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Case Report

# Successful Cochlear Implantation in the Face of Persistent Stapedial Artery: Surgical Technique and Imaging Features

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The stapedial artery is an embryologic structure that very rarely persists into adulthood. Termed the persistent stapedial artery (PSA), it is most often asymptomatic, identified retrospectively, and can complicate middle ear surgery. A 70-year-old woman presented with profound bilateral sensorineural hearing loss and elected to undergo cochlear implantation. During surgery, a pulsatile, cord-like structure was found obscuring the round window niche. A high-resolution computed tomography (HRCT) imaging review confirmed PSA diagnosis. A cochleostomy was made using a cochleostomy burr and gentle vessel compression. Complete insertion of the cochlear implant was achieved and its placement confirmed. The patient went on to develop open-set discrimination. We report the first successful case of cochlear implantation in the face of a PSA. Inverted HRCT imaging was found to enhance PSA visualization and may aid preoperative diagnosis. A cochleostomy technique is recommended for electrode insertion to minimize the risk of bleeding.

**KEYWORDS:** Arteries, cochlear implantation, ear, tomography, x-ray computed, persistent stapedial artery

## INTRODUCTION

The stapedial artery is a fleeting embryonic structure arising from the second aortic arch. In humans, the stapedial artery links and contributes to the formation of the adult internal carotid, internal maxillary, and middle meningeal arteries[1]. Thereafter, the vessel undergoes normal involution, leaving only the obturator foramen of the stapes as the evidence of its existence[2]. However, failed regression results in a persistent stapedial artery (PSA).

Here, we report the first case of successful cochlear implantation in the presence of a PSA. We will briefly discuss the PSA anatomy and imaging features, as well as the potential for preoperative diagnosis of PSA via inverted high-resolution computed tomography (HRCT) scanning. We will also discuss surgical techniques for successful cochlear implantation in the presence of a PSA.

## CASE PRESENTATION

A 70-year-old woman presented to the neurotology clinic with complaints of worsening hearing loss. She had used hearing aids for many years but was now having difficulty communicating with even the most powerful of hearing aids. Hearing tests confirmed profound bilateral sensorineural hearing loss. AzBio testing identified her as a good candidate for cochlear implantation, and the patient consented for elective surgery.

The operation proceeded under general anesthesia without the use of skeletal muscle relaxants, utilizing a mastoidectomy and a standard facial recess approach. The NIM-2 Facial Nerve Integrity Monitor® (Medtronic, Minneapolis, Minnesota) was utilized for the duration of the operation. The Zeiss Pentero 800 microscope (Carl Zeiss GmbH, Germany) was utilized for microdissection. During

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the procedure, a rather tough mucosa-covered cord-like structure was encountered obscuring the round window niche (Figure 1). This structure also obscured the obturator foramen of the stapes. An intraoperative review of the HRCT imaging revealed an absent foramen spinosum (Figure 2), confirming the diagnosis of a PSA. On close observation, the structure was observed to be pulsatile and synchronous with the heartbeat. In an effort to visualize the round window niche, an attempt was made to mobilize the posterior limit of the structure using a Rosen pick. Troublesome bleeding occurred from mucosal vessels, temporarily obscuring the surgical field. This was controlled with a Gelfoam® pledget (Pharmacia & Upjohn, New York). The Rosen pick and a House gimmick was then utilized to mobilize the artery along its anterior limit, with dissection proceeding cranio-caudally. The anterior lip of the round window could now be palpated. A 24-gauge Barron suction was used to gently compress the vessel in order to prevent vascular injury from the shaft of the sheathed 1-mm cochleostomy burr (Anspach® Emax-2 Plus Drill System, West Palm Beach, Florida) (Figure 3). Using the anterior lip as a landmark, a standard cochleostomy was drilled and the endosteum was penetrated. Healon® OVD (Johnson and Johnson, New Jersey) was injected gently into the scala tympani to remove bone dust, blood, and air bubbles and for lubrication. The modiolus hugging CI512 Contour Advance® electrode (Cochlear Americas, Denver, Col-

