001$ ). The cumulative incidence

of cochlear disorders in the migraine cohort was significantly higher than that in the matched

non-migraine cohort (log rank  $p<0.001$ ).

#### **Conclusions:**

In this population-based study, the risk of cochlear disorders was found to be significantly higher among patients with migraine. We supported the presence and/or concept of "cochlear migraine".

## **S11-S1**

### **Tinnitus and Its Heredity**

*Lan Yu Hongyang Wang Lan Lan Guohui Chen Dayong Wang Lidong Zhao Qiuju Wang\**

*Medical School of Chinese PLA, Chinese PLA General Hospital, Department of Otorhinolaryngology Head and Neck Surgery, PLA Institute of Otorhinolaryngology*

*Corresponding author: [wqcr301@vip.sina.com](mailto:wqcr301@vip.sina.com)*

#### **Abstract:**

Recent etiological studies emphasized the important role of genetic factors in tinnitus, but lack of reproducibility. This study retrospectively analyzed the gene research related to tinnitus in recent years. Found that gene studies related to tinnitus mainly involve growth associated proteins, immediate early genes, activity regulated cytoskeleton genes, receptor gene, potassium circulation pathway genes and neurotrophic factors. The studies of gene in patients with tinnitus are still in its infancy. Careful and accurate selection of subjects based on phenotype is required. This will help identify tinnitus genes or genes associated with tinnitus complications. In this study, we conducted comprehensive audiological assessment and gene testing on 40 patients with auditory neuropathy. The characteristics of tinnitus in different types of auditory neuropathy were analyzed, with the purpose of finding out the rare variation of monophyletic tinnitus. Our study shows that patients with different types of genetic mutations had different characteristics of tinnitus. Most patients with OTOF gene mutation did not have tinnitus, while almost all patients with AIFM1 gene mutation had tinnitus symptoms of varying degrees. The characteristics of tinnitus in different types of patients have reference value for our understanding of various diseases and the differential diagnosis of diseases. The classification of diseases according to phenotypes combined with the further study of big data and the new generation of sequencing technology will play a key role on genetic research of tinnitus in the future.

**Key Words:** Tinnitus; Gene

**Fund program:** This work was supported by the grants of the National Natural Science Foundation of China (Major Project No.81530032 & No.81830028) and the National Key Basic Research Program of China (No.2014CB943001).

## **S12-O1**

### **Analysis of tinnitus occurrence related factors in patients with asymmetric hearing loss**

*Bowen Xue   Xiuli LIU*

*Department of Otolaryngology, the First Affiliated Hospital of Dalian Medical University*

#### **Abstract**

##### **Objective :**

To detect the condition of tinnitus occurrence in patients with asymmetric hearing loss (AHL). And to analyze the local and general factors related to tinnitus severity.

##### **Methods :**

We observed 72 cases of AHL among whom there were 32 single-sided deafness(SSD) patients and 40 double-sided deafness(DSD) patients. All patients were asked to complete basic information questionnaires. The routine audiological tests were used to assess tinnitus severity by Tinnitus Evaluation Questionnaire(TEQ). The correlation between sides of hearing loss and tinnitus, tinnitus severity and the type of hearing loss, the severity of hearing loss and general factors was analyzed statistically.

##### **Results :**

Of the 72 cases, 54 patients combined with tinnitus while 18 patients didn't. ①It showed positive correlation between the side of tinnitus and hearing loss ( $\chi^2=39.02$ ,  $P=0.00<0.01$ ). Among the 54 patients that accompanied hearing loss with tinnitus, 50 patients (92.59%) had the same side of hearing loss and tinnitus. ②The severity of hearing loss, the type of hearing loss and 16 general factors including gender/age/hypertension and so on had no correlation with tinnitus severity. ③Tinnitus severity had significant correlation with the impacts on patients' daily life ( $F=34.24$ ,  $P=0.00$ ). That meant the more severe the tinnitus was, the more patients' daily life was influenced.

##### **Conclusion:**

The majority of AHL patients combine with tinnitus. Tinnitus sides are consistent with hearing loss sides/relatively severe hearing loss sides. Tinnitus severity has no correlation with the type of hearing loss, the severity of hearing loss and 16 general factors. Tinnitus severity has negative impacts on patients' daily life.

**Key words :** Asymmetric hearing loss; The side of tinnitus; The severity of hearing loss; The type of hearing loss; General factors; Impacts on patients' daily life

## **S12-O2**

### **Analysis of the incidence of tinnitus in 135 patients with symmetrical hearing loss**

#### **Objective**

To investigate the incidence and influencing factors of tinnitus in patients with symmetrical hearing loss.

#### **Methods**

From December 2018 to January 2019, 187 patients with hearing loss in the First Affiliated Hospital of Dalian Medical University were enrolled. 135 patients have bilateral symmetrical hearing loss. Of the 135 patients with symmetrical hearing loss, 84 (62.2%) had tinnitus (40 unilateral tinnitus, 44 bilateral tinnitus), and 51 (37.8%) had no tinnitus. All patients completed the questionnaire to get the general condition, history characteristics, BMI, tinnitus psychological assessment scale, etc., and pure tone listening test, acoustic impedance and other related audiological examinations. The data were analyzed by rank sum test, chi-square test and second-order Probit statistical method.

#### **Results**

① There was no significant difference in the degree of hearing loss (PTA) (mild, moderate, moderate to severe, severe) between tinnitus and non-tinnitus group ( $P=0.593$ ), in the type of hearing loss (low frequency, high frequency, full frequency), there was also no significant difference ( $P=0.651$ ); ② Take age, hypertension, hyperlipidemia, diabetes, kidney disease, thyroid disease, etc, a total of 15 as independent variables, and tinnitus Binary Probit regression analysis as the dependent variable showed  $p$  values of 0.122, 0.445, 0.095, 0.005, 0.179, 0.008, 0.452, 0.274, 0.21, 0.695, 0.874, 0.63, 0.847, 0.783, 0.765, and the results showed diabetes, thyroid disease are risk factors for tinnitus; ③ After the rank sum test between the tinnitus group and the non-tinnitus group, the BMI showed a significant difference ( $P=0.006$ ); ④ There was no significant difference in the severity of tinnitus between unilateral and bilateral tinnitus ( $p=0.447$ ), between patients with different degrees of hearing loss and different types of hearing loss ( $p$  value 0.082, 0.755, respectively)

#### **Conclusion:**

① Over 60% of patients with bilateral symmetrical hearing loss have tinnitus; ② The incidence and severity of tinnitus are not significantly related to the degree and type of hearing loss; ③ BMI, diabetes, thyroid disease have an effect on tinnitus; ④ There was no significant difference in the severity of tinnitus between patients with bilateral tinnitus and unilateral tinnitus.

## **S12-O3**

### **CENTRAL AUDITORY PROCESSING DISORDER (CAPD) IN TINNITUS AND NON-TINNITUS PATIENTS WITH NORMAL HEARING**

*Carol A. Lau, MA (Aud), Sound idEARS Hearing & Listening Clinic / Vancouver Tinnitus & Hyperacusis Clinic, Vancouver, Canada*

There are various postulations regarding the possibility of central and subcortical abnormalities in the Central Auditory Nervous System in normal-hearing, tinnitus patients as well as the possibility of altered cochlear functioning that are not reflected in measures of hearing loss.

The questions arise whether Central Auditory Processing Disorder (CAPD) may be present in tinnitus patients with normal hearing; and, whether performance on the CAPD test battery is significantly different between tinnitus and non-tinnitus patients with normal hearing.

A group of 14 tinnitus patients were selected from the presenter's clinical database (T group), and a comparison group of 13 normal (non-tinnitus) subjects was also examined (NT group). All patients presented with clinically normal hearing abilities and underwent a routine audiological evaluation, tinnitus and hyperacusis assessment and a CAPD test battery. For the analysis, the CAPD test battery was classified into 3 sub-groups: (1) auditory closure, (2) dichotic listening and (3) temporal processing.

Test findings revealed that the difference between the number of CAPD tests failed by the T and the NT groups was highly significant ( $p < 0.0001$ ), with the T group failing more CAPD tests than the NT group. Analysis on test results by CAPD test sub-group revealed a significant difference for auditory closure tests ( $p < 0.01$ ) and dichotic listening tests ( $p < 0.05$ ). In this study, there were insufficient failures on tests of temporal processing in the T group for statistical analysis.

The conclusions of this study suggest that CAPD may be more common in tinnitus patients with normal hearing than non-tinnitus patients based on the number of failed CAPD tests. The entire CAPD test battery's failed-test results were more significant than the individual sub-group failed-test results.



## **S12-O4**

### **Analysis of the Precise Audiology Test for the Subjective Tinnitus Patients**

*XIONG Binbin<sup>1</sup>, SUN Wei<sup>2</sup>, ZHAO Xiaoming<sup>3</sup>,*

*<sup>1</sup> Department of Otolaryngology, Zhuhai Hospital Affiliated with Jinan University  
(Zhuhai People's Hospital), Zhuhai, Guangdong, P.R. China, 519000*

*<sup>2</sup> Center for Hearing & Deafness, Department of Communicative Disorders and  
Science, State University of New York at Buffalo, 3435 Main Street, Buffalo, NY  
14214*

*<sup>3</sup> Department of Otolaryngology, Zhuhai Hospital Affiliated with Jinan University  
(Zhuhai People's Hospital), Zhuhai, Guangdong, P.R. China, 519000*

#### **Introduction:**

To detect the clinic characteristic and effect of the precise audiology test for the subjective tinnitus patients with normal conventional pure-tone audiograms (PTA).

#### **Material & Method:**

106 tinnitus patients with normal conventional PTA visited the Outpatients Department at Zhuhai Hospital from February 2017 to December 2017 were tested using the precise pure-tone audiogram(P-PTA). The P-PTA is a fine frequency pure-tone test (1/24 octave step) at tinnitus frequency. 41 aged matched normal listening volunteers were used as controls. Tinnitus matching and residual inhibition re-evaluated based on P-PTA testing results.

#### **Results:**

- (1) Using the P-PTA test, 54 (out of 106) tinnitus patients with normal conventional audiograms did show "notched" hearing loss at their tinnitus frequencies. Compared to the tinnitus group, only 8 (out of 82) ears of the control subjects showed "notched" hearing loss in P-PTA which was significantly lower than the tinnitus group( $P<0.0001$ ).
- (2) For tinnitus pitch match, the match rate increased from 50.9% to 84.0% ( $P<0.001$ ) by using P-PTA. The tinnitus loudness decreased significantly by using the new identified tinnitus-pitch and the number of the tinnitus patients whose tinnitus loudness was less than 5 dB SL increased from frequency from 25.9% to 55.1% ( $P<0.01$ ).
- (3) Based on P-PTA, the percentage of patients with residual inhibition increased from 30.7% to 53.9% ( $P<0.05$ ).

#### **Conclusion:**

Our study confirmed P-PTA can help to identify the potential hearing loss that was missed by conventional PTA. The P-PTA test also improve tinnitus pitch and loudness match and increase the positive rate of residual inhibition. P-PTA provides important information in hearing evaluation and may help to develop a sound treatment for tinnitus patients.

## **S12-S1**

### **Subjective tinnitus assessment and treatment in clinical practice: the necessity of personalized medicine and counseling of the patient**

*Annick Gilles, Laure Jacquemin, Emilie Cardon, Vedat Topsakal, Paul Van de Heyning, Vincent Van Rompaey*

#### **ABSTRACT S003-1**

Due to the strong variety of etiologies, patients with tinnitus constitute a very heterogeneous population. Therefore every patient with subjective tinnitus has its unique 'tinnitus profile' which provides a guide to the necessary combination of therapeutic actions. A thorough anamnestic procedure as well as ENT and audiological investigations are essential in the guidance towards proper treatment of tinnitus patients. It is essential to explain to the patient which mechanism(s) cause(s) his or her tinnitus to provide reassurance. Tinnitus Retraining Therapy and Cognitive Behavioral Therapy are currently among the most effective interventions for tinnitus patients. Often, the barrier to engage in certain therapies is high. Therefore, the University Hospital Antwerp developed an informational psycho-educational group session providing basic information concerning the symptom of tinnitus. After thorough multidisciplinary investigations and a possible diagnosis, informational group sessions are provided by experienced therapists to patients visiting the tinnitus clinic of the University Hospital Antwerp with tinnitus as the primary complaint. The sessions consists of a theoretical part explaining the causes of tinnitus, the neural correlates, possible interventions as well as the impact of tinnitus on daily life. In the second part, more practical tips are provided in order to learn how to shift the attention away from the tinnitus. After this informational session, the patients have the possibility to attend further individual sessions if necessary. The current study assesses the effects of a basic informational session on tinnitus severity by use of questionnaires (Tinnitus Functional Index, Visual Analogue Scale, Hospital Anxiety and Depression Scale, Hyperacusis Questionnaire) prior to and 6 months after the session(s) in order to provide long-term data on the effects of psycho-education.

