
# Neuromodulation of Tinnitus: A Review of Current Therapies and Future Applications

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## Introduction

Tinnitus is the conscious perception of an auditory sensation in the absence of external stimulus. Proposed theories are based on neuroplastic changes from sensory deprivation (1). Thalamic dysrhythmia is one model where disruption in the normal feedback mechanism of the thalamus on the auditory cortex leads to generation of the tinnitus precept (2). The authors review relevant literature available on neuromodulation of tinnitus and describe potential targets for deep brain stimulation (DBS) for the management of tinnitus.

## Methods

A MedLine keyword and Medical Subject Heading term literature search using Pubmed for tinnitus, neuromodulation, deep brain stimulation, transcranial magnetic stimulation, epidural electrode stimulation, intradural electrode stimulation yielded 26 reports. Data from these reports were extracted and reviewed.

## Conclusions

DBS shows promise as a therapeutic option for tinnitus (3). Stimulation of the auditory pathway, particularly MGB, could counteract thalamocortical dysrhythmias and reduce gamma activity implicated in the tinnitus precept (4). Stimulation of the limbic pathway likely acts through decreasing attention and perception of tinnitus (3, 5). At this juncture in tinnitus management, additional studies focusing on the involvement of thalamic and limbic structures in the pathophysiology of tinnitus to support the use of DBS are needed.

## Results

More commonly used imaging studies to understand the pathophysiology of tinnitus include functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), positron emission tomography (PET), Single Photon Emission Computed Tomography (SPECT) and magnetoencephalography (MEG). Abnormal regions and altered connectivity implicated in tinnitus include auditory pathway structures such as primary auditory cortex, inferior colliculus and medial geniculate body (MGB), as well as limbic structures such as amygdala, hippocampus, anterior cingulate gyrus and locus of caudate neurons (area LC) (3-7). Neuromodulation attempts to correct this hyperexcitable state by disrupting these aberrant connections and returning activity to baseline. Applied treatment modalities include transcranial magnetic stimulation, epidural/intradural electrode stimulation, and deep brain stimulation (3, 4).

## Learning Objectives

By the conclusion of this session participants should be able to:

1) Describe the importance of deep brain stimulation in the management of tinnitus.

2) Discuss, in small groups, which imaging modalities are most useful in identifying viable DBS targets

3) Identify an effective cortical or subcortical target for neuromodulation for the management of tinnitus.

## References

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