

# Surgical Treatment of Tinnitus



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## KEYWORDS

• Tinnitus • Surgery for tinnitus • Objective tinnitus • Sigmoid sinus wall anomalies

## KEY POINTS

- Most patients with objective tinnitus, whether pulse-synchronous or not, will have an identifiable and frequently treatable cause.
- Venous etiologies of pulse-synchronous tinnitus are the most common.
- A thorough diagnostic evaluation must look for causes of abnormal sound production and abnormal sound perception.
- Vascular studies must include venous phases, with particular attention to imaging the transverse and sigmoid sinuses.
- Subtle sigmoid sinus wall anomalies will only be detected with high-resolution appropriately windowed computed tomography.

## INTRODUCTION

Surgery for tinnitus can be divided into procedures directed specifically at elimination of tinnitus versus those directed at an independent primary otopathology whose symptoms include tinnitus (**Table 1**). For the latter, although there may be an independent primary goal for which the surgery is undertaken, tinnitus may be expected to improve secondarily. This article will address both tinnitus-specific and nontinnitus-specific procedures for objective and subjective causes.

Tinnitus is defined as the abnormal perception of sound in the absence of an external sound source. Objective tinnitus has traditionally referred to a sound that can be heard by another listener aside from the patient. This term can be misleading, since it is highly dependent on the degree of attention the examiner pays and the tools employed. However, if one defines objective tinnitus as that which, based on its auditory characteristics and other features, is thought to arise from an objective, mechanical sound source, the

ambiguity is eliminated. Objective tinnitus can be pulsatile (or, more precisely, pulse-synchronous) or nonpulsatile. Surgical intervention for tinnitus relief is most commonly performed for objective tinnitus.

Using the same rationale for definition, a so-called subjective tinnitus is that which, based on the presumed etiology and pathophysiology, is thought to be caused by a purely electrochemical phenomenon. This type of abnormal sound perception cannot be heard by an objective listener no matter the sensitivity of the listening equipment. Although commonly perceived as a continuous tone, it too can often have rhythmicity, such as that of chirping crickets, although it is only very rarely truly pulse-synchronous or regularly rhythmic. Throughout this article, sounds thought to arise from an objective, mechanical sound source will be referred to as objective tinnitus, and those arising from a purely electrochemical phenomenon will be referred to as subjective tinnitus.

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**Table 1**  
Surgical options for tinnitus

Tinnitus Specific Surgery	Surgery with Secondary Benefit on Tinnitus
Subjective	Subjective
Vagus nerve stimulation	Hearing restoration surgery
Cochlear or cochlear nerve stimulation	Ossicular chain reconstruction
Deep brain stimulation	Cochlear implantation
Intratympanic steroid injection	Other implantable hearing devices (eg, bone conduction devices)
Objective	Intratympanic steroid injection (eg, for Meniere's disease or sudden sensorineural hearing loss)
Tensor tympani and/or stapedius tenotomy	Objective
Sigmoid sinus wall reconstruction	Superior canal dehiscence syndrome
Eustachian tube dysfunction	Excision of paraganglioma
Middle ear ventilation	
Eustachian tuboplasty	
Internal jugular vein ligation	

## CLINICAL EVALUATION

For a detailed discussion of the clinical evaluation of the patient with tinnitus, please refer to [Hertzano R, Teplitzky TB, and Eisenman DJ: Clinical Evaluation of Tinnitus](#), in this issue. To summarize, the focus of the evaluation must be directed both at identifying potentially treatable causes and at assessing the impact of the tinnitus on the patient's daily activity and well-being. It is important to distinguish early on between objective and subjective causes, because the focus of the evaluation will differ significantly. A thorough history and complete head and neck examination are the critical foundation upon which the further evaluation rests. Complete audiometry will identify and classify any associated, and possibly causative, hearing loss. Most patients with subjective tinnitus

have underlying hearing loss.<sup>1</sup> If the audiogram demonstrates symmetric sensorineural hearing loss, the tinnitus itself is perceived bilaterally or with no lateralization, and there are no other associated symptoms or physical examination findings of concern, then no further diagnostic evaluation is required.

The differential diagnosis for pulse-synchronous tinnitus should be divided into causes due to abnormal sound production (eg, transverse sinus stenosis, sigmoid sinus wall anomalies, acquired dural vascular lesions) and those due to abnormal sound perception (eg, third mobile window syndromes) ([Table 2](#)). There are also some causes whose pathophysiology is uncertain, such as migraine and Meniere's disease. If during the initial clinical assessment a particular category is found

**Table 2**  
Differential diagnosis for pulsatile tinnitus

Abnormal Sound Perception	Abnormal Sound Production
Eustachian tube dysfunction	Carotid stenosis
Patulous eustachian tube	Durai arteriovenous malformation
Eustachian tube dysfunction with diminished middle ear aeration	High riding carotid artery
Causes of conductive hearing loss	Sigmoid sinus wall anomalies
External auditory canal obstruction	Sigmoid sinus wall dehiscence
External auditory canal stenosis	Sigmoid sinus diverticulum
Middle ear disease	Transverse sinus stenosis
Tympanic membrane perforation	Paraganglioma
Ossicular discontinuity	Glomus tympanicum
Otosclerosis	Glomus jugulare
Third mobile window syndromes	Unknown or uncertain cause
Superior semicircular canal dehiscence	Migraine
Cochlear-carotid fistula	Meniere disease
Enlarged vestibular aqueduct	

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