

Can a Persistent Stapedial Artery be Safely and Effectively Removed?

A Case Report with Therapeutic Implications

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Abstract: In the past, a persistent stapedial artery was frequently cited as a reason to discontinue stapes surgery, however, several authors have had success operating on the oval window despite the presence of a persistent artery. We present a case of a patient with conductive hearing loss and tinnitus successfully treated with removal of a persistent stapedial artery that was filling the obturator foramen. This experience, in conjunction with a review of the literature and a discussion with several neurotologic colleagues, leads us to suggest that a stapedial artery can be safely removed allowing unhindered access to the oval window.

INTRODUCTION

The stapedial artery is an important vessel in the developing embryo, supplying most of the non-neural structures of the head and neck; however, with maturation this vessel takes on much less importance and by ten weeks gestation the external carotid system becomes the primary arterial supply of the head and neck. The diagnosis of a persistent stapedial artery is haphazard and usually only discovered by direct observation during tympanotomy which explains why it is commonly seen with otosclerosis. In the patient, to be discussed, removal of a stapedial artery led to resolution of the pulsatile tinnitus and hearing improvement.

CASE REPORT

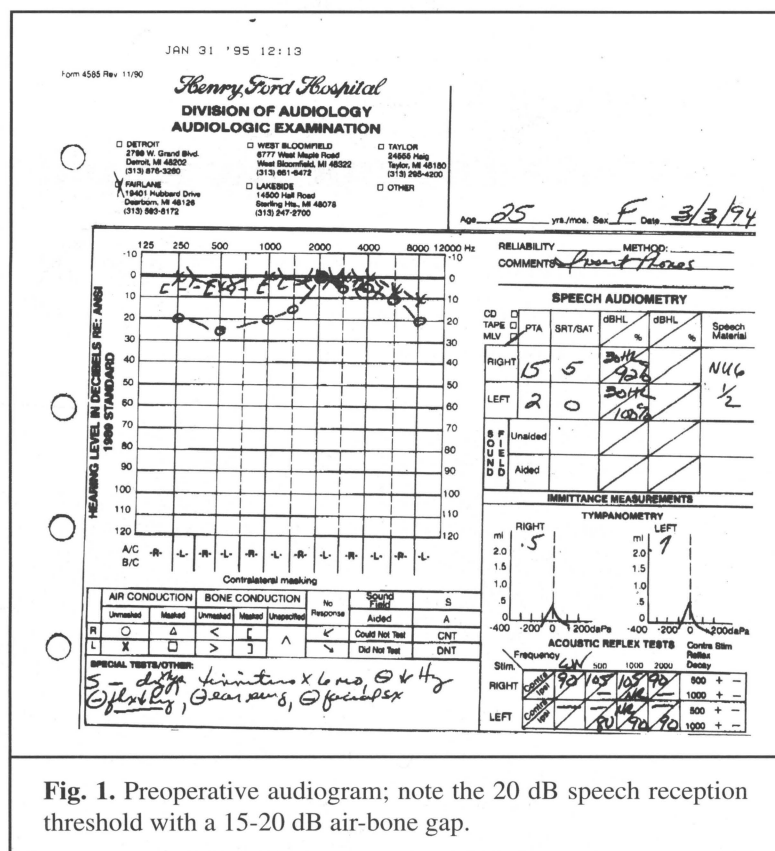
A 26-year-old woman without previous family history or previous otologic problems presented to the Division of Otology/Neurotology at Henry Ford Hospital with a right-sided conductive hearing loss and pulsatile tinnitus. This was present for at least six months. Otoscopic examination demonstrated a small pulsatile red mass in the posterior-superior quadrant of the middle ear. The Weber lateralized to her right ear and Rinne was equivocal in the right and positive in the left with a 512 Hertz tuning fork, suggesting a right-sided conductive hearing loss. Audiometric analysis revealed a 20 dB right conductive hearing loss with elevated stapedial reflexes (Fig. 1).