## S12-S2

### Potential mechanisms for tinnitus with a normal audiogram

Hyun Joon Shim, Hyeon Sik Oh, Yong-Hwi An, Dong Hyun Kim

Department of Otorhinolaryngology-Head and Neck Surgery, Eulji University School of Medicine, Eulji Medical Center, Seoul, Korea

For a long time, tinnitus subjects with normal audiograms have been used to investigate the pathophysiology of tinnitus. However, normal hearing thresholds do not necessarily indicate the absence of cochlear damage or complete innervation of central auditory pathways. Several human studies have demonstrated that tinnitus subjects with normal audiograms show increased hearing thresholds at extended high frequencies above 8 kHz compared to normal-hearing subjects without tinnitus (Shim et al., 2009; Fabijanska et al., 2012). Some investigators doubt that subtle damage to the outer hair cells (OHCs) that alters otoacoustic emissions can cause tinnitus (Shiomi et al., 1997; Onishi et al., 2004; Gouweris et al., 2005; Job et al., 2007; Ami et al., 2008). Recently, “cochlear synaptopathy” has been suggested as a potential pathophysiology of tinnitus in patients with normal hearing thresholds. Several human studies have demonstrated that subjects with tinnitus and normal audiograms show significantly reduced auditory brainstem response (ABR) wave I amplitudes compared with control subjects (Schaette and McAlpine, 2011; Gu et al., 2012). However, we could not replicate these results in human subjects with a normal audiogram through a within-subject comparison of wave amplitudes in conventional ABR. Moreover, wave latency shifts with increasing noise level in masked ABR were not different between tinnitus-affected ears (TEs) and non-tinnitus ears (NTEs). In a different study, we compared psychoacoustic performance between TEs and NTEs with normal-hearing thresholds, and no inferiority of spectral/temporal resolution in TEs was observed compared to NTEs. These results suggest that there may be no more peripheral damage in including outer hair in tinnitus side, and the occurrence of tinnitus does not depend upon the degree of damage to the OHCs, but upon different plastic changes in the CNS.

## **S12-S3**

### **Using Qualitative Data Analysis with Patients in Audiology**

*Nicolas Dauman*

Scientific research in audiology has a well-established tradition of quantitative (i.e. statistical) and theory-driven approach to clinical issues. With robust achievements, this tradition has contributed to compare the effectiveness of treatments, assess patients characteristics, and cluster co-morbidities on a inter-groups (or inter-individuals) basis. In this presentation, a more recent approach to audiology will be defined and contrasted, namely a qualitative approach to and analysis of clinical data. Developed within the human and social sciences, from the 1960's, qualitative research is an inductive, data-driven approach to clinical issues and practices. Many questions that cannot be answered by statistical analysis fall into the scope of qualitative research. The meaning of their experience for disabled individuals (e.g. Ménière disease patients), the context of their choices and behaviors (e.g. purposeful non-use of hearing aids) or changes in their attitude towards their suffering (e.g. progressive tolerance to tinnitus) are among such questions. Qualitative research also has inherent limitations regarding to quantitative standards, and specific criteria of assessment of its relevance. Recent interest in clinical medicine for intra-individual variability of behaviors and ecological validity of data (i.e. measurement of behaviors in 'real-life' settings) support a better understanding of this data-driven tradition of research in audiology. Examples of publications on the experience of patients suffering from hyperacusis, tinnitus and hearing impairment will be presented as a contribution to this purpose.

**Keywords:** Qualitative Research, Induction, Meaning, Intra-individual Variability, Audiology

## **S12-S4**

### **Change of the Pitch of Tinnitus after Tinnitus Retraining Therapy**

*Shoko Kato<sup>1)</sup>, Tetsushi Sakashita<sup>1)</sup>, Hirokazu Sakamoto<sup>1)</sup>, Yuka haruta<sup>1)</sup>, Sakurako Takano<sup>1)</sup>, Yuki Kosugi,<sup>1)</sup> Hiromi Nakayama<sup>1)</sup>, Satomi Kinoshita<sup>1)</sup>, Tatsuya Tomoe<sup>1)</sup>*

*<sup>1)</sup> Department of Otolaryngology and Head & Neck Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan*

#### **Introduction**

The pitch of tinnitus often changes after TRT (Tinnitus Retraining Therapy). The aim of this study is to evaluate the relationship between pitch change and therapeutic effect or psychological performance.

#### **Materials & Methods**

Three hundred and four cases in which TRT was performed for more than 1 year were included. At the beginning and one year after, evaluation was made using the pitch match test and the following questionnaires: THI (Tinnitus Handicap Inventory), VAS (Visual Analogue Scale) of annoyance, SDS (Self-rated Depression Scale), STAI (State-Trait Anxiety Inventory). The improvement rates of each score was obtained by dividing the difference between the score at the beginning and the one year later by the score at the start. After 1 year, they underwent the question that how the severity of their tinnitus changed, and were divided into three groups: marked improvement, mild improvement, invariance or worsening. Regarding the change of the pitch, the patient was divided into 4 groups: markedly decreased (1.5 octave or more lower), mildly decreased (less than 1.5 octave lower), invariant, and increased.

#### **Results**

In the markedly decreased group of pitch, approximately 57% of cases showed a marked improvement and the invariance or worsening was the smallest at about 7%. On the other hand, in the pitch increased group, the rate of marked improvement cases was as small as about 26%, and about 47% showed invariance or worsening. In the markedly decreased group of pitch, the improvement rates of the THI, VAS, SDS and STAI (State) score were significantly higher than those of the group with increased pitch.

#### **Conclusion**

Changes in the tinnitus pitch due to sound therapy are related to changes in the severity of the tinnitus, depression and anxiety levels of the patient.

## **S13-O1**

### **Mapping off-on tinnitus related brain activation in tinnitus patients**

#### **Abstract**

##### **Objectives:**

Limitations of tinnitus studies is the heterogeneous condition presented in tinnitus patients and the choice of control. We explore the evidence of off-on tinnitus related brain activation in three special cases.

##### **Methods :**

The present study delineate the differences between the neural networks involved in off-on pure tone tinnitus conducting sLORETA based source analysis of resting state EEG with 256 channels. Bilateral tinnitus was induced by strong noise in one patient, by one bite in the second patient, by special position in the third patient and lasting for more than ten minutes then disappeared. Tinnitus without hearing loss bothers them more than three months with high THI scores.

##### **Results:**

Comparison of the power spectra in the presence and absence of tinnitus revealed significant increase in alpha power and theta power when appears of the tinnitus consistently in three patients. Using sLORETA source analysis, the generators of alpha and theta power increases were localized dominantly to right auditory (Brodmann Areas 41,42), cingulate anterior and parahippocampal cortical areas.

##### **Conclusions:**

In the presence of tinnitus shows a deviation from the absence of different resting EEG parameters, characterized by an overproduction of resting state alpha and theta brain activities. The source analysis results also provide further confirmation that reciprocal involvements of both auditory and associative areas are essential in the generation of tinnitus.

## **S13-O2**

### **Menopausal Hormone Replacement Therapy for Chronic Tinnitus in Migraine**

#### **Patients**

*Chia-Yi Chen<sup>1</sup>, Chiung-Lin Liu<sup>2</sup>, Tien-Chen Liu<sup>3</sup>, Jen-Tsung Lai<sup>4</sup>*

*<sup>1, 2, 4</sup> Department of Otolaryngology, Juan-Tien General Hospital, Taichung, Taiwan*

*<sup>3</sup> Department of Otolaryngology, National Taiwan University Hospital*

#### **Introduction (Times New Roman, 12pt, Bold):**

Chronic tinnitus is highly prevalent among the migraine patient. As menopause approaches, fluctuating and declining estrogen may trigger migraine attack. Therefore, we want to evaluate the role of HRT in the associated chronic tinnitus.

#### **Material & Method (Times New Roman, 12pt, Bold):**

We review chronic tinnitus cases confirmed menopause stage collected in the autumn of 2016. Low dose hormone replacement therapy (HRT) [0.625/0.3125 mg conjugated estrogen with 5 mg progesterone daily or estrogen only] was prescribed as a prevention and protection strategy in the management of chronic tinnitus. The severity of tinnitus was assessed by Tinnitus Handicapped Inventory (THI) [0~100] , and the loudness was assessed by Visual Analog Scale (VAS) [0~10]. Patients with vertigo/dizziness, conductive hearing loss, or retrocochlear lesion were excluded.

#### **Results (Times New Roman, 12pt, Bold):**

26 migraine cases (average age 54.7 years old) randomly chose in Vertigo & Tinnitus Center in Taiwan were analyzed. Average initial THI, VAS scores was 61.2 and 7.5 point. Average THI and VAS scores decreased to 14.1 and 2.8 point after 3 months course. 14 patients with atypical hearing loss show surprising result in hearing and tinnitus improvement after HRT.

#### **Conclusion (Times New Roman, 12pt, Bold):**

HRT significantly lessen chronic tinnitus condition in the migrainer during menopause status. Sleep quality improvement and the prefrontal cortex positive processing may be the possible effects of HRT. Besides, atypical mild hearing loss in one or consecutive tone requires more attention among the clinicians and the patients for chronic tinnitus management. More or less hearing improved results of 14 cases with atypical hearing loss imply the association of migraine and unstable hearing. In fact, cochlear migraine, a neuroinflammatory disease, usually results in varied isolated atypical hearing loss. In all, low dose HRT show satisfied result in chronic tinnitus condition, especially in the migraine patients.

## S13-O3

### Why is Tinnitus a Problem? A Qualitative Cross-cultural Comparison of Problems Reported by Tinnitus Patients in China and England

Hall DA <sup>1,2,3</sup>, Li W <sup>4</sup>, Wang Y <sup>5</sup>, Xiong B <sup>6</sup>, Zhang X <sup>7,8</sup>, Fei Zhao <sup>9</sup>

<sup>1</sup> NIHR Nottingham Biomedical Research Centre, Nottingham, UK

<sup>2</sup> Hearing Sciences, Division of Clinical Neuroscience, University of Nottingham, Nottingham, UK

<sup>3</sup> University of Nottingham Malaysia, Malaysia.

<sup>4</sup> Department of Otolaryngology, Affiliated Eye and ENT Hospital of Fudan University, Shanghai, PR of China.

<sup>5</sup> Department of ENT, Ningbo First Hospital, Zhejiang Sheng, PR of China.

<sup>6</sup> Department of Otolaryngology, Zhuhai People's Hospital, Zhuhai City, PR of China.

<sup>7</sup> Department of Otolaryngology Head and Neck Surgery, Affiliated Drum Tower Hospital of Nanjing University Medical School, PR of China, 210008;

<sup>8</sup> Research Institute of Otolaryngology. Nanjing, PR of China,

<sup>9</sup> Cardiff School of Health Sciences, Cardiff Metropolitan University, Cardiff, UK.

#### Introduction

The individual symptoms of tinnitus can be categorised into domains but there is no common understanding on what these tinnitus domains are, nor whether they are universally experienced across peoples of different cultures and lifestyles. Our primary objective is therefore to determine what are the tinnitus-related symptoms experienced by patients living in China who have a clinically bothersome tinnitus, and to compare this pattern with responses to the same question from patients in England.

#### Method

This is an observational study asking about personal perspectives on their condition. It is being conducted as a multi-centre study across four clinical sites in China. We aim to recruit at least 280 patients in total so that we can compare findings to those data collected at a UK clinic (London, England) <sup>1</sup>.

#### Results

The study is ongoing. Preliminary qualitative data has so far been collected on 48 patients at two sites. Although this is insufficient for thematic analysis, patients seem to be complaining about the negative impact on sleep, on work, on ability to hear, and talk about worries and concerns (such as about the tinnitus getting louder, developing a serious illness or becoming deaf), and negative emotional reactions including being irritable, or depressed.

#### Conclusion

A cross-cultural study is vital to answer the question about whether the Western-centric view of tinnitus is relevant and appropriate to people's living in other countries, such as in China. The study findings will also help to ascertain whether the existing questionnaires that have been translated from English into Chinese mandarin are appropriate for patient assessment.

<sup>1</sup> Watts, E. J., Fackrell, K., Smith, S., Sheldrake, J., Haider, H., & Hoare, D. J. (2018). Why Is Tinnitus a Problem? A Qualitative Analysis of Problems Reported by Tinnitus Patients. Trends in hearing, 22, 2331216518812250.



## **S13-O4**

### **New insight of sudden sensorineural hearing loss- cerebral blood flow**

*Jen-Tsung Lai<sup>1</sup>, Sheng-Kai Huang<sup>1</sup>, Tien-Chen Liu<sup>2</sup> Keh-Bin Wang<sup>3</sup>*

*<sup>1</sup> Department of Otolaryngology, Kuang-Tien General Hospital, Taichung, Taiwan*

*<sup>2</sup> Department of Otolaryngology, National Taiwan University Hospital, Taipei, Taiwan*

*<sup>3</sup> Department of Radiology and Nuclear Medicine, Kuang- Tien General Hospital, Taichung, Taiwan*

#### **Introduction:**

Tinnitus and sudden sensorineural hearing loss(SSNHL) are closely related. There were many hypothesis of SSNHL, including vascular compromise, cochlear membrane rupture, viral infection. However, in our experience, the patient who suffered from migraine headache may had fluctuation hearing impairment and even reach definition of SSNHL. The etiology of SSNHL of these group of patient may possibly due to neuro-inflammation initiated in the brain and affected the peripheral auditory system, which may cause increased blood flow rather than decreased. This article was aim to evaluate the cerebral blood flow (CBF) during acute course of sudden hearing loss and examine the relationship between migraine and severity of hearing impairment.

#### **Material & Method:**

We collected the patient with acute tinnitus due to sudden sensorineural hearing loss, the onset time limit in 3 months. The patients' past history were recorded including migraine, old cerebrovascular accident. Technetium (Tc)-99 m ethyl cysteinate dimer (ECD) single-photon emission computed tomography (SPECT) were used to evaluate the CBF of temporal lobe and the score scale were divided for zero to ten according to an experienced nuclear medicine doctor.

#### **Results:**

We collected 42 patients and 16 patients had migraine headache. Among them, 14 patients(87.5%) were detected to have increased temporal lobe CBF in same side of hearing impaired ear, compared to normal side. In non-migraine group(n=26), 10 patients (38.5%) had increased temporal lobe CBF; 14 patients(53.8%) had decreased temporal lobe CBF and 3 of them had old CVA, 2 had ESRD under dialysis, 2 had CKD history. Besides, pure tone audiometry(PTA) were worsen in non- migraine group (P=0.01).

