

FUNCTIONAL IMAGING OF CHRONIC TINNITUS: THE USE OF POSITRON EMISSION TOMOGRAPHY

Eichhammer P, Langguth B, Kleinjung T, Landgrebe M, Sand P, Hajak G

Department of Psychiatry, University of Regensburg, Germany

Department of Otorhinolaryngology, University of Regensburg, Germany

Modern brain imaging methods including functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) afford unprecedented opportunities for the in vivo study of central auditory system function. With the advent of these mapping techniques more than 15 years ago, new insights into the etiology of chronic tinnitus could be gained. Particularly, PET studies have contributed to a paradigm shift, demonstrating that the actual generator of chronic tinnitus is central in most cases. In detail, using [18F] deoxyglucose (FDG) as a radiotracer our group could replicate and confirm previous PET data pointing to a significantly increased metabolic activity in the left primary auditory cortex (PAC, Brodmann area 41) in patients suffering from permanent tinnitus complaints. These imaging results have also build the rationale basis to use low-frequency PET-guided repetitive transcranial magnetic stimulation as a causally orientated treatment option for tinnitus.

Beside this therapeutically orientated approach offered by 18-FDG-PET, PET measurements of regional cerebral blood flow enabled to identify a variety of cortical and subcortical brain structures additionally involved in the generation of tinnitus. Based on these imaging results chronic tinnitus can now be conceptualized as a “phantom auditory perception” caused by dysfunctional activity in large-scale neuronal circuits that include regions located outside the PAC, particularly in attentional and limbic systems.

Most recently, we were able to identify gender-related metabolic activity patterns in distinct cortical regions of patients with chronic tinnitus using PET. Whereas female patients showed increased metabolic activity in temporo-parietal brain regions, male tinnitus patients displayed significantly increased activity in frontal and occipital brain areas. These results may help to develop new treatment targets for chronic tinnitus and to further individualize treatment strategies.

Moreover, PET can be used to map neurochemical pathways and receptors, which may play a pivotal part in auditory processing. Up to now, PET studies using selective radiotracers to characterize specific neurochemical systems in patients with tinnitus have not been reported. Changes in neuroreceptor ligand binding related to pharmacological intervention and detected by PET may pave the way to develop new central acting agents especially designed to modify activity in tinnitus related cortical regions.

Taken together, PET has the potential to make a valuable contribution to basic neuroscience, to identify potential treatment targets for chronic tinnitus and to further individualize treatment strategies based on individual activity profiles in distinct brain regions. A unique advantage of PET is to use radiotracers to specify even a particular receptor subtype, which may help to design new drugs for tinnitus on a molecular level.