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Diagnostic considerations included otosclerosis with Schwartze's sign, a vascular tumor, persistent stapedial artery, or possibly granulation tissue. Laboratory testing was normal including tests for urine and serum norepinephrine and metanephrines. High resolution computed tomographic scan with 1.5 mm axial and coronal cuts with contrast was obtained, and initially was interpreted as normal. However, on repeat evaluation the classic findings of a widened tympanic segment of the facial nerve as well as an absent foramen spinosum were identified (Figs. 2 and 3).

Exploratory tympanotomy was performed by one of the senior authors (MDS) under general anesthesia with continuous facial nerve monitoring (Silverstein Facial Nerve Monitor, Weigand; Minneapolis, MN). A large persistent stapedial artery was identified and was seen to completely fill the obturator foramen (Fig. 4).

This vessel measured approximately 2-3 mm in diameter and was pulsatile. Stapes mobility was only slightly reduced and it was felt to be due to the large size of the persistent vessel. Although there was no evidence of otosclerotic plaque, mild otosclerosis could not be entirely ruled out. Bone covered the facial nerve except for a small dehiscence on the inferior aspect of the nerve where the stapedial vessel turned medially. The facial nerve monitor was adjusted to its lowest setting, 0.05 mAmps, and stimulation of the inferior most portion of the facial nerve led to a response. This suggested that cautery near this area could be dangerous, and that any use of the bipolar would have to be performed at a low setting and as far away from the facial nerve as possible. The inferior portion of the artery was cauterized using a standard bi-



polar instrument set at 10-12 watts.

Extreme caution was exercised for the superior aspect of the vessel near the facial nerve. In this area superior to the oval window and inferior to the facial nerve, cautery was set at 7 watts. The cauterized segment was excised and removed from the obturator foramen and middle ear exposing a 2 mm area of bone erosion in the promontory which extended inferiorly from the oval window (Fig. 4). The facial nerve was stimulated again at the lowest setting, and there was an excellent response, suggesting normal facial function. A small amount of surgical (Johnson and Johnson, Texas) was placed over the inferior stump of the vessel and after 15 minutes of observation, hemostasis was assured and the ear was closed (Fig. 5). Immediately postoperatively, the pulsatile tinnitus was gone. The packing was removed one week postoperatively and the Rinne was positive to a 512 Hertz tuning fork. Subjectively, her hearing was improved. A post-operative audiogram at four weeks and six months showed improvement of the air-bone gap.

DISCUSSION

It has been estimated that 1 in 5,000 to 10,000 people have a persistent stapedial artery,¹ however a more recent study of 1000 temporal bones found an incidence of 1 in 500.² It has even been suggested that a small remnant of

this artery can be found in every ear.³ A review of the literature revealed 48 documented cases of a persistent stapedial artery. Twelve of these cases were isolated findings, without any associated ear anomalies, and of the 48, seven patients had surgical disruption of this vessel at the time of the procedure.⁴

The stapedial artery is a second branchial arch derivative that develops from the dorsal end of the hyoid artery. The distal stapedial artery branches develop into the supraorbital, frontal, anterior ethmoid, lacrimal, inferior orbital and inferior alveolar arteries. The cartilage of the developing stapes, at ten weeks gestation, limits further growth of the artery while the external carotid artery anastomosis with the distal stapedial artery leads to eventual atrophy of the stapedial vessel. Until this point at 10 weeks, the stapedial artery is the primary non-neural blood supply to the fetus' head and neck.⁴

The persistent stapedial artery usually enters the middle ear in the anterior/inferior hypotympanum and courses posteriorly and superiorly through the obturator foramen into the fallopian canal just posterior to the cochleariform process.⁴ It then leaves the canal superiorly and divides into an intracranial dural branch and sphenoidal branch. The intracranial dural branch substitutes for the middle meningeal artery, and thus explains the absent foramen spinosum. In theory, disruption of this vessel could lead