#### **Conclusion:**

In our study, migraineur who suffered from SSNHL seemed to have higher ratio of increased perfusion in the effected temporal lobe, which may due to neuro-inflammation etiology. This may make a difference though to previously etiology of vascular compromise of SSNHL.

## **S13-O5**

### **The evaluation of brain perfusion SPECT in auditory cortex in rTMS treatment-effective tinnitus patients**

*Hsiung-Kwang Chung<sup>1</sup>, Chia-Der Lin<sup>1</sup>, Chin-Yuan Wang<sup>1</sup>, Tang-Chuan Wang<sup>1</sup>, Chon-Haw Tsai<sup>2</sup>, Te-Chun Hsieh<sup>3</sup>, Ming-Hsui Tsai<sup>1</sup>*

*<sup>1</sup>Department of Otolaryngology – Head and Neck Surgery*

*<sup>2</sup>Department of Neurology*

*<sup>3</sup>Department of Nuclear Medicine, China Medical University Hospital, Taichung, Taiwan*

#### **Introduction**

rTMS is a non-invasive and safe neuromodulation intervention for treating chronic tinnitus in selected patients. However, the rationale of how rTMS modulate hyperactive auditory cortex has not been clearly demonstrated. This study investigates the brain perfusion SPECT changes in primary and secondary auditory cortex after immediate rTMS in treatment-effective tinnitus patients.

#### **Material & Method**

Only rTMS treatment-effective (TQ and THI scales rating reduction more than 25%) patients in previous study were enrolled. Data of 12 patients were analyzed, all of them were treated with further neuronavigated continuous theta-burst rTMS. Brain perfusion SPECT before and after treatment was evaluated. All patients were right-side handed and left secondary auditory cortex was targeted.

#### **Results**

After rTMS, direct perfusion changes in targeted auditory cortex were not significantly decreased, but remote bilateral temporal lobes, including primary auditory cortex and limbic areas were changed. Inter-regional correlation SPECT analysis demonstrated reduction of connectivity between the left secondary auditory cortex and propagated brain region but not related with the clinical response.

#### **Conclusion**

The brain perfusion SPECT results suggested that possible hypoperfusion in secondary auditory cortex led by rTMS had influence on tinnitus-related auditory pathway.

## S13-O6

### A preliminary study of the treatment of chronic tinnitus in menopausal women

MA Xin 1 · ZHAO Yixin 1 · ZHAO Ying 2 , MAO Lele 3 · YU Lisheng 1 · BAI Wenpei 4 · Jen-Tsung LAI 5

1 People's hospital · Peking university

2 the second hospital of shijiazhuang

3 Department of Gynaecology and Obstetrics · Peking University First Hospital

4Beijing Shijitan Hospital, Capital Medical University

5 President Taiwan Tinnitus Association Chief, ENT department Kuang-Tien general hospital

Corresponding author: YU Lisheng · BAI Wenpei

#### Objective:

To explore the efficacy of the menopause related tinnitus with hormone treatment and the possible pathogenesis of menopause related tinnitus.

#### Methods:

- (1) From April 2016 to October 2016, 59 patients who were diagnosed with menopausal syndrome in the menopause clinics of Beijing Shijitan Hospital were enrolled in our study and carried out questionnaire investigation. According to the presence or absence of tinnitus, they were divided into two groups. Age, BMI, menopausal KMI scores, estrogen levels, menopausal symptoms and other possible risk factors of tinnitus were statistically analyzed.
- (2) Among those 18 cases with tinnitus, according to the patients' wishes, they were divided into hormone therapy group and untreated group. Compared two groups of patients age, BMI levels, menopause KMI scores, degree of tinnitus, and carried on the statistics analysis. Follow-up of 3 months, analyze the tinnitus curative effect.

#### Results:

- (1)The results indicated that significant correlativity existed between the incidence of headache and occurrence of tinnitus while other risk factors including insomnia showed no statistical association.
- (2) There were no statistical differences between the two groups of patients with tinnitus about age, BMI levels, menopause KMI scores and degree of tinnitus. After follow up for 3 months of the two groups, there was no change in the untreated group. Among 9 patients in the treated group , tinnitus disappeared in 5 patients, there was no change in 4 patients .

#### Conclusion :

Menopause related tinnitus was an independent menopausal symptom rather than secondary to insomnia of perimenopause. Tinnitus is caused by the interactions among multifactors in which headache plays an important role in the pathogenesis of tinnitus. we can try menopause hormone therapy for the right tinnitus patients.

.Apr;43(2):722-725. doi: 10.1111/coa.13024. Epub 2017 Nov 28.

[Lai JT·Liu TC](#).Higher prevalence and increased severity of sleep-disordered breathing in male patients with chronic tinnitus: Our experience with 173 cases. [Clin Otolaryngol](#). 2018

## **S13-S1**

### **Clinical Analysis of the Idiopathic Tinnitus Management with " Tinnitus Combined Management "**

*Ming Li*

*Yueyang Hospital of Integrated Traditional Chinese and Western Medicine, Shanghai University of Traditional Chinese Medicine, Shanghai, 200437*

#### **Objective:**

To explore the long-term clinical efficacy and value of " Tinnitus Combined Management (TCM)" in the treatment of patients with idiopathic tinnitus.

#### **Methods:**

From August 2008 to May 2013, a total of 1348 idiopathic tinnitus patients in Yueyang Tinnitus Clinic Center were treated with TCM. Tinnitus Evaluation Questionnaire (TEQ) was used to assess the severity and efficacy of tinnitus before and 1 week, 1 month, 3 months, 6 months, 1 year, 2 years, and 5 years, after treatment, respectively. TCM was first proposed by Li Ming. TCM was performed by three stages: (1) tinnitus communication and explanation: analysis and explain the tinnitus onset process, examination results, and possible causes of tinnitus, relieve their tinnitus attention, fear and change a negative understanding of tinnitus to a positive and "neutral stimulus", improve patient compliance. 2. Sound therapy: at least 3-6 months sound therapy is to gradually eliminate the conditional reflex arc of the secondary psychological symptoms of tinnitus. There are two forms of sound therapy. One is to live and work in a sound environment. The purpose is to weaken the cerebral cortex exciting. The second is carefully listening to the sound (the sound volume should not exceed the tinnitus), which is to cut off the vicious circle between the tinnitus and the brain negative psychological reaction. 3. Symptomatic treatment: The essence is to directly reduce or eliminate the psychological and physical symptoms caused by tinnitus by taking advantage of the prescription right of the doctor: the measures include Chinese and Western medicine, acupuncture, transcranial magnetic stimulation, percutaneous vagus nerve stimulation, and hearing aid treatment, etc.

#### **Results:**

A total of 1348 idiopathic tinnitus patients were enrolled, including 569 males and 779 females; the course of tinnitus ranged from 2 months to 15 years; 397 cases with tinnitus in left ear, and 360 at right ear, 510 at binaural and 81 cases of cranial sound. The patients achieved good curative effect after TCM treatment, and the cure rates in 1 week, 1 month, 3 months, 6 months, 1 year, 2 years, and 5 years were 11.50%, 21.66%, 29.82%, and 39.38% 48.17%, 47.86%,53.45%,respectively.The total effective rates were 48.37%, 72.01%, 80.04%, 85.96%, 89.53%, 94.02%, and 93.10%, respectively.

#### **Conclusion:**

TCM can significantly improve tinnitus efficiency. On the base of no drugs or treatments available to eliminate tinnitus, TCM system presents with a better long-term effect than other methods provide by audiologists.

Keywords: tinnitus; tinnitus combined management;

## **S13-S3**

### **Psychological Factors for Tinnitus and Hyperacusis patients.**

*Yoshitaka Takanashi<sup>1 2</sup>*

*1 YAMATO E.N.T. clinic*

*2 Division of Otolaryngology, Tohoku Medical and Pharmaceutical University*

#### **Introduction**

It is believed that psychological factors strongly influence tinnitus. Risk factors for tinnitus include hearing loss, ototoxic medication, head injury and depression. We have encountered many cases of tinnitus that have improved through treatment of stress and depression. It is therefore important to evaluate anxiety and depression before tinnitus treatment. In this study, we investigated cases of tinnitus patients that were evaluated for anxiety and depression.

#### **Material & Method**

We retrospectively the medical records of patients at Tohoku University Hospital from April 2012 to March 2014. Among patients whose chief complaint was tinnitus, 74 patients (34 males, 40 females, average age 57.0 years) who were able to undergo psychological evaluation using HADS (Hospital Anxiety Depression Scale) during the treatment were included in this study.

#### **Results**

More than half the cases (37/74) were categorized as catastrophic and severe handicap based on their THI (Tinnitus Handicap Inventory) score. For HADS A score, A doubtful of anxiety was seen in 24.3% (18/74) of cases, while definitive anxiety was observed in 29.7% (22/74) of cases. For HADS D score, A doubtful of depression was seen in 25.7% (19/74) of cases, while definitive depression was observed in 25.7% (19/74) of cases. There was a strong correlation ( $r=0.647$   $p<0.001$ ) between HADS A score and THI. In addition, HADS D score and THI, HADS A score and VAS (Handicap), as well as HADS D score and VAS (Handicap) also had positive correlation ( $r=0.418$   $p<0.001$ ,  $r=0.477$   $p<0.001$ ,  $r=0.290$   $p<0.05$ ).

#### **Conclusion**

Tinnitus severity was correlated with the degree of anxiety and depression. The possibility of improving tinnitus severity by intervention for anxiety and depression was suggested. On the day of my presentation, I will also present an actual case of depression with a tinnitus patient, and the relationship between hyperacusis and psychological factors.

## S14-O1

### Sleep architecture features in adult tinnitus patients with sleep complaints

Cheng-Yu Lin<sup>1,2</sup>, Yi-Lu Li<sup>1,3</sup>, Yu-Ching Hsu<sup>4,5</sup>, Jiunn-Liang Wu<sup>1\*</sup>

<sup>1</sup> Department of Otolaryngology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan.

<sup>2</sup> Sleep Medicine Center, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan.

<sup>3</sup> Department of Otolaryngology, Kuo General Hospital, Tainan, Taiwan

<sup>4</sup> Department of Chinese Medicine, Tainan Hospital, Ministry of Health and Welfare, Tainan, Taiwan.

<sup>5</sup> Sleep Center, Tainan Hospital, Ministry of Health and Welfare, Tainan, Taiwan.

#### Introduction:

Sleep was listed as the most difficult action in tinnitus patients. Sleep complaints were classified as the main characteristics in 50% of severe tinnitus population. However, objective polysomnography (PSG) based studies were limited. The aim of our study was to investigate the PSG features in adult patients with different tinnitus severity.

#### Material & Method:

Adult tinnitus patients with sleep complaints who visited the departments of otolaryngology in our hospitals were recruited. Assessment tools were over-night hospital PSG and Tinnitus Handicap Inventory (THI). THI scores for the mild, moderate, severe levels were divided into 0–16, 18–56, and 58–100, respectively.

#### Results:

The 1616 tinnitus patients (1110 male, 68.7%) were analyzed. The mean age was  $48.3 \pm 14.3$  years old and body mass index was  $27.8 \pm 5.7$  kg/m<sup>2</sup>. The tinnitus severity groups included mild (1336, 82.7%), moderate (194, 12.0%) and severe (86, 5.3%). Age and gender were the significant risk factors of tinnitus severity. THI score was significantly associated with different PSG parameters, including sleep latency ( $\beta = 0.185$ ), slow wave stage ( $\beta = -0.282$ ) and sleep efficiency ( $\beta = -0.168$ ). Compared to mild tinnitus group, severe tinnitus patients had lower apnea-hypopnea index (mean 32.3,  $p = 0.011$ ) and higher periodic limb movement index (mean 12.1,  $p = 0.010$ ).

#### Conclusion:

PSG revealed to be a useful assessment tool in adult tinnitus patients, to confirm what was reported from them. The significant alteration of sleep architecture in severe tinnitus patients might imply the necessity to improve their sleep quality.

**Keywords:** Tinnitus, sleep complaint, over-night polysomnography.

## S14-O2

### **A preliminary study on the correlation between obstructive sleep apnea hypopnea syndrome and chronic tinnitus**

*LIU Xiuli WANG Jing*

*(Department of Otolaryngology, Vertigo Clinic Treatment Center, the First Affiliated Hospital of Dalian Medical University Dalian, 116011, China)*

*Corresponding author: LIU Xiuli, E-mail: yicsun521@163.com*

**Objective:** To investigate and analyze the chronic tinnitus prevalence and its related factors in OSAHS patients.

**Method:** We studied 115 patients who were diagnosed with OSAHS by polysomnography. All patients BMI were calculated. The amount of patients accompanying tinnitus was calculated by investigating the History of tinnitus. Univariate and multivariate logistic analyzes were used to calculate the association between gender, age, hearing loss, BMI, and the lowest SPO<sub>2</sub> with tinnitus. The differences in tinnitus prevalence among different age groups and gender were compared using chi-square test.

**Result:** ① The prevalence of tinnitus in 115 OSAHS patients was 38.26% (44/115). ② Between the ages of 31-80 years, the prevalence of tinnitus in every 10-year-old group was 9.09%, 6.82%, 11.36%, 38.64%, and 29.55%, respectively. There was a significant difference between the age groups ( $\chi^2=14.55, P<0.01$ ). The prevalence of female was 44.12% (15/34) which was higher than the male 35.80% (29/81), there was no significant difference ( $\chi^2=0.70, P>0.05$ ). ③ The results of univariate and multivariate logistic regression analysis showed that sex, BMI and lowest SPO<sub>2</sub> had no correlation with tinnitus in patients with OSAHS, while age and hearing loss were independent correlates of tinnitus ( $P<0.05$ ).

