

# Pulsatile Tinnitus and Carotid Artery Atherosclerosis

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**Abstract:** This cross-sectional study was designed to determine the prevalence of carotid artery atherosclerosis in patients with pulsatile tinnitus. All patients who had pulsatile tinnitus and presented to the otolaryngology clinic of Rasoul Akram Hospital, Iran University of Medical Sciences, and to some other private hospitals and clinics were referred to a tertiary referral center. From November 1999 to September 2003, 34 patients with pulsatile tinnitus underwent a clinical evaluation. Color Doppler ultrasonography was performed in all patients. Atherosclerotic carotid artery disease (ACAD) was found to be a cause of pulsatile tinnitus in four patients (11.76%). The mean age of these patients was higher than that of the other patients (59 vs. 34 years). All patients had at least one risk factor for ACAD. In three patients, pulsatile tinnitus was the first manifestation of ACAD; in two of these, this symptom occurred when the stenosis affected more than 70% of the artery's diameter. ACAD should be considered in evaluation of all patients with pulsatile tinnitus and associated cardiovascular risk factors. As pulsatile tinnitus may be the sole manifestation of severe carotid artery stenosis, immediate color Doppler ultrasonographic study is recommended in those patients with risk factors and in the elderly.

**Key Words:** atherosclerosis; carotid artery; pulsatile tinnitus

Tinnitus is a prevalent and troublesome condition. Roughly 17% of the general population suffers from tinnitus [1]. When the tinnitus is rhythmic and synchronous with the heartbeat, it is called *pulsatile tinnitus* [2]. A small percentage (8–10%) of people, however, experience tinnitus that they describe as rhythmic, beating, pounding, throbbing, or “swooshing” in nature [3]. Pulsatile tinnitus is a rare symptom and is believed to be a consequence of sound transmission created by turbulent blood flow through the petrous bone to the inner ear [2,4]. At times, however, these

pulsations occur in or around the middle ear or inner ear or near the hearing nerve and become audible to us. The perception of the rhythmic flow of blood through the head or neck region is also termed *pulsatile tinnitus*. It may be subjective (perceived by the patient only) or objective (perceived by both the patient and the examining physician) [5]. Pulsatile tinnitus usually occurs in one ear only, and it is an important variant among tinnitus patients. This symptom may result from a wide variety of diseases. One of the reported etiologies of pulsatile tinnitus is atherosclerotic disease of the carotid arteries. Diagnosis of atherosclerosis in affected patients is critical to prevent the more serious central nervous system complications and to guide treatment.

Such conditions as hardening of the arteries (atherosclerosis), benign intracranial hypertension, and heart murmur can be effectively treated with medications, which often, though not always, results in elimination of or dramatic reduction in pulsatile tinnitus. As few

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studies have addressed the prevalence of carotid artery atherosclerosis in affected patients, and no study has been carried out in Iranian patients, we decided to determine the prevalence of carotid artery atherosclerosis in patients with pulsatile tinnitus.

## MATERIALS AND METHODS

We designed a descriptive cross-sectional study to assess the association between pulsatile tinnitus and atherosclerosis of the carotid artery. From November 1999 to September 2003, 34 patients who had pulsatile tinnitus and attended the otolaryngology clinic at Rasoul Akram Hospital, Iran University of Medical Sciences, and some other private clinics and hospitals were examined. All underwent a clinical evaluation consisting of a thorough medical history, otoscopic examination, and auscultation of the head, neck, and chest. In addition to a medical examination, patients underwent a complete audiologic examination. Hearing testing was performed to determine whether hearing loss existed and, if so, of what type (e.g., middle ear, inner ear, or hearing nerve). In addition, tympanometry and tinnitus evaluation were performed in an attempt to record objective evidence of the pulsatile tinnitus from patients' ear canal.

Color Doppler ultrasonography was performed on all patients, with patients in the supine position and the head slightly extended and turned away from the site of examination. A 3- to 7.5-MHz transducer was used. Scans were obtained along the entire course of the carotid artery, from the supraclavicular notch cephalad to the angle of the mandible. Carotid arteries of both sides of the neck were studied. We evaluated instances of atherosclerotic plaque in the carotid artery as to their location, extent, thickness, and degree of stenosis.

## RESULTS

Thirty-four patients with pulsatile tinnitus were submitted to color Doppler evaluation (20 women and 14 men; mean age, 34 years; range, 17–80 years). Tinnitus was objective in 10 patients (29.40%) and subjective in 24 (70.60%); it was bilateral in 3 patients (8.82%).

Atherosclerotic carotid artery disease (ACAD) was diagnosed as a cause of pulsatile tinnitus in 4 of the 34 patients (11.76%; Table 1). Objective unilateral tinnitus was present in 4 patients, and ipsilateral carotid bruit was heard in all 34. The otoscopic examination results were normal, and no retrotympanic mass was detected. All four patients with diagnosed ACAD underwent brain computed tomography, and the findings were normal. All 34 patients evinced at least one risk factor

**Table 1.** Clinical and Ultrasound Findings in Patients with Pulsatile Tinnitus Caused by Carotid Artery Atherosclerosis

Patient No.	Age	Gender	Type of Pulsatile Tinnitus	Percentage of Carotid Artery's Diameter Affected by Stenosis	Risk Factors of ACAD
1	75	F	Objective	40	Diabetes mellitus, hypertension
2	52	M	Objective	70	Heavy smoking, hypercholesterolemia
3	50	M	Objective	50	Hypertension
4	67	M	Objective	75	Hypertension, heavy smoking

ACAD = atherosclerotic carotid artery disease; F = female; M = male.

for ACAD. A brief history of the four patients with ACAD follows.