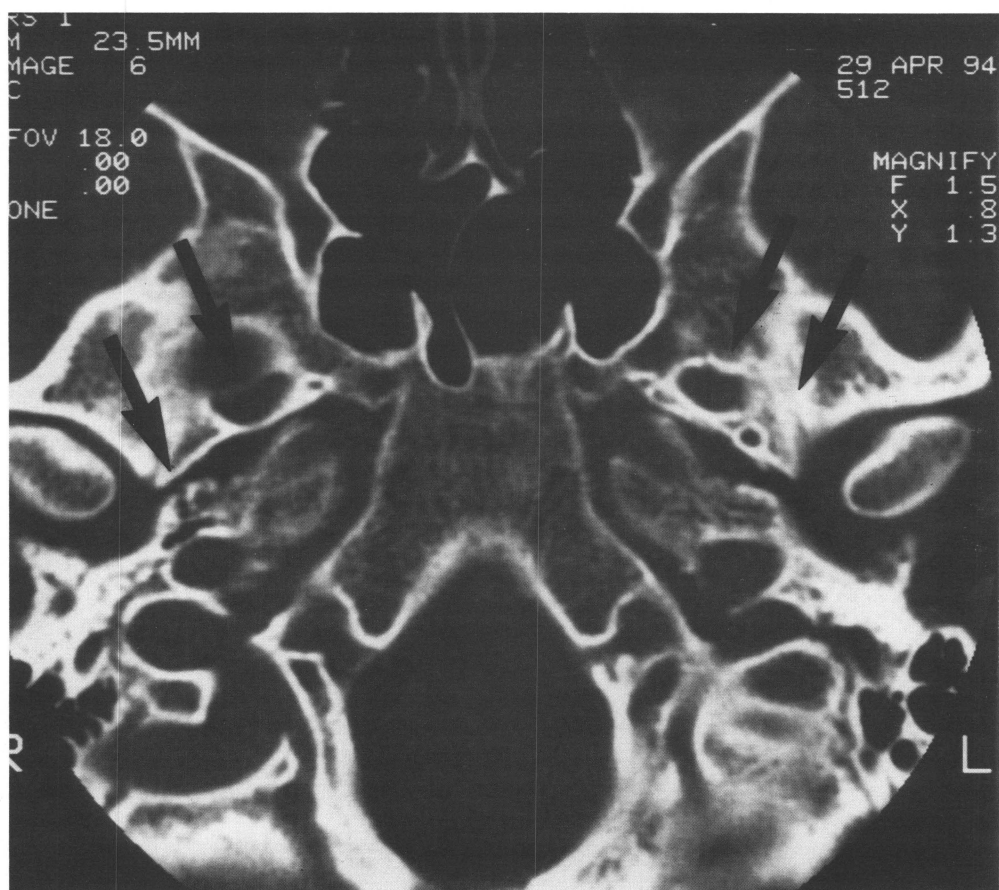


Fig. 2. Axial CT scan of the temporal bone with the arrows indicating normal foramen ovale anteriorly on both sides, a normal foramen spinosum on the left with no foramen spinosum on the right.