**Conclusion:** More than 1/3 of patients with OSAHS had chronic tinnitus, both age and hearing loss maybe the risk factors of tinnitus in patients with OSAHS, but neither BMI nor the lowest SPO<sub>2</sub> was clearly related to chronic tinnitus.

## **S14-O3**

### **Tinnitus and comorbidities**

Tinnitus denotes the phantom perception of a sound in the absence of an external source.

Tinnitus research has focused on peripheral-central-auditory etiologies. For example, research investigating tinnitus in patients with concurrent hearing loss highlighted the roles of cochlea irritations and altered neural processing alongside the central auditory pathway. Hence, a growing body of evidence points towards complex interactions of central auditory and non-auditory processes across cortical and subcortical brain regions.

The identification of tinnitus-specific pathophysiological mechanisms is further complicated by its frequent co-occurrence with a wide range of psychological comorbidities – such as depression, anxiety, somatoform disorders and insomnia. Increasingly, these comorbidities are conceptualized across transdiagnostic cognitive-emotional dimensions such as emotion regulation difficulties, experiential avoidance, repetitive negative thinking, intolerance of uncertainty or intolerance of negative affect.

On a phenomenological level, emotional difficulties can precede, exacerbate, or result from the tinnitus percept. For example, tinnitus may 1] be associated with pathological functions that also cause psychological distress, 2] temporally precede or 3] cause emotional difficulties in vulnerable individuals, 4] exacerbate existing psychological distress, 5] interact with psychological factors in increasing the risk of chronicity, i.e. altering the course of the percept, or 6] be influenced by third variables that account for both tinnitus and the development or maintenance of depressive or anxiety-related states.

Studies have highlighted the effect of acute stress on auditory processing via processes that have also been implicated in anxiety or depression such as changes in attention, changes in cortisol levels or limbic processes, suggesting distress as a shared risk factor for the development, exacerbation or maintenance of both tinnitus and emotional difficulties, particularly depression.

In summary, tinnitus is a common and distressing auditory disorder that is associated with substantial personal and economic burden. Whilst its exact pathophysiology remains unclear, recent research has begun to focus on interactions between central audiological, attentional and emotion-processing networks that partly overlap with neurological systems previously associated with psychological distress – particularly depressive mood.



## **S15-O1**

### **Changes in tinnitus after vestibular schwannoma surgery**

Zhengkong Chen<sup>1</sup>, Jingjing Wang<sup>1</sup>, Shan-Kai Yin<sup>1</sup>

*Otolaryngology Institute, Affiliated Sixth People's Hospital, Shanghai Jiao Tong University*

#### **Introduction**

Tinnitus is a frequent symptom of vestibular schwannoma (VS), occurring in more than half of all patients. Because tinnitus can reduce the quality of life in these patients<sup>3</sup>, it is important for clinicians to be aware of changes in tinnitus after VS microsurgery. Recently, several retrospective studies have been published focusing on changes in tinnitus after microsurgery; however, the results varied. Most papers showed that tinnitus improved after microsurgery regardless of which approach was used. The objective of this study was to prospectively evaluate changes in tinnitus after VS microsurgery.

#### **Material & Method**

Subjects included 41 patients who were definitively diagnosed with VS and underwent translabyrinthine microsurgery (TLM) between January 2015 and May 2016. All patients underwent related examinations and were asked to answer the Tinnitus Handicap Inventory (THI) scale and a visual analog scale (VAS) both pre- and postoperatively.

#### **Results**

Of the 41 patients, 31 (75.6%) suffered from tinnitus before surgery. Microsurgery was associated with an overall decrease in tinnitus ( $p = 0.007$ ). There was a significant improvement in THI and VAS scores after surgery ( $p = 0.001$  and  $p = 0.005$ , respectively). The decrease in THI scores in the low-frequency group was significantly larger than that of the middle- and high-frequency groups after surgery ( $p = 0.034$  and  $p = 0.001$ , respectively). The loudness of tinnitus decreased significantly after surgery ( $p = 0.031$ ).

#### **Conclusion**

Tinnitus in patients with VS improved after TLM. Patients with middle- and high-frequency tinnitus as well as louder tinnitus preoperatively seemed have a worse prognosis than those with low-frequency and quieter tinnitus.

## **S15-O2**

### **Mal de débarquement syndrome (MdDs)- Case Report and Review article**

*Chih-en Chang <sup>1</sup>, Po-Hung Li<sup>1, 2</sup>, An-Suey Shiao <sup>1</sup>*

*<sup>1</sup> Cheng-Hsin General Hospital*

*<sup>2</sup> National Yang Ming University*

#### **Introduction :**

Mal de débarquement syndrome (MdDS) is a rare condition which presents with persistent swaying, rocking or bobbing sensation after sea voyage or air travel, and alleviates when back to motion. It may or may not accompanied by migraines. Unlike motion sickness, duration of symptoms may last for hours to years. The exact pathophysiology is unknown, and there is not yet a definite diagnostic tools. Medication such as vestibular suppressants are usually ineffective, latest study suggests that management of MdDS as vestibular migraine can improve patients' symptoms. Moreover, some studies also suggest that MdDS maybe a disorder of over-synchronization of brain networks, which may benefit from repetitive transcranial magnetic stimulation( rTMS).

#### **Material &Method :**

We are presenting a 50 year-old Taiwanese female, who has suffered from disequilibrium and floating sensation for 2 months after ship cruise since 2018 September, with limited improvement with vestibular suppressants. No positive findings were examined from vestibular examination or image studies.

#### **Conclusion :**

Although MdDS is a rare disease and little is known about the exact pathophysiology, but we still can diagnose by patient's clinical course and symptoms. It is a disease of exclusion. It should be highly considered if someone suffers from abnormal perception of motion after a recent trip (air or sea), as well as negative laboratory or image studies. Treatments used for motion sickness are usually helpless, but treatments with tricyclic antidepressants or benzodiazepines, or simply adjusting lifestyle is proven to be helpful. Ongoing studies using rTMS may open a new era in treating MdDS.

## S15-O3

### Optimized test battery for discriminating between Menière's disease and vestibular migraine

Su-Lin Zhang\*, Yangming Leng, Renhong Zhou, Jingjing Liu, Wei-Jia Kong\*

\*Correspondence to:

Su-Lin Zhang, Department of Otorhinolaryngology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1277 Jiefang Avenue, Wuhan, Hubei Province, 430022, PR China. Tel: +86-27-85726169. Fax: +86-27-85776343. E-mail: [156933024@qq.com](mailto:156933024@qq.com)

Wei-jia Kong, Department of Otorhinolaryngology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1277 Jiefang Avenue, Wuhan, Hubei Province, 430022, PR China. Tel: +86-27-85726900. Fax: +86-27-85776343. E-mail: [entwjkong@hust.edu.cn](mailto:entwjkong@hust.edu.cn)

#### Introduction:

The diagnosis of Menière's disease (MD) and vestibular migraine (VM) is principally based on clinical symptoms. Currently, no specific diagnostic tests and biological markers are available. Comorbidity is common between MD and VM, and their symptoms overlap, which renders the differential diagnosis difficult. Due to the similarities between MD and VM in the clinical symptoms and diagnostic criteria, and differences in their management, our research effort was mainly directed at their differentiation.

#### Material & Method:

We examined the clinical features of MD, VM and MDVM in terms of demographics, symptoms and findings of neurotologic tests, audiometry and vestibular laboratory assessment.

#### Results:

We investigated 252 patients with only VM, 168 with only MD, and 62 with MDVM. Clinical features that differentiated VM from MD were found in all groups. MD tended to have an advanced age of onset, more fluctuating or low tone hearing loss, progressive hearing loss, tinnitus, ear fullness, abnormal caloric asymmetry, abnormal vestibular evoked myogenic potential and endolymphatic hydrops (ELH on ECOG, -SP/AP amplitude ratio). On the other hand, VM tended to have family history of vertigo/dizziness, involved females more, and had higher attack frequency. Moreover, VM patients had more headaches, photophobia, phonophobia and visual aura, high tone hearing loss, abnormal nystagmus, and abnormal findings of vestibular autorotation test.

#### Conclusion:

In conclusion, this study confirmed a considerable overlap of clinical symptoms among MD, VM and MDVM. Integrating clinical symptoms, the findings of audiovestibular tests and follow-up can help differentiate the two conditions and find the comorbidity.

## **S15-S1**

### **Title: How do sleep relate to tinnitus and vertigo**

*Meiho Nakayama<sup>1&2</sup>, Kayoko Kabaya<sup>2</sup>, Mariko Takahashi<sup>2</sup>, Takenao Mihara<sup>1&2</sup>, Sachie Arima<sup>1&2</sup>, Shintaro Sato<sup>1&2</sup>*

*1) Good Sleep Center, Nagoya City University, Nagoya, Japan.*

*2) Department of Otolaryngology, Nagoya City University, Nagoya, Japan.*

*Send Correspondence to Meiho Nakayama, Good Sleep Center & Department of Otolaryngology, Nagoya City University, 1, Kawasumi, Mizuhocho, Mizuhoku, Nagoya, 467-8601, Japan. E-mail: [nakayama@med.nagoya-cu.ac.jp](mailto:nakayama@med.nagoya-cu.ac.jp)*

*Phone: +81-52-853-8256*

*Fax: +81-52-851-5300*

### **ABSTRACT**

Several recent reports have described the relation between sleep disorders and inner ear function. Ménière's disease patients often complain that dizziness and/or tinnitus disturbs their sleep. Many clinicians may also have had the experience of patients who say their dizziness and/or hearing symptoms are less noticeable when they sleep well. However, not much importance has been attached sleep quality. Stress has been postulated to trigger or contribute to Ménière's disease. Stress hormones have been presented as an objective measure of stress. Ménière's disease patients have higher levels of stress hormones, but it is suggested that these higher hormone levels are rather the result than the cause of this chronic disease, since patients affected longer seem to have higher hormone levels. The combination of Ménière's disease and stress is well known to cause psychosomatic symptoms such as anxiety or depression, but not much is known about its relationship with insomnia. Approximately 40% of Ménière's disease patients suffer from inadequate sleep.

One possibility that may affect patients sleep quality is the obstructive sleep apnea (OSA). OSA may cause not only vestibular but also auditory dysfunction. Several reports suggest that insufficient supply of blood via the vertebral basilar artery, which supplies the inner ear, may cause hydropic distension of the endolymphatic system and lead to Ménière's disease. However, few people noticed that in OSA this insufficient supply might be exacerbated in the night while patients are sleeping. Even more, we should note not only that Ménière's patients may suffer from insomnia, but that the impaired sleep might be caused by OSA. Physicians routinely prescribe benzodiazepines or other drugs that have hypnotic, muscle relaxing, anti-anxiety, and anti-convulsant properties for insomnia, but these properties may have the effect of aggravating OSA symptoms. Continuous positive airway pressure (CPAP) is an effective therapy used worldwide for the treatment OSA. CPAP may also be useful as one aspect of treatment for Ménière's disease patients with OSA.

## **S15-S2**

### **Cochlear migraine and tinnitus**

*Jen-Tsung Lai , MD*

*ENT department Kung-Tien General Hospital, Taiwan*

Migraine plays an important role in clinical tinnitus management. " Inner ear migraine" a migraine variant, is often encounter in our neurological practice. Inner migraine presented as well known vestibular migraine (VM) and new proposed diagnosis cochlear migraine (CM).

CM often confused in the clinical practice as acute low tone hearing loss (ALHL), sudden hearing loss and cochlear Meniere disease. Migraine might damage the hearing and balance. The neuroinflammation resulted from migraine is a possible cause of hearing loss and tinnitus.

In large-scale cohort study, we found that patients with a history of migraine had a tendency to develop cochlear disorder and tinnitus. People with migraine had almost three times increased risk of cochlear disorder especially tinnitus , compared with people without migraine.

In our clinical observation, we presented four possible patterns of auditory features in CM:

1. Unilateral fluctuation hearing loss with or without tinnitus and aural fullness.
- 2.Repeated sudden hearing loss in the same or opposite ear, with good recovery.
3. Sudden hearing loss with limited improvement but continues change in hearing over time.
- 4.Acute Unilateral tinnitus and aural fullness or pain with mild hearing loss.

Besides acute tinnitus, CM is one of significant factors in developing chronic tinnitus. The difficulty of tinnitus habituation may be due to unstable cochlear condition caused by CM. Furthermore, sensitive migraine may induce tinnitus switch ( frontostriatal gating ) out of function and delayed turn off of central tinnitus signal.

## **S15-S3**

### **Clinical Sound therapy for tinnitus**

*Hayato Tsuge<sup>1</sup>, Junpei Ito<sup>1</sup>, Aki Miyake<sup>2</sup>, Daisuke Kato<sup>2</sup>, Masami Yakushiji<sup>2</sup>, Yuki Kato<sup>2</sup>, Michihiko Sone<sup>3</sup>*

<sup>1</sup> *Department of Otolaryngology, Japanese Red Cross Nagoya Daiichi Hospital*

<sup>2</sup> *Speech hearing therapist, Department of Otolaryngology, Japanese Red Cross Nagoya Daiichi Hospital*

<sup>3</sup> *Department of Otolaryngology, School of Medicine, Nagoya University*  
*Hayato Tsuge [S030] h-tsuge@nagoya-1st.jrc.or.jp*

### **Abstract**

Acoustic therapy is highly valuable in treatment of tinnitus. We present the key point of acoustic therapy we perform which is based on idea of tinnitus retraining therapy (TRT).