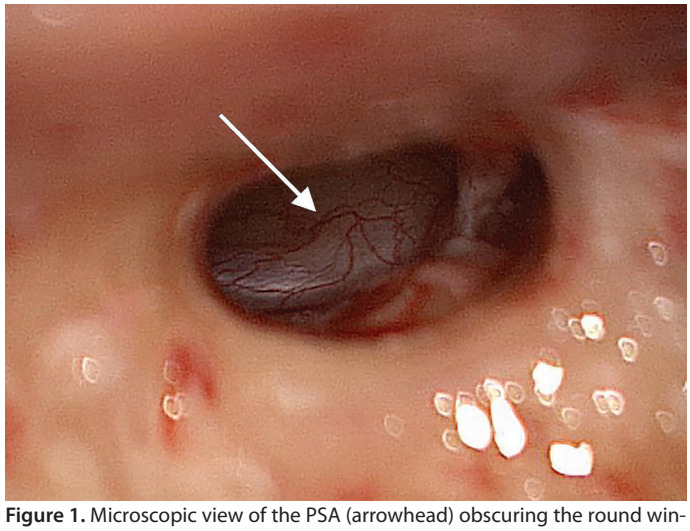

**Figure 1.** Microscopic view of the PSA (arrowhead) obscuring the round window niche.

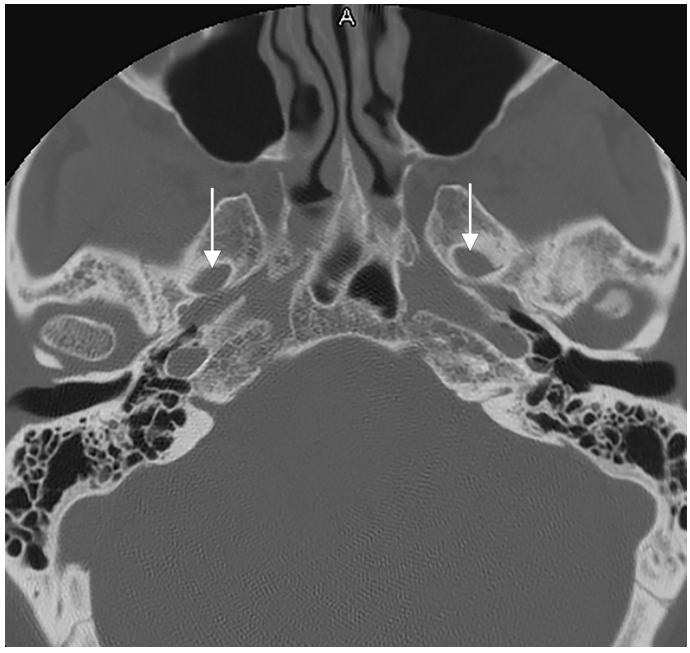


**Figure 2.** HRCT image showing absent foramen spinosum and normal foramen ovale (*arrowheads*).

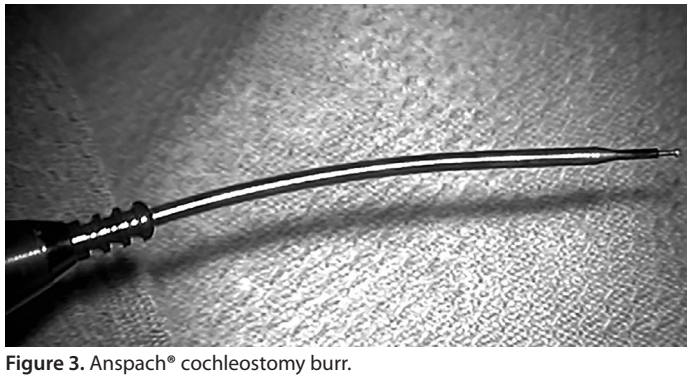

**Figure 3.** Anspach® cochleostomy burr.

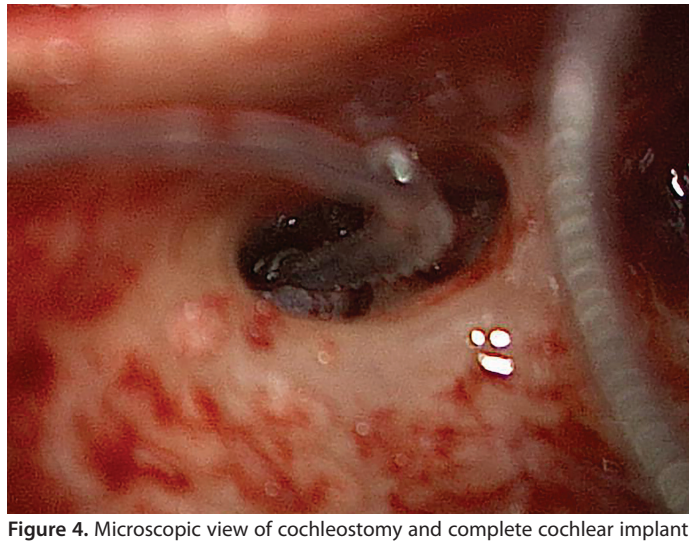

**Figure 4.** Microscopic view of cochleostomy and complete cochlear implant electrode insertion.