### Patient 1

Patient 1 was a 75-year-old woman who developed left-sided pulsatile tinnitus some 2 months before admission. She suffered from non-insulin-dependent diabetes mellitus and hypertension. She had a history of transient ischemic attack 6 months before admission. Color Doppler ultrasonography revealed an atherosclerotic plaque in the distal portion of her left common carotid artery, with the resultant 40% decrease in diameter.

### Patient 2

Patient 2 was a 52-year-old man who presented with left-sided pulsatile tinnitus of 1-month duration. He was a heavy smoker and had hypercholesterolemia. Color Doppler ultrasonography showed a 70% decrease in diameter of the distal portion of his common carotid artery due to an atherosclerotic plaque.

### Patient 3

Patient 3 was a 50-year-old man with hypertension. He complained of pulsatile tinnitus in his right ear of 6 months' duration. Color Doppler ultrasonography revealed an atherosclerotic plaque in the proximal part of his right internal carotid artery, which caused 50% decrease in diameter.

### Patient 4

Patient 4 was a 67-year-old man who suffered from pulsatile tinnitus in his right ear from 5 months before

admission. The patient was hypertensive and a heavy smoker. He had a history of transient ischemic attack 3 months previously and amaurosis fugax 1 month previously. Color Doppler ultrasonography revealed an atherosclerotic plaque in the proximal part of his right internal carotid artery, with the resultant 75% decrease in diameter.

## DISCUSSION

Tinnitus is defined as *pulsatile* when an affected patient describes a rhythmic sound synchronous with the heart beat [2]. Pulsatile tinnitus is a rare symptom, but correct diagnosis is critical because, in the majority of cases, the underlying etiology is treatable.

A wide variety of abnormalities have been found to cause pulsatile tinnitus. The most common causes are arteriovenous fistulae from branches of the external carotid artery to the dural sinuses; benign intracranial hypertension syndrome; paragangliomas of the temporal bone; atherosclerotic disease of the internal carotid artery; and anomalies of the jugular bulb and intrapetrous carotid artery [2,5–10].

ACAD is one of the known causes of objective pulsatile tinnitus [2,4,6–8,10]. As the elderly population grows and the risk factors of atherosclerosis (smoking, lack of exercise, and stressful lifestyle) increase, more patients with pulsatile tinnitus due to carotid atherosclerosis will be identified. Thus, carotid artery atherosclerosis should be highly suspected in patients who are older than 50 years and have risk factors of atherosclerosis. According to several studies, the frequency of tinnitus increases in the elderly, so carotid artery atherosclerosis may be one of its possible causes [1].

A review of 100 cases of pulsatile tinnitus by Sismanis and Smoker [6] revealed that ACAD accounts for 15% of such cases. In another study by Sismanis [7], mild to severe carotid artery stenosis due to ACAD was the cause of pulsatile tinnitus in 24 cases (16%) of 145 patients with pulsatile tinnitus. In the survey carried out by Waldvogel et al. [2], the records of 84 patients with pulsatile tinnitus were reviewed, and atherosclerosis of the internal carotid artery was found in 7 (8%). Gutmann et al. [11] studied the incidence of Doppler ultrasonography–detectable atherosclerosis of cervical arteries in patients with tinnitus. That study found that patients with tinnitus had a greater risk of atherosclerotic stenosis of extracranial arteries (18%) than did asymptomatic people (1%).

In our study, atherosclerosis of the carotid artery was the cause of objective pulsatile tinnitus in 4 (11.76%) of 34 patients. Our results are in agreement with the data indicated by Sismanis et al. [6,7,10] but are

higher than the frequency reported by Waldvogel et al. [2]. In three (8.82%) of our patients (patients 2, 3, and 4), pulsatile tinnitus was the first manifestation of ACAD [9]. In patients 2 and 4, pulsatile tinnitus occurred as the first symptom when the degree of stenosis increased to more than 70%. Thus, early and accurate diagnosis of atherosclerosis is imperative and will prevent stroke and other central nervous system complications.

Color Doppler ultrasonography is a noninvasive and cost-effective method to assess suspected extracranial carotid artery atherosclerosis, and carotid artery angiography has largely been replaced with this technique. Most studies indicate 90–95% accuracy rates for color Doppler ultrasonography [12,13]. Color Doppler ultrasonography can also facilitate measurement of the degree of stenosis [12]. It is also important for identifying patients who would benefit from surgical interventions.

Atherosclerosis responsible for pulsatile tinnitus is being treated by either endarterectomy for proximal internal carotid artery disease or ligation for distal internal carotid artery lesions [4]. Tinnitus attributable to stenosis at the common carotid artery bifurcation has been successfully treated by carotid endarterectomy (CEA) [4,14,15]. Results of different trials demonstrated that CEA is more beneficial than medical therapy in symptomatic patients with greater than 70% carotid stenosis. Recent data have also demonstrated a 19% decrease in the incidence of ipsilateral stroke in symptomatic patients who had stenosis greater than 70% and underwent CEA [12,16]. In two (8.33%) of our patients (patients 2 and 4), CEA would be the most beneficial management approach and decreases the risk of stroke.

## CONCLUSION

ACAD accounts for pulsatile tinnitus in some 11.76% of patients, and it should be considered in the evaluation of patients, particularly in those with the risk factor of atherosclerosis and in the elderly. As pulsatile tinnitus may be the first and sole manifestation of severe carotid artery stenosis, it should prompt immediate color Doppler ultrasonographic study in patients with cardiovascular risk factors.

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