Although tinnitus patients with psychosomatic tendency are referred to psychosomatic medicine or psychiatry department, it is true that they are not solved solely by them. We consider that one reason is that measures taken to reduce the agony of tinnitus itself are not enough. We show in this lecture, our specific method of “acoustic therapy aimed to reduce agony during night-time” and “adjustment of hearing aid” for tinnitus patients.

Most of the time, the agony of tinnitus during night-time is not solved only by explanation of acoustic therapy. We show our specific method which we perform. We use natural environment sound such as sound of stream or broadband noise for sound source. With an image of listening to them, it will not be effective and the best way is basically to be surrounded by these sounds. We will show that it is related to the difference of processing mechanism between target sound and background sound in our hearing.

In treatment of tinnitus, usage of hearing aid is highly effective. However, this is also not easy in general. This is due to acoustic hyperesthesia phenomenon observed during adjustment. We call this phenomenon “the wall of acoustic hyperesthesia.” The agony of tinnitus will not be solved until we go beyond this wall. Here are the key points of adjustment: use different two modes properly at the beginning of audition; thoroughly limit the maximum output at the beginning of audition; and do not compromise in securing functional gain in high-frequency area. We now apply these methods to adjustment of hearing-impaired patients since they also contribute to improving aural comprehension of words.

## S16-O1

### Psychological complaints in tinnitus patients with sleep disturbance

Yi-Lu Li<sup>1,2</sup>, Cheng-Yu Lin<sup>1,3</sup>, Yu-Ching Hsu<sup>4,5</sup>, Jiunn-Liang Wu<sup>1\*</sup>

<sup>1</sup> Department of Otolaryngology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan

<sup>2</sup> Department of Otolaryngology, Kuo General Hospital, Tainan, Taiwan

<sup>3</sup> Sleep Medicine Center, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan

<sup>4</sup> Department of Chinese Medicine, Tainan Hospital, Ministry of Health and Welfare, Tainan, Taiwan.

<sup>5</sup> Sleep Center, Tainan Hospital, Ministry of Health and Welfare, Tainan, Taiwan.

#### Introduction:

Sleep difficulty and psychological distress are among the most prevalent comorbidities of tinnitus. We aimed to clarify the correlation between these sleep and psychological complaints and tinnitus severity.

#### Material & Method:

Adult tinnitus sufferers who visited the otolaryngology department in two hospitals from January, 2017 to December, 2018 were recruited in this cross-sectional study. Participants were requested to complete questionnaires including demography, Tinnitus-Handicap Inventory (THI), Pittsburgh Sleep Quality Index (PSQI). Sleep difficulty was defined as PSQI scoring greater than 5 in past one-month period. Hospital Anxiety and Depression Scale for Anxiety (HADS-A) and Depression (HADS-D) were evaluated for psychological symptoms. Among different levels of PSQI, the correlation between psychological complaints and tinnitus severity was analyzed.

#### Results:

1610 tinnitus patients (1105 male, 68.6%) with mean age of  $48.3 \pm 14.3$  years completed all questionnaires. The average THI score was  $9.2 \pm 19.4$ , and 10.8% of patients reported to have moderate to severe tinnitus with THI scores ranging from 38 to 100. 70.8% of participants had sleep difficulty. Significant risk factors of tinnitus severity included old age, higher PSQI, higher HADS-A and HADS-D scores. Among patients with sleep difficulty, positive correlations were found between adjusted THI and HADS-A ( $R^2 = 0.070$ ,  $p < 0.001$ ) and HADS-D ( $R^2 = 0.034$ ,  $p < 0.001$ ). However, no such significant correlation was found in patients without sleep difficulty.

#### Conclusion:

The severity of tinnitus is interfered with anxiety and depression, especially in patients with sleep difficulty. Management of sleep and psychological complaints is necessary to break this vicious circle.

**Keywords:** tinnitus, sleep disturbance, anxiety, depression

## **S16-O2**

### **The effects of personality traits and hearing status on the acute tinnitus sensation of idiopathic sudden hearing loss cases**

*Pak-In Jeong<sup>1</sup>, Dian-Sian Li<sup>2,3</sup>, Ming-Hsien Tsai<sup>1</sup>, Chii-Yuan Huang<sup>2,3</sup>*

*National Taipei University of Nursing and Health Sciences<sup>1</sup>*

*Taipei Veterans General Hospital Otolaryngology Department <sup>2</sup>*

*National Yang-Ming University <sup>3</sup>*

#### **Background:**

The connection between psychology and tinnitus is important. The aim of this topic is to investigate the relationship between personality and tinnitus.

#### **Material & Method:**

Patients with Idiopathic Sudden Sensorineural Hearing Loss (ISSNHL) were recruited in our hospital. All patients underwent steroid treatment and then follow-up for 3 months. The evaluation included standardized questionnaires, such as: personality: Big Five Inventory (BFI-44); tinnitus: Tinnitus Handicap Inventory (THI) and Visual Analogue Scale (VAS); emotion: Hospital Anxiety and Depression Scale (HADS) and hearing status: Pure Tone Audiometry (PTA). According to the THI scores, we divide patient into two groups: high coopers (THI $\geq$ 38) and low coopers (THI $\leq$ 36). Mann-Whitney U test was used to analyze the difference between the two groups with personality traits.

#### **Results:**

THI score could measure the tinnitus patient's psychological distress. Twenty-nine patients were the study, however, highly coopers (N= 16) were significant different with lowly coopers (N= 13) on the Extraversion (p=0.006), Neuroticism (p=0.001), anxiety (p<0.001), depression (p<0.001), loudness (p=0.027). But, there are no significant different on the age (p= 0.368), sex (p= 0.349), PTA (p=0.136) and side (p= 0.978). The correlation result shown that Extraversion has significant negative correlation with tinnitus stress (p= 0.014); Neuroticism has significant positive correlation with tinnitus stress (p< 0.001). Neuroticism and hearing recovery were significant interaction effect for tinnitus stress (p= 0.033).

#### **Conclusion:**

Personality will affect the tinnitus stress. After 3 months' follow-up, Neuroticism still effect tinnitus stress, but for the hearing non-recovery patient, there are no effect between personality and tinnitus.



## **S16-O3**

### **Tinnitus and personality; a systematic review**

*J.J.C.M. van Munster, MD<sup>1,2</sup>, W.H. van der Valk, MD<sup>1</sup>, I. Stegeman, PhD<sup>3,4</sup>, A.F. Liefink, MSc<sup>3</sup>, A.L. Smit, MD PhD<sup>3,1</sup> Department of Otorhinolaryngology and Head and Neck Surgery, Leiden University Medical Center, Leiden University, the Netherlands*

<sup>2</sup> *Department of Neurosurgery, Leiden University Medical Center, Leiden University, the Netherlands*

<sup>3</sup> *Department of Otorhinolaryngology and Head and Neck Surgery, University Medical Center Utrecht, Utrecht, the Netherlands*

### **Introduction:**

An association between tinnitus and anxiety and depression is described in the literature. The same might account for personality traits, especially since associations between personality traits and other chronic diseases are already revealed. In present study we evaluated the relationship between the existence of tinnitus, tinnitus burden and personality traits by systematically reviewing the literature.

### **Material and Method:**

PubMed and EMBASE databases were searched from inception up to June 21, 2017 for articles on the association between tinnitus and personality. Titles, abstracts and full texts were screened for eligibility. Directness of evidence and risk of bias were assessed. From the included studies, study characteristics and outcome data of tinnitus existence, burden and personality traits were extracted.

### **Results:**

A total of 352 unique articles were screened of which 18 were eligible for critical appraisal and were used for data extraction. Eleven articles (68.8%) showed one or more associations between the existence of tinnitus and personality traits, and nine articles (90%) showed one or more associations between tinnitus severity or burden and personality. Neuroticism stands out.

### **Conclusion:**

There might be a relationship between some personality traits and tinnitus, especially when tinnitus burden is taken into account. As differences in personality traits can influence the response on different tinnitus treatments, this insight might be of benefit to understand the disease and treatment outcome.

## **S16-O4**

### **The correlation between tinnitus, coping, psychopathology and quality of life**

Sebastiaan M Meijers <sup>1</sup>, Inge Stegeman <sup>1,2</sup>, Arno F Liefink <sup>1</sup>, Adriana L Smit <sup>1,2</sup>

<sup>1</sup> Department of Otorhinolaryngology, Head and Neck Surgery, University Medical Center Utrecht, Utrecht, The Netherlands

<sup>2</sup> Brain Center Rudolf Magnus, University Medical Center Utrecht, Utrecht, The Netherlands

#### **Introduction:**

A large part of the adult population experiences tinnitus but never seeks professional help, suggesting that the experience of tinnitus varies widely among individuals and may be influenced by coping strategies. The objective of this study is to investigate the relationship between the perceived tinnitus handicap, different coping strategies, psychopathology and quality of life.

#### **Material and Method:**

Cross-sectional study of chronic tinnitus patients visiting the tertiary tinnitus referral center of the University Medical Center Utrecht, the Netherlands from 6-2007 till 11-2012. Patients completed tinnitus burden questionnaire (THI), psychopathological and coping questionnaires (SCL-90-R, CISS) and a Quality of life questionnaire (SF-36).

#### **Results:**

308 patients were analyzed. Emotional-oriented coping (male R 0.609, 95%CI 0.289 - 0.929, female R 0.762, 95%CI 0.342 – 1.183) and distraction-orientated coping strategies (male R 0.650, 95%CI 0.036-1.264, female R 0.755, 95%CI 0.049 -0.460) were significantly correlated with THI score. Tinnitus burden had also a significant positive correlation with several psychopathological factors (e.g. anxiety, agoraphobia, hostility and sleeping problems) and a significant negative correlation with quality of life.

#### **Conclusions:**

Patients with higher tinnitus handicap scores demonstrate the use of more emotional-oriented coping and distraction-orientated coping strategies and other psychological characteristics than the patients with lower scores. Patients with a higher tinnitus burden also have a lower quality of life. This information could be useful for counseling patients suffering from tinnitus and to create opportunities for intervention.

## S16-O5

### The Effect of Tinnitus on Listening Effort in Patients with Sudden Sensorineural Hearing Loss

李典憲<sup>1,2</sup> 蔡明憲<sup>3</sup> 楊伯彥<sup>3</sup> 黃啟原<sup>1,2</sup>

*Dian-Sian Li<sup>1,2</sup>, Ming-Hsien Tsai, Pak-In leong, Chii-Yuan Huang*

台北榮民總醫院耳鼻喉頭頸醫學部<sup>1</sup> 國立陽明大學<sup>2</sup> 國立台北護理健康大學<sup>3</sup>

*Taipei Veterans General Hospital Otolaryngology Department<sup>1</sup> National Yang-Ming University<sup>2</sup>*

*National Taipei University of Nursing and Health Sciences<sup>3</sup>*

#### **Purpose:**

Listening effort is defined as the cognitive resources necessary to understand speech. Patients with tinnitus or hearing impairment had increased listening effort. Clinically, patients who have single-sided deafness caused by sudden sensorineural hearing loss, may suffer from tinnitus symptoms and have poor speech recognition under background noise. The objective of this study is to investigate the effect of tinnitus on listening effort in patients with sudden sensorineural hearing loss under single-sided hearing.

#### **Method:**

The patients with sudden sensorineural hearing who were treated and followed up at the outpatient department during 2018, April to 2019, March were enrolled in this prospective study. A dual-task paradigm and tinnitus handicap inventory were used to evaluate listening effort and severity of tinnitus respectively before and one month after the systemic steroid treatment. Moreover, the affected ears were masked for making sure a condition of single-sided hearing during the dual-task paradigm. Also, the dual-task paradigm was performed under or without the background noise.

#### **Result:**

The hearing on affected ear, listening effort, and tinnitus were all improved after systemic steroid treatment in patients with SSNHL. In patients with SSNHL under single-sided hearing, the background noise increased the listening effort no matter whether it was before treatment or one month after treatment ( $p < 0.05$ ). Before the treatment, the listening effort had tendency of positive correlation with the tinnitus severity, especially when it was under the background noise. However, one month after the treatment, there was no correlation between the tinnitus severity and listening effort under the background noise or not.

#### **Conclusions:**

The background noise increases listening effort in patients with SSNHL under single-sided hearing. In patient with moderate tinnitus, the tinnitus severity is correlated positively with the listening effort under the background noise. However, in patient with mild tinnitus, the tinnitus severity is not correlated with listening effort.

## **S16-S1**

### **The Role of Frustration in Tinnitus Suffering and Progressive Tolerance**

*Nicolas Dauman, René Dauman, Soly I. Erlandsson*

#### **Abstract:**

Reliability of counseling and trustfulness of clinicians are central to the achievement of a successful management of tinnitus patients. The understanding of patients' experience, which can vary substantially from unbearable intrusiveness to progressive tolerance, grants this reliability in the clinical dialogue. Moreover, for enlightening the lack of control over the condition the patients' questioning regarding moment-to-moment variability of the intrusiveness of tinnitus should be dealt with. It promotes their autonomy and sense of ability to handle tinnitus by their own as well as endure empowerment. In this presentation, the role of frustration in understanding the intrusiveness of tinnitus will be explained within a 4-stages model of tinnitus tolerance. This model has been grounded on daily experiences of chronic sufferers (n=22) who were investigated by a clinical psychologist during open-ended interviews. The data were subjected to a constant, comparative analysis with the end purpose of building a theory from empirical indicators (i.e. the grounded theory method). The main hypothesis of the model is that the intrusiveness of tinnitus varies according to the degree of frustration the patients meet in the course of physical and social interactions. From a pervasive intrusion (stage 1, highest frustration) to self-induced relief (stage 4, handled frustration) each of the 4 stages enable the clinicians to tailor counseling according to the individual patient's needs. It also enables the clinician to understand and discuss relapses with patients, and their ability to cope with new sources of frustration in life. There are many ways to alleviate frustration in patients with tinnitus, from maskers and hearing aids to psychotherapy. However, the treatment alternative must also be perceived as achievable, and convincing enough, for the patients to become involved. Furthermore, it demands a renewed attitude to deal with frustration and to bear living with tinnitus in a long-term perspective.