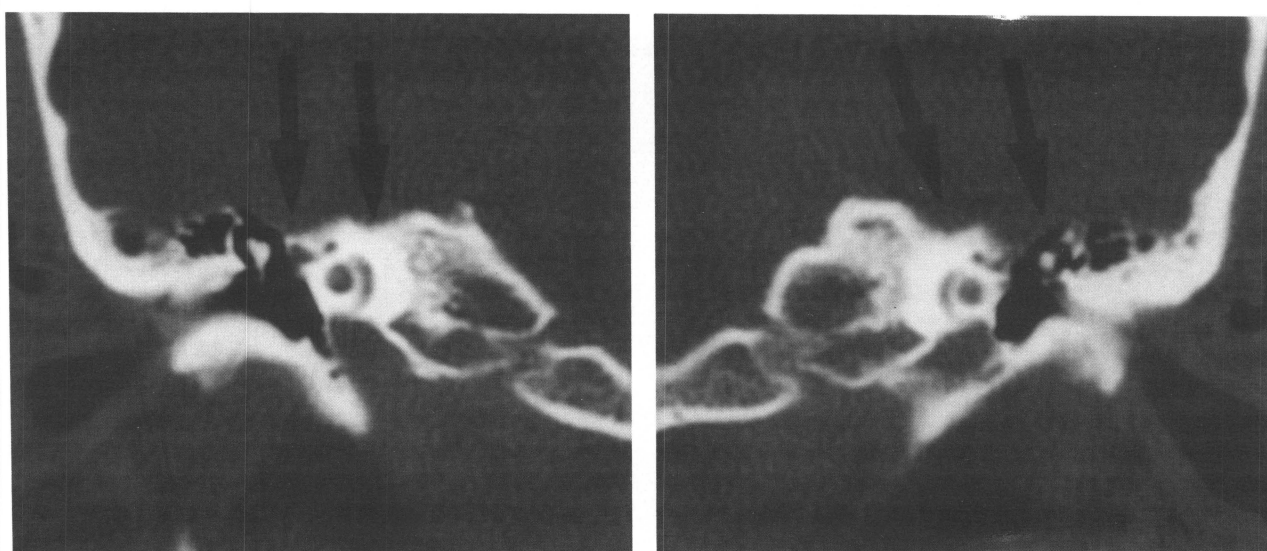


Fig. 3. Coronal CT scans showing a flared facial nerve canal on the right (the outer arrow). The inner arrows show normal appearing cochlea bilaterally.

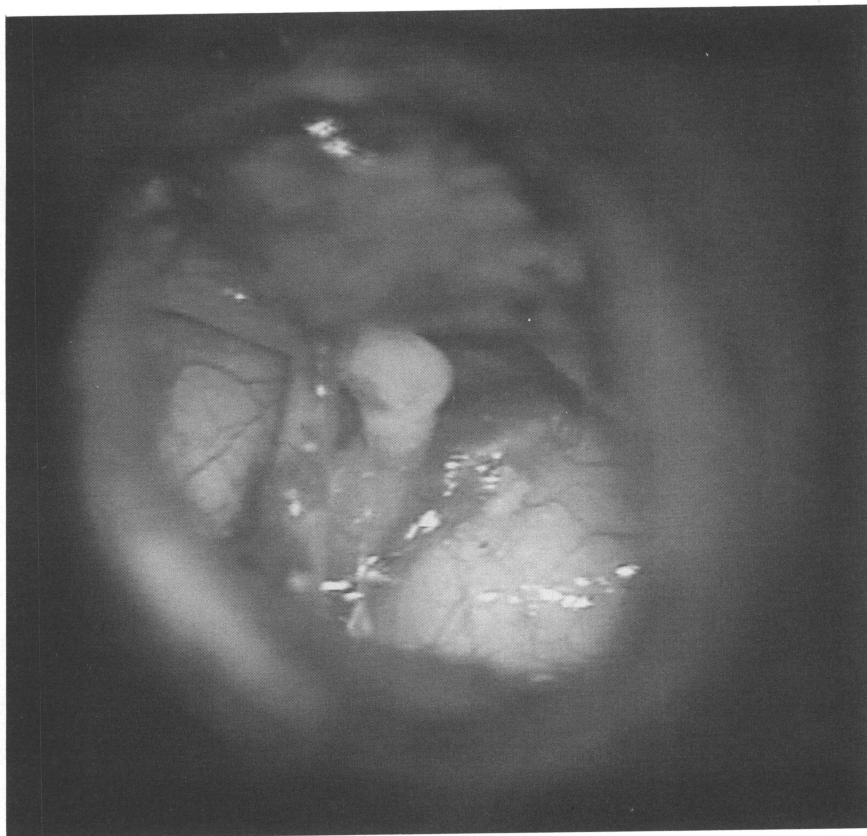


Fig. 4.

Demonstrates the persistent stapedial artery completely occupying the obturator foramen.