**Keywords:** Frustration, Tolerance, Patients Empowerment, Moment-to-moment Variability, Qualitative Research.

## **S16-S2**

### **Anxiety, Depression and Health-related Quality of Life in Chinese Tinnitus Sufferers with and without Hearing Loss**

*Anna C.S. Kam*

*Department of Special Education and Counselling, The Education University of Hong Kong*

*Integrated Centre of Wellbeing (I-WELL), The Education University of Hong Kong*

#### **Introduction:**

Anxiety and depression are often comorbid in patients with chronic tinnitus. Tinnitus is sometimes associated with poorer health-related quality of life (HRQoL). This study aims to evaluate co-morbid anxiety, depression and HRQoL associated with tinnitus only and tinnitus with hearing loss.

#### **Material &Method:**

This retrospective study included 290 outpatients who attended four local hospitals in Hong Kong with a primary complaint of tinnitus. They were divided into two groups: (1) tinnitus only, and (2) tinnitus with hearing loss. All patients received comprehensive otological examination and audiological assessment. Anxiety and depression level were evaluated by the Hospital Anxiety and Depression Scale. HRQoL was measured with the SF36 health questionnaire. Tinnitus severity and related distress were assessed with the Tinnitus Handicap Inventory and visual analogy scales. Results obtained were compared between the tinnitus only and tinnitus with hearing loss group.

#### **Results:**

Significantly higher level of anxiety and depression, and poorer HRQoL were observed in the tinnitus with hearing loss group. This group of patients also showed significantly more severe tinnitus and more affected by the negative impact caused by tinnitus as compared to the patients with tinnitus only. Anxiety, depression and HRQoL were significantly correlated with the tinnitus severity and the degree of hearing loss.

#### **Conclusion:**

As hearing loss appeared to be a contributing factor to higher level of anxiety and depression, poorer HRQoL and tinnitus handicapping effect, further research investigating the therapeutic effect of tinnitus with hearing compensation for those patients with hearing loss is warranted.

## S17-O1

### **Long term reactions to pulsatile tinnitus is featured by weakened short-range functional connectivity within a brain network on the right sided temporal lobe**

Lv Han<sup>1\*</sup>, Wang Zheng<sup>1</sup>, Zhang Peng<sup>1</sup>, Zhao Pengfei<sup>1</sup>, Li Jing<sup>1</sup>, Yin Hongxia<sup>1</sup>, Liu Yawen<sup>2</sup>, Zhang Zhengyu<sup>1</sup>, Gong Shusheng<sup>3</sup>, Yang Zhenghan<sup>2</sup>, Wang Zhenchang<sup>1\*</sup>

<sup>1</sup>Department of Radiology, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

<sup>2</sup>School of Biological Science and Medical Engineering, Beihang University, Beijing

<sup>3</sup>Department of Otolaryngology Head and Neck Surgery, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

#### **Introduction:**

Recently, efforts that characterizing the brain functional activity features in patients with pulsatile tinnitus (PT) are getting increasingly concern. Accumulating evidence indicated aberrant functional connectivity (FC) of right middle temporal gyrus (MTG) in PT patient group with prolonged disease duration. Possible predictive effect of those functional connections may be existed.

#### **Material &Method:**

To test this hypothesis, resting-state functional magnetic resonance imaging (fMRI) were obtained from 34 patients with recent onset PT (RPTIN), 24 patients with long-term PT (LPTIN) and age-, gender-, education-matched 35 healthy controls were enrolled in this study. Right MTG was set as seed region to investigate the intrinsic FC within the whole brain. Results were further correlated with pulsatile tinnitus characteristics, especially disease duration.

#### **Results:**

Functionally connected with hubs belong to executive control network, default mode network (DMN) and limbic network, the strength of FC was mainly decreased in patient groups compared with normal controls. Relative to RPTIN and normal controls, LPTIN patients were further characterized by significant decreased FC among several short-range brain regions adjacent to the seed. Lastly, the disease duration showed negatively correlated with decreased FC between the seed and right fusiform gyrus/parahippocampal gyrus, right inferior frontal gyrus as well as right MTG (brain area adjacent to seed region) significantly, indicating a possible predictive effect of those functional connections.

#### **Conclusion:**

Long term reactions to pulsatile tinnitus mainly involved weakened short-range functional connectivity, especially within a functional network in the temporal lobe on the right hemisphere of the brain. Our work extended the understanding of the neuro-pathophysiological abnormality in PT patients by providing an overview of functional connectivity alteration feature of the right MTG over time.

#### **Key Words:**

Pulsatile tinnitus; Resting-state fMRI; Neural networks; Functional connectivity; disease duration

## **S17-O2**

### **Management of Palatal Myoclonic Tinnitus Based on Clinical Characteristics: A Large Case Series Study**

*Jung Mee Park, Woo Jin Kim, So Young Park, Shi Nae Park*

*Department of Otolaryngology-Head and Neck Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea*

#### **Objectives:**

Palatal myoclonic (PM) tinnitus is a rare condition of the ear caused by rhythmic contractions of soft palate muscles. Due to its rarity, only small case series studies have been reported in the literature at the present time. This large case series study was performed to review treatment outcome of PM patients over the past 15 years based on clinical characteristics.

#### **Materials and Methods:**

Between the year 2003 and 2018, 55 patients with a diagnosis of PM were assessed. Their clinical characteristics, audiological findings, psychological status, and other relevant medical histories were thoroughly reviewed. Responses to treatments that included simple reassurance and behavior therapy, medication, tinnitus retraining therapy, and botulinum toxin injection have been retrospectively analyzed.

#### **Results:**

The mean age of enrolled patients was  $28.9 \pm 16.3$  years with female gender predominance (61.8% Vs. 38.2%). Twenty-four patients (43.6%) had comorbid middle ear myoclonic tinnitus and 11 patients (20.0%) had sensorineural tinnitus combined with PM. Majority of the patients complained of “clicky” sounding tinnitus, and those who perceived palatal movement at the physical examination had a tendency to show perturbation on acoustic reflex decay ( $P < .05$ ). Reassurance and behavior therapy seemed to be enough for patients of young age ( $< 18$  years), and medication including muscle relaxant showed complete or partial improvement in 54.5% of adult patients. Botulinum toxin injection at the palate which was performed to 12 patients with intractable PM, showed complete resolution of symptoms in 81.8% of patients.

#### **Conclusion:**

Management of PM should be customized according to the individual clinical characteristics of the patients. The result of this large case series study may provide insightful information to establish optimizing treatment modalities for PM tinnitus.

## **S17-S1**

### **Title: Somatosensory tinnitus: challenges in diagnosis and treatment**

*Speaker: dr. Sarah Michiels*

Somatosensory tinnitus is a subtype of tinnitus where somatosensory afference from the cervical spine and/or temporomandibular area influences the tinnitus percept. The neurophysiological explanation for this type of tinnitus has been extensively studied in animals. Additionally, an international group of somatosensory tinnitus experts presented a new set of diagnostic criteria for somatosensory tinnitus in 2018. Nevertheless, it is often hard to decide in a clinical situation whether or not a patient's tinnitus is influenced by somatosensory input or not. This might result in overdiagnosis and unnecessary treatments, causing an increase in healthcare costs that can be avoided.

Regarding the treatment of somatosensory tinnitus, scientific literature suggests lots of different treatment techniques and approaches, but many of these are only studied in case series without control group. This makes it often difficult for healthcare providers to choose the best option for their patients.

In this presentation we aim to provide clinically applicable strategies for the diagnosis of somatosensory tinnitus, based on the current evidence and to give an overview of the different treatment strategies that are sufficiently proven effective for the treatment of somatosensory tinnitus.



## **S17-S2**

### **Pulsatile tinnitus update: objective documentation and surgical management**

*Jae-Jin Song*

Pulsatile tinnitus (PT) refers to the perception of auditory stimuli that usually show heartbeat-synchronous and periodic nature. Although PT accounts for fewer than 10% of all tinnitus cases, the precise evaluation and management of this disorder are crucial because if vascular abnormalities are found in patients with either severe symptoms or objective findings on physical examination, there may be possible treatment options to correct the structural abnormality. In the first part of this talk, diagnostic evaluation for subjects with PT focusing on objective measurement using transcanal sound recording and spectro-temporal analysis will be delivered. In the second part, surgical or interventional management options for subjects with PT due to various vascular disorders such as sigmoid sinus diverticulum, dominant sigmoid sinus with/without dehiscence, jugular bulb diverticulum, and dural arteriovenous fistula will be discussed.

## **S17-S4**

### **Sigmoid sinus constriction on sigmoid sinus associated venous pulsatile tinnitus**

*Wuqing Wang, Shanghai, Eye & ENT Hospital of Fudan University*

#### **OBJECTIVE**

Transverse-sigmoid sinus junction (TSSJ) anomalies are currently proposed as the most predominant causative factor of pulsatile tinnitus (PT). Though poorly understood, venous PT generation originates from the abnormal intravascular hemodynamic state in the dural sinus system. On the basis of the dominant dural sinus (DSS) system, the pathological development and PT mechanisms of intracranial vascular and osseous abnormalities are differentiated. In the current study, the authors introduced a transtemporal surgical method, extraluminal sigmoid sinus angioplasty (ESSA), targeting the alteration of intrasinus hemodynamics and aimed to establish thorough clinical management of venous PT with confirmatory objective measurements to provide profound insights into surgical elimination of PT and venous PT pathophysiology.

#### **METHODS**

Fifty-four venous PT patients underwent ESSA between April 2009 and December 2018. The extraluminal reshaping of TSSJ contour under local anesthesia was objectively analyzed. Clinical management, surgical outcome, and PT pathophysiology were extensively reviewed. Computational fluid dynamics (CFD) study on the variation of intrasinus hemodynamics of operative PT with sigmoid sinus diverticulum (SSD) and non-SSD (NSSD) patients was discussed.

#### **RESULTS**

In 53 of 54 (98%) patients experienced a significant reduction or complete resolution of PT sensation after ESSA. No major surgical complications were discovered except full collapse of the sinus lumen. The averaged reduction of TSSJ cross-sectional area was 60.1%. Intraoperative discoveries suggested that PT did not alter by eliminating smaller SSD and/or resurfacing the sigmoid sinus plate dehiscence (SSPD). The morphological measurements demonstrated that the cross-sectional area and volume of ipsilesional TS and TSSJ region were significantly larger than those of the healthy side in both SSD and NSSD group. The wall pressure and vortex flow at TSSJ were considerably reduced, and the flow velocity and wall shear stress (WSS) significantly increased after ESSA.

#### **CONCLUSION**

ESSA is a highly effective surgical technique towards PT patients with DSS and SSD. The surgical outcome and objective measurements indicated that DSS is a predisposing factor of PT, and only by improving intrasinus hemodynamics could venous PT be resolved efficiently. The extraluminal reshaping of TSSJ contour reduces vascular wall pressure, redirects blood flow direction and increases mean WSS at TSSJ. Without complete obstruction of the venous return, ESSA is safe, and postoperative complications related to neurological disorders are avoided.

## **S18-O1**

### **Injections of lidocain in the ganglion oticum for the therapy of tinnitus**

*Vielsmeier V.<sup>1</sup>, Biesinger E.<sup>2</sup>, Strohmeyer L.<sup>3</sup>, Langguth B.<sup>3</sup>, Schlee W.<sup>3</sup>*

<sup>1</sup> *University of Regensburg, Department of Otorhinolaryngology*

<sup>2</sup> *Privat Practice - Centre of Otorhinolaryngology, Traunstein*

<sup>3</sup> *University of Regensburg, Department of Psychiatry and Psychotherapy*

#### **Introduction:**

Tinnitus is defined as the perception of noise without an acoustic stimulus. Due to the heterogeneity among the group of tinnitus patients there is a lack of a unique therapeutic concept. Many studies showed associations between somatic manouvers and perception of tinnitus. Therefore, the concept of a therapeutic use of injections of lidocain in trigeminal structures was developed.

#### **Material & Method:**

Data of 19 patients treated in the Practical Practice of Otorhinolaryngology in Traunstein were analysed at the University of Regensburg. After three injections in the anatomical area of the ganglion trigeminale and the ganglion oticum by an oral approach we performed a follow-up investigation during 12 weeks. In addition to changes of the subjective tinnitus complaints, potential side effects were documented.

#### **Results:**

There were no relevant side effects, and we found that patients with hearing loss, with craniomandibular dysfunction, with neck complaints or with dizziness showed a different benefit by the therapeutic intervention of injections of lidocain. The improvement of complaints occurred especially as a short time effect, concerning primarily the reduction of tinnitus loudness. Clear associations between the auditorial pathway and trigeminal structures could not be shown.

#### **Conclusion:**

Our analysis showed that injections in the area of trigeminal structures could result in changes of tinnitus perception. We perform additional research with placebo controlled injection to investigate the effects in detail.

## S18-O2

### Abstract Title

*Kim Hee-Young<sup>1</sup>, Jung Eun-kyung<sup>2</sup>, Jang chul-ho<sup>3</sup>*

*<sup>1</sup> Department of Otorhinolaryngology-Head and Neck Surgery, Chonnam National University Medical School, Gwangju, Korea*

*<sup>2</sup> Department of Otorhinolaryngology-Head and Neck Surgery, Chonnam National University Medical School, Gwangju, Korea*

*<sup>3</sup> Department of Otorhinolaryngology-Head and Neck Surgery, Chonnam National University Medical School, Gwangju, Korea*

### Introduction

Tinnitus is associated with outer hair cell, inner hair cell, central nerve system. If imbalances or damages are happened in this system, tinnitus can appear. If these damages are longer than 3months, can be lead to irreversible damage, so that early treatment is important. There are many mineralocorticoid & glucocorticoid receptor in inner ear structure, so steroid is considered 1<sup>st</sup> option of treatment. But, there's a few study about intratympanic steroid effect on tinnitus patient, especially acute onset. So we evaluated the effectiveness of intratympanic steroid in acute tinnitus patients.

### Material & Method

Between april 2017 and may 2018, 33 patients with unilateral acute onset tinnitus were enrolled. Acute onset means tinnitus happened less than 3months. All patients take a medicine during treatment. Intratympanic steroid injections 1cycle was administered 3times every other day. All of patients administered steroid injection for 1cycle to 3cycles. After finish of steroid injection, we analyzed the improvement rates of tinnitus using the tinnitus handicap inventory(THI) and visual analogue scale(VAS). Also, we analyzed THI and VAS score improvement after long term visit.

### Results:

Right after finish of intratympanic steroid injection, there's little reduction of VAS and THI score.( THI 1.7 p=0.392, VAS 1.33 p=0.012 ) But there's significant reduction of VAS and THI score long term after finish intratympanic steroid injection.( THI 14.71, p=0.003, VAS 3.46, p=0.00 )

### Conclusion:

In this study, there's significant improvement of THI, VAS score of tinnitus. Although there's no control group of this study, there's few study about intratympanic steroid effect on tinnitus and almost study showed no significant change of tinnitus after intratympanic steroid injection. So the result of this study is meaningful. Therefore, intratympanic steroid should be considered as treatment for patients with acute onset tinnitus.

## **S18-O3**

### **Middle ear dexamethasone delivery via ultrasound microbubbles attenuates noise-induced hearing loss**

*Cheng-Ping Shih<sup>1</sup>, Chih-Hung Wang<sup>1,2,3,4</sup>*

*<sup>1</sup> Department of Otolaryngology-Head and Neck Surgery, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan.*

*<sup>2</sup> Graduate Institute of Medical Sciences, National Defense Medical Center, Taipei, Taiwan.*

*<sup>3</sup> Graduate Institute of Microbiology and Immunology, National Defense Medical Center, Taipei, Taiwan.*

*<sup>4</sup> Taichung Armed Forces General Hospital, Taichung City, Taiwan, Republic of China*

#### **Introduction:**

In this study, we expanded our previous investigation by testing the efficiency of trans-round window membrane dexamethasone (DEX) delivery mediated by ultrasound (US)-aided microbubbles (MBs) and its preventive effects regarding noise exposure in animal models.

#### **Material &Method:**

Totally 42 pigmented male guinea pigs were divided into the following three groups: (1) an US-MBs (USM) group: the tympanic bulla was filled with DEX and MBs and exposed to US or (2) a round window soaking (RWS) group: without the US irradiation, and (3) a control group. The above-mentioned manipulations were performed 2 h prior to white noise exposure. The cochlear damage, including auditory threshold shifts, hair cell loss, and expression of cochlear HMGB1, was evaluated.

#### **Results:**

The results showed that the enhanced DEX delivery efficiency of USM group was approximately 2.4 to 11.2 times greater than that of RWS group. After the noise exposure, the RWS group showed significant cochlear protection compared to the control group, and more significant and dominant protective effects were demonstrated in the USM group.

#### **Conclusion:**

The application of US-MBs provides a safe and more effective approach than those obtained by spontaneous diffusion, which is commonly used in clinical practice; thus, this technique holds potential for future inner ear drug delivery.

## **S18-O4**

### **Dextromethorphan attenuates hidden hearing loss in military gun-shooting practice**

*Hsin-Chien Chen, MD, PhD<sup>1</sup>; Chih-Hung Wang, MD, PhD<sup>1,2,3</sup>*

*<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, Tri-Service General Hospital, National Defense Medical Center, Taipei, 114, Taiwan*

*<sup>2</sup>Taichung Armed Forces General Hospital, Taichung, 411, Taiwan*

*<sup>3</sup>Graduate Institute of Medical Sciences, National Defense Medical Center, Taipei, 114, Taiwan*

#### **Introduction:**

Impulse noise may cause auditory nerve excitation through N-methyl-d-aspartate (NMDA) receptor activation and cause hearing loss. Dextromethorphan (DXM), an NMDA receptor antagonist, has been a widely used antitussive and has significantly neuroprotective properties in experimental and clinical studies. This study aimed to evaluate the potential effect of DXM on shooting practice-related acoustic trauma.

#### **Materials and Methods:**

Subjects who perform first shooting practice after joined the army aged between 20 and 30 years old were recruited and randomly assigned into one of DXM and control group. This study had three visits (V0-V2) including V0 was the screening visit before shooting, V1 was the day after first shooting practice, and V2 was 7 days after V1. All subjects had worn earplugs when shooting. The treatment of DXM started from 4 days before V1 until 2 days after V1. PTA, OAE and tinnitus questionnaire were performed for each subject at three visits.

#### **Results:**

A total of 278 males, 116 men in control group (23.11±1.5 y/o) and 162 men in DXM group (22.01±1.43 y/o), were enrolled. Subjects in DXM group had significantly less hearing loss in most of the frequencies in both ears on V1 and some of the frequencies on V2 when compared to control group. Mean hearing threshold of V0, V1, and V2 were within normal range in two groups, while compared the results of hearing threshold shift (HTS) among V0, V1, and V2, subjects in DXM group had less HTS in most of the frequencies in left ear between V2-V0 than control group. Besides, subjects in DXM group showed a significantly lower percentage in developing tinnitus compared to control group at V2.

#### **Conclusion:**

DXM was demonstrated to provide a protective effect on hidden hearing loss during military gun-shooting practice. Further studies will be needed to investigate whether DXM can be used to prevent noise-induced hearing loss.

## **S19-O1**

### **What for Whom? Single-Case Experimental Design as a tool for tailoring CBT for tinnitus**

*Matheus PCG Lourenco<sup>1</sup>, Thomas Fuller<sup>1</sup>, Rilana FF Cima<sup>1, 2, 3</sup>, Johan WS Vlaeyen<sup>1, 3</sup>*

<sup>1</sup> *Department of Clinical Psychological Science, Maastricht University, Maastricht, The Netherlands*

<sup>2</sup> *Adelante Centre for Expertise in Rehabilitation & Audiology, Hoensbroek, The Netherlands*

<sup>3</sup> *Research Group Health Psychology, KU Leuven University, Leuven, Belgium*

#### **Introduction:**

Research output employing Single-Case Experimental Designs (SCED) has exponentially grown in the past few years. SCED methodology is very well suited to clinical research as it focuses on individual experience and can enable the development of tailored treatments. The unique tinnitus-related experiences of the individual tinnitus patient offers a rich environment for the development of research employing innovative SCED.

#### **Material &Method:**

Specialised Cognitive Behavioural Therapy (CBT) for tinnitus is effective in reducing the adverse impact of tinnitus, and consist of several components. So far, it is unknown what role each part has on reducing tinnitus-related distress and disability. In a series of three studies, components of specialised CBT for tinnitus will be dismantled and analysed using SCED methodology. Audiological counselling, psychological assessment and counselling, psychologically informed educational sessions, effects of group-versus individual treatment approaches, exposure versus relaxation therapy, are closely examined to reveal the respective impact on patients' cognitions, emotions and behaviours. Participants provide self-report data several times per day, allowing for systematic visual analysis complemented by randomization tests, effect size calculations and meta-analytical approaches to establish causality while using few participants.

#### **Results:**

Results will further add to the body of literature on the effects of individual tinnitus treatment components and establish the SCED paradigm and its potential in the field of tinnitus research.

#### **Conclusion:**

By introducing the SCED methodology, valuable insights can be gained next to and beyond the more traditional established methods. Considering randomized control trial's limitations, SCED offers a viable alternative for research that follows the current push for individualized medicine and tailored treatment.

## S19-O2

### **Cognitive performance in chronic tinnitus patients: preliminary results of a cross-sectional study using the RBANS-H**

Emilie Cardon <sup>1\*</sup>, Laure Jacquemin <sup>1,2\*</sup>, Griet Mertens <sup>1,2</sup>, Paul Van de Heyning <sup>1,2</sup>, Olivier Vanderveken <sup>1,2</sup>, Vedat Topsakal <sup>1,2</sup>, Vincent Van Rompaey <sup>1,2</sup>, Annick Gilles <sup>1,2,3</sup>

<sup>1</sup> Department of Translational Neurosciences, Faculty of Medicine and Health Sciences, Campus Drie Eiken, Antwerp University, Antwerp, Belgium; <sup>2</sup> Department of otorhinolaryngology – Head and neck surgery, Antwerp University Hospital, Wilrijkstraat 10, 2650 Edegem, Belgium; <sup>3</sup> Department of Education, Health & Social Work, University College Ghent, Ghent, Belgium.

\* These authors contributed equally to the work.

#### **Introduction:**

Many older tinnitus patients report cognitive deficits such as concentration and attention difficulties. Nevertheless, current research has not yet produced a clear picture of the effects of tinnitus on cognition due to inconsistent use of disparate tests focusing on different cognitive domains. We used a standardized test battery, the Repeatable Battery for the Assessment of Neuropsychological Status adjusted for Hearing impaired individuals (RBANS-H), to comprehensively assess the effects of tinnitus on various aspects of cognition.

#### **Material & Method:**

Twenty-eight tinnitus patients (14 women, mean age:  $60.1 \pm 5.4$ ) and twenty-eight control participants (matched for sex, age, hearing level, and education level) participated in this cross-sectional study. All participants completed the RBANS-H, which includes subtests probing immediate and delayed memory, visuospatial capabilities, language, and attention. Hearing levels of all participants were determined. In addition, tinnitus severity was measured via the Tinnitus Functional Index (TFI) and subjective tinnitus loudness was assessed using a Visual Analogue Scale (VAS).

#### **Results:**

The total RBANS-H scores did not differ between tinnitus patients and controls. However, on the language subscale, mean scores of the tinnitus group ( $97.6 \pm 11.0$ ) were significantly lower than those of controls ( $104.4 \pm 12.0$ ), with correction for age, sex, hearing level, and education level (general linear model:  $p = 0.034$ ). *Post hoc* t tests revealed a specific deficit concerning the semantic fluency subtest (tinnitus:  $19.5 \pm 6.2$ ; control:  $23.1 \pm 6.0$ ;  $p = 0.031$ ). No correlations between TFI and RBANS-H scores were found, while mean VAS scores were negatively correlated to scores on the RBANS-H attention subscale ( $r = -0.475$ ,  $p = 0.012$ ).

#### **Conclusion:**

In accordance with previous studies, we found a specific negative influence of tinnitus on verbal fluency. In addition, patients experiencing louder tinnitus sounds performed worse on specific subtests concerning attention.



## **S19-O3**

### **The effect of Temporomandibular treatment on tinnitus severity and intensity in patients with somatosensory tinnitus: A Pilot Study**

*A. van der Wal, S. Michiels, P. van de Heyning, M. Braem, A. Gilles, V. Topsakal, C. Visscher, W. De Hertogh*

#### **Background**

Subjective tinnitus can be influenced by the somatosensory system, then called somatosensory tinnitus (ST). ST is pathophysiologically explained by activity in connecting fibers between the dorsal cochlear nucleus (DCN) and the somatosensory nuclei which are located in the medulla. This mechanism can explain the greater prevalence of tinnitus in patients with temporomandibular disorders (TMD) (30.4% to 64%), compared to the prevalence in the general population, and indicates that TMD treatment might be beneficial for patients with ST.

The purpose of this study is to evaluate the effect of TMD treatment on tinnitus severity and intensity in patients with ST.

#### **Methods**

Patients were recruited by otolaryngologists at a tertiary tinnitus clinic. They were included when suffering from moderate to severe subjective tinnitus (Tinnitus Functional Index between 25-90 points) and TMD (Diagnostic Criteria for TMD). Patients were randomly allocated to a usual care group, comprising general information and advice about tinnitus (UC group), or a usual care with adjuvant TMD treatment group (UCA group). The UCA group received general information and advice and additional TMD treatment (physical therapy and/or occlusal splints). Tinnitus Functional Index (TFI) and Tinnitus Questionnaire (TQ) were collected at baseline (week 0) and after therapy (week 9) to compare both groups.

#### **Results**

A sample of 10 patients was recruited. At baseline, both groups were similar. Averagely, patients in the UCA group scored 49,04 points on TFI and 36,50 points on TQ. The baseline scores of the UC group was 40,16 on TFI and 37,0 on TQ. After 9 weeks treatment patients in the UCA group showed a decrease of 7,84 points on TFI and 4,70 points on TQ. The UC group had a very small decrease of 1,84 points of TFI and 0,40 points on TQ.

#### **Conclusions**

Based on this pilot study, it appears that TMD treatment can be beneficial for patients suffering from ST.

## S20-O1

### **Tinnitus distress is associated with enhanced resting-state functional connectivity within the default mode network**

Yu-Chen Chen<sup>1</sup>, Xindao Yin<sup>1\*</sup>

<sup>1</sup>Department of Radiology, Nanjing First Hospital, Nanjing Medical University, Nanjing, China.

\*Corresponding author: Xindao Yin

Address Correspondence to:

\* Xindao Yin, MD, Ph.D., Department of Radiology, Nanjing First Hospital, Nanjing Medical University, No.68, Changle Road, Nanjing 210006, China, Tel: +862587726268, Fax: +862552236361, E-mail: [y.163yy@163.com](mailto:y.163yy@163.com)

#### **Purpose:**

The default mode network (DMN) has been confirmed to be involved in chronic tinnitus perception. Tinnitus distress may be associated with abnormal functional connectivity (FC) within the DMN regions. The goal of this study was to determine if tinnitus disrupted the FC patterns within the DMN as measured using resting-state functional magnetic resonance imaging (fMRI) approach.

#### **Methods:**

Resting-state fMRI scans were acquired from 40 chronic bilateral tinnitus patients and 41 healthy controls. Both were age, sex and education well-matched with normal hearing. Two important DMN regions, the anterior cingulate cortex (ACC) and posterior cingulate cortex (PCC), were chosen as seed regions to detect the FC patterns within the DMN and then determine if these changes were linked to clinical measures of tinnitus such as tinnitus duration and tinnitus severity.

#### **Results:**

Compared with healthy controls, chronic tinnitus patients manifested significantly enhanced FC between the ACC and left precuneus, which was correlated with the tinnitus duration ( $r=0.451$ ,  $p=0.007$ ). Moreover, enhanced FC between the PCC and right medial prefrontal cortex (mPFC) in tinnitus patients was positively correlated with the tinnitus distress ( $r=0.411$ ,  $p=0.014$ ).

#### **Conclusions:**

Chronic tinnitus patients showed disrupted FC patterns within the DMN regions that are correlated with tinnitus distress. Increased resting-state connectivity pattern of the DMN may play a pivotal role in neuropathological features underlying chronic tinnitus.

**Keywords:** tinnitus; anterior cingulate cortex; posterior cingulate cortex; default mode network; resting-state fMRI.

## **S20-O2**

### **Cross-Modal Stochastic Resonance as a Cause of Subjective Tinnitus**

*Patrick Krauss<sup>1</sup>, Holger Schulze<sup>1</sup>*

*<sup>1</sup> University Erlangen-Nuremberg, University Hospital Erlangen, Germany*

#### **Introduction:**

Cross-modal interactions are common in sensory processing, and phenomena reach from changed perception within one modality to misperceptions like synesthesia. A recent study demonstrated that electro-tactile stimulation applied to the index finger significantly improves speech perception thresholds. We argue that such cross-modal enhancement can be explained in terms of stochastic resonance (SR), a phenomenon that is ubiquitous in nature, and especially within the context of neuroscience, receives increasing attention.

SR refers to a processing principle where signals otherwise sub-threshold for a given sensor can, at least partially, be detected anyway by adding noise (i.e. a random signal) of a suitable intensity to the sensor input.

#### **Material & Method:**

We demonstrate the plausibility of our hypothesis using a computational model and provide exemplary findings in animal and human studies that are consistent with that model.

#### **Results:**

We suggest that SR is a major processing principle of the auditory system and takes place in the dorsal cochlear nucleus (DCN). Following hearing loss, SR serves to lift signals above the increased neuronal thresholds, thereby partly compensating for the hearing loss. Numerous studies have indicated that tinnitus is correlated with pathologically increased spontaneous firing rates and hyperactivity of neurons along the auditory pathway. The noise necessary for SR to work corresponds to somatosensory input to the DCN leading to increased spontaneous neuronal firing rates in the DCN and subsequent stages of the auditory system. In that view, SR is the primary cause of tinnitus-related neuronal hyperactivity and tinnitus perception.

#### **Conclusion:**

The afore mentioned finding of improved speech perception thresholds during electro-tactile stimulation applied to the index finger supports this interpretation. The electro-tactile stimulation increases somatosensory input to the DCN, which is equivalent to increased neuronal noise, which in turn improves detection thresholds for auditory stimuli via SR.

## **S20-O3**

### **Are gray matter volume changes in frontal brain regions associated with speech-in-noise performance in tinnitus patients?**

*Yihsin Tai<sup>1,3</sup>, Somayeh Shahsavarani<sup>1,2,3</sup>, Rafay Khan<sup>2,3</sup>, Sara Schmidt<sup>2,3</sup>, Fatima Husain<sup>1,2,3</sup>*

*<sup>1</sup> Department of Speech and Hearing Science, University of Illinois at Urbana-Champaign*

*<sup>2</sup> Neuroscience Program, University of Illinois at Urbana-Champaign*

*<sup>3</sup> Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign*

#### **Introduction:**

Speech-in-noise (SiN) difficulties are reported in tinnitus patients, regardless of their hearing sensitivity. Although brain structural changes such as reduced gray matter volume (GMV) in cognitive control regions have been reported in tinnitus patients compared with controls, such changes have not been linked to their SiN performance. The aim of the current study was to examine if SiN recognition in challenging listening conditions can be predicted by the GMVs in the auditory and cognitive brain regions in tinnitus patients.

#### **Material & Method:**

Pure-tone audiometry and Quick Speech-in-Noise test were conducted on participants with tinnitus (tinnitus group) and those without tinnitus (control group); all participants had bilateral normal hearing sensitivity ( $\leq 25$  dB HL from 0.25 to 8 kHz). T1-weighted structural MRI images were obtained from all participants. After preprocessing, GMVs were compared between the tinnitus and control groups using whole-brain and region of interest (ROI) analyses. Further, regression analyses were performed to examine the correlation between the GMVs and SiN scores in each group.

#### **Results:**

Preliminary results showed decreased GMV in the bilateral inferior frontal gyri, left insula, and left hippocampus in the tinnitus group compared with the control group. Regression analyses revealed a significant negative correlation between GMVs in the left inferior frontal gyrus (IFG) and SiN scores in the tinnitus group; this correlation was not found in the control group.

#### **Conclusion:**

The results indicate that tinnitus patients, even with normal hearing, demonstrated some morphological changes in the cognitive and limbic brain regions. The findings that less GMV in left IFG predicts better SiN performance may suggest such association is necessary for tinnitus patients as a compensatory mechanism to maintain comparable performance in everyday listening tasks.

## **S20-O4**

### **Resting-state MEG Functional Connectivity Analysis in Patients with Tinnitus**

*Po-Yi Lin<sup>1</sup>, Lieber Po-Hung Li<sup>1</sup>, Yi-Hsuan Li<sup>2</sup>, Tai-Shih Chi<sup>2</sup>*

*<sup>1</sup> Department of Otolaryngology, Cheng-Hsin General Hospital, Taipei, Taiwan*

*<sup>2</sup> Department of Electrical and Computer Engineering, National Chiao Tung University*

#### **Introduction:**

Tinnitus is a perception of sound in the absence of any external auditory stimuli. According to the American Tinnitus Association, around 15 % of the population is affected by tinnitus. In this study, our goal is to try and understand the neuropathological origin of tinnitus through magnetoencephalography (MEG).

#### **Material & Method:**

We included 31 patients with tinnitus and 34 normal subjects and compared the resting state MEG recordings for each group. Signals from 10 brain regions were extracted from MEG recordings for functional connectivity analysis. To achieve higher spatial resolution on localization, individual MRIs were co-registered with MEG recordings. Functional connectivity analysis was further conducted between 68 brain regions rather than 10 brain regions. Based on the findings of functional connectivity, we also investigated the effect of rTMS treatment.

#### **Results:**

The results showed patients with tinnitus having significant differences on delta band (1~4Hz) amplitude envelope correlation (AEC) connectivity and correlation connectivity between brain regions comparing to those of normal subjects. Significant differences were also noted on correlation connectivity in regions related to monitoring verbal information and delta band AEC connectivity in regions related to emotions and facial language processing. Another result we observed was that patients reporting improvement of tinnitus after rTMS treatment will develop functional connectivity patterns more similar to that of normal subjects.

#### **Conclusion:**

The results suggest that analysis of functional connectivity could provide a hint of outcome and prognosis on patients with tinnitus. Objective evaluation models have achieved an accuracy of above 70 percent for diagnosing tinnitus. Our study provides a closer look into the neuropathology of tinnitus and a reliable model for evaluating tinnitus.

## S20-O5

### Residual Inhibition and Neural Activity in Patients with Tinnitus: Preliminary

#### Results of Within- and Between-Subject Comparison

Hu S<sup>1,2</sup>, Anschuetz L<sup>1,2</sup>, Huth M<sup>1</sup>, Hall D<sup>3,4</sup>, Sznitman R<sup>5</sup>, Caversaccio M<sup>1,2</sup>, Wimmer W<sup>1,2</sup>

<sup>1</sup>Department of Otorhinolaryngology, Head & Neck Surgery, Inselspital, Bern University Hospital, Bern, CH

<sup>2</sup>Hearing Research Laboratory, ARTORG Center, University of Bern, Bern, CH

<sup>3</sup>NIHR Nottingham Biomedical Research Centre, Nottingham, UK

<sup>4</sup>Hearing Sciences, Division of Clinical Neuroscience, University of Nottingham, Nottingham, UK

<sup>5</sup>Ophthalmic Technology Laboratory, ARTORG Center, University of Bern, Bern, CH

#### Introduction

We present preliminary results of a study investigating the association between residual inhibition (RI) and electroencephalography (EEG) in patients with tinnitus. To minimize data heterogeneity, a within- and between-subject study design using RI is applied [1].

#### Method

Data of 26 subjects were collected so far; herein results of 9 subjects are presented. EEG was recorded during 24 trials, consisting of the epochs *Baseline*, *Stimulus* and *Poststimulus*. Two stimulus types were presented in randomized order: RI and control (no RI after stimulation). Further details on the study procedure are available in [1]. The effects of RI on EEG power (temporal brain region) were analyzed using linear mixed effects models. Fixed effects were stimulus type and epoch, while subject as well as trial number within subject were included as random effects to account for repeated measures.

#### Results

After RI stimulation an effect on EEG power in alpha (-0.5 dB,  $p < .001$ ), beta (-0.5 dB,  $p < .001$ ) and gamma (-0.4 dB,  $p = .036$ ) bands was observed; no change after control stimuli was seen. Delta band power increased by 0.2 dB ( $p = .013$ ) during control and decreased by 0.2 dB ( $p = .033$ ) during RI *Stimulus* exposure. Theta power decreased by 0.3 dB after exposure to both RI ( $p = .035$ ) and control stimuli ( $p = .025$ ). Post-hoc testing revealed no differences between RI and control stimuli in the *Poststimulus* epoch. Difference in delta power was statistically significant between RI and control stimulation (0.5 dB,  $p < .01$ ).

#### Conclusion

Our preliminary results indicate differences in neural activity during and after stimulation with RI and no RI causing (control) stimuli. However, the analysis has to be performed with higher sample size to consolidate the findings. In addition, source-based as well as machine-learning based analysis will be performed.

[1] Hu et al. Association Between Residual Inhibition and Neural Activity in Patients with Tinnitus: Protocol for a Controlled Within- and Between-Subject Comparison Study. *JMIR Res Protoc* 2019. 8:e12270; doi: 10.2196/12270.

## **S20-S1**

### **Age-related change of auditory functional connectivity in Human Connectome**

#### **Project data and tinnitus patients**

*Shujiro B Minami<sup>1</sup>, Naoki Oishi<sup>2</sup>, Kaoru Ogawa<sup>2</sup>*

*<sup>1</sup> National Tokyo Medical Center, National Institute of Sensory Organs*

*<sup>2</sup> Keio University, School of Medicine, Department of Otolaryngology, Head and Neck Surgery*

#### **Introduction:**

Auditory functional connectivity (AFC) refers to the statistical association or dependency between two or more anatomically distinct time-series among the auditory-related region and is measured via resting-state functional magnetic resonance imaging (rs-fMRI) using cross correlation-based techniques. We previously reported that tinnitus patients with or without hearing loss showed reduced levels of statistically significant AFC in comparison with normal hearing control subjects. However, age-related change of the AFC is not clarified. In this study, we examined the age-related change of the AFC using the database of Human Connectome Project (HCP) and compared with the tinnitus patients.

#### **Material &Method:**

From the HCP Lifespan Pilot project, we study 5 age groups; 8-9, 14-15, 25-35, 45-55, and 65-75 years old. MRI structure images and rs-fMRI images were analyzed. The fMRI images were pre-processed with SPM version 12, and region of interest (ROI)-based correlation analyses were performed using the CONN toolbox version 18. As an auditory-related region, Heschl's gyrus, planum temporale, planum polare, operculum, insular cortex, and superior temporal gyrus were set as the ROI from our previous reports.

#### **Results:**

At a beta threshold of more than 0.2, the percentages of all possible connections between the auditory-related ROIs remained intact in the 5 age groups (8-9, 14-15, 25-35, 45-55, and 65-75) are  $84\% \pm 8$ ,  $98 \pm 2$ ,  $89 \pm 1$ ,  $81 \pm 6$ , and  $78 \pm 2$ . ANOVA with SNK (Student-Newman-Keuls) comparison showed that the mean percentage score from Group 14-15 was significantly more than Group 8-9 and 25-35. Both Groups 14-15 and 25-35 were significantly more than Groups 45-55, and 65-75.

#### **Conclusion:**

The people during adolescence have the strongest AFC, and AFCs decrease with age. Previously, we reported objective diagnosis of tinnitus by AFC, but elderly tinnitus patients should be cared, because their AFC can be declined by aging.