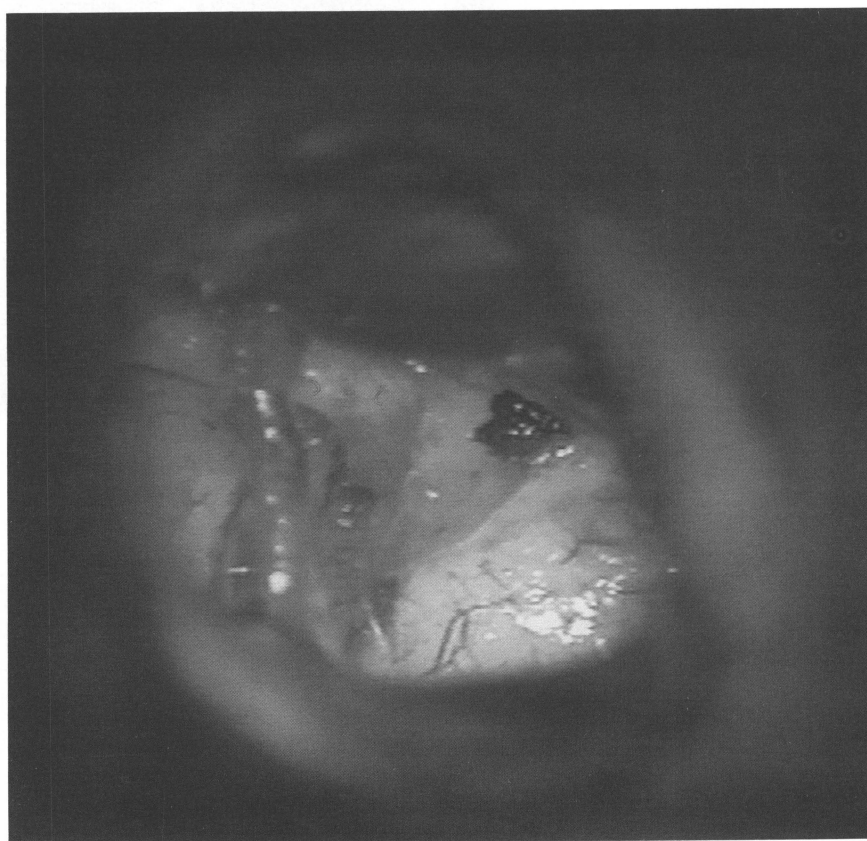
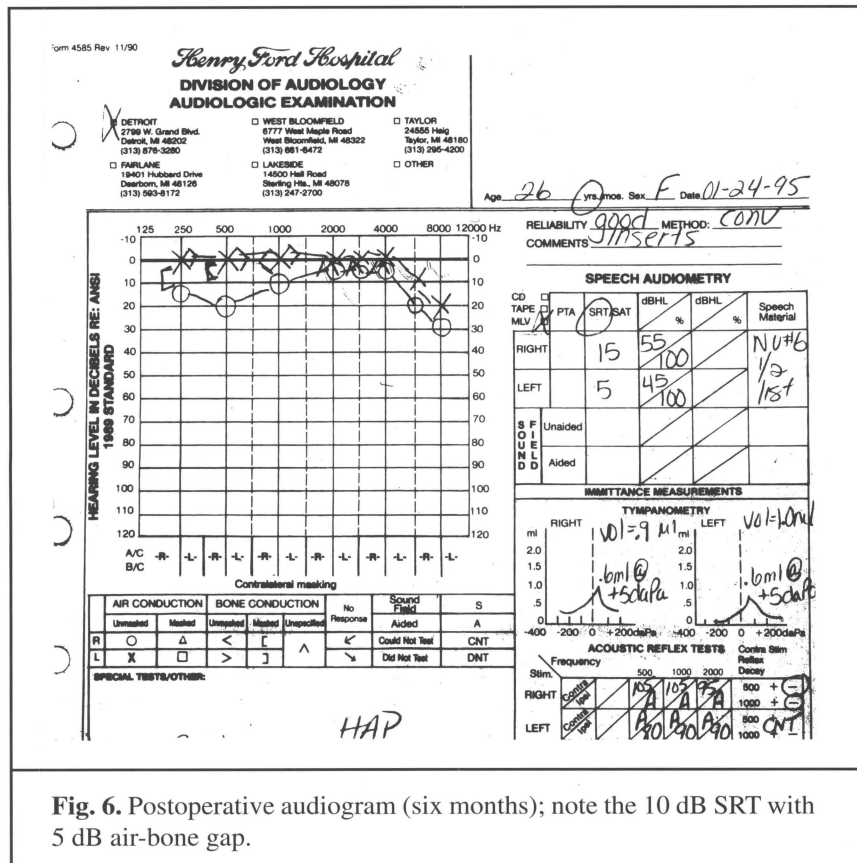


Fig. 5.

Demonstrates the appearance of the middle ear following removal of the persistent stapedial artery.



The diagnosis of a persistent stapedia artery was usually made during surgery for otosclerosis and when it was encountered it was generally recommended to abort the procedure.^{5,6} The primary reasons cited, were concern of uncontrollable hemorrhage and the possibility of causing distal ischemia of neural or cochlear structures. Although distal ischemia is a theoretical possibility, it was not reported in the seven previously reported cases of stapedia artery injury/ligation nor was it evident in our case.⁴ Two other cases described by Glasscock and Jackson also showed no adverse sequela following stapedia artery cauterization.⁷ As suggested by some, this might indicate that a persistent stapedia artery is rarely the sole vascular supply to any important structure. Cautious extension of these findings indicates that planned surgical ligation will not likely effect any distal neural or cochlear structures. Preoperative angiogram or magnetic resonance angiography may better address this question, however no studies are available to prove this. Uncontrolled hemorrhage is another reason surgeons in

This report coupled with other literature as well as personal communication with Drs. Glasscock,⁷ Jackson,⁷ Brackmann,¹² Silverstein,¹³ Graham¹⁴ and Kartush¹⁵ raises doubts about the previously reported concerns regarding stapled artery electrocauterization. Data from the neurosurgical¹⁶ and gastrointestinal literature¹⁷ suggests that bipolar cautery is effective when arterial diameter is less than 2.0 - 2.5 mm, under normotensive conditions, and is effective when venous diameter is less than 4.0 mm. In order to optimize coagulation lower heat with increased contact time and slow continuous motion along the vessel is recommended. This increases the total amount of heat transferred before electrodesiccation of tissues breaks the current flow.¹⁸ There are few reports

on the safety of bipolar cautery near neural structures, however, a study of bipolar cautery on rat femoral arteries and the damage to the nearby femoral nerve shows that 3 mm is a safe distance.¹⁹ It is difficult to make recommendations regarding how close bipolar cautery may be used near a facial nerve, however we cauterized within 1 mm of the dehiscent facial nerve at a low current of 7 watts without adverse consequences. Additionally, it is routine during vestibular schwannoma surgery to use cautery at even closer distances without harmful effects on facial nerve function. Facial nerve monitoring may provide a further margin of safety. Various lasers may be a suitable alternative to bipolar cautery when ablating small vessels. We have found that defocusing either the potassium titanyl phosphate (KTP) or CO₂ laser allows us to safely ablate smaller vessels less than 1.5 mm in diameter.

Individual consideration for the patient's problem including the degree of hearing loss and severity of the tinnitus must be carefully assessed prior to recommending surgical removal of a persistent stapedial artery. However, our experience and review of the literature as well as personal communication with known authorities in the field of otology/neurotology, suggest that the persistent stapedial artery can be safely removed without untoward effects. Additionally, in the presence of otosclerosis with a small persistent stapedial artery we would consider ablating the vessel and completing the stapedotomy. Moving the vessel away from the stapedotomy site and then completing the procedure is also still an option.

CONCLUSION

Our report represents a unique case of a persistent stapedial artery causing conductive hearing loss and pulsatile tinnitus. The fact that this patient did not have complete resolution of her conductive hearing loss suggests that she may indeed have a component of otosclerosis. We are also aware of the possibility that manipulation near the stapes during removal of the artery may have led to a partial mobilization, and caused some hearing improvement. However, assessment of ossicular chain mobility prior to any middle ear manipulation showed normal malleus mobility and only slightly reduced stapes mobility. Postoperatively, this patient's hearing improved and the pulsatile tinnitus resolved with removal of this artery. We were able to safely cauterize this vessel with bipolar cautery, excise it, and remove it from the obturator foramen with no bleeding or postoperative neural sequelae. Of the 48 reported cases of a persistent stapedial artery, nine underwent successful stapedotomy near the vessel with good audiologic results.⁴ Our case extends these findings and demonstrates that a large stapedial artery segment may be safely cauterized and removed giving unhindered access to the

oval window. Additionally, an artery that completely fills the obturator foramen may also be a cause of conductive hearing loss and pulsatile tinnitus. It is clear from current thinking that complications such as facial paralysis or hemiparesis secondary to vessel disruption are not likely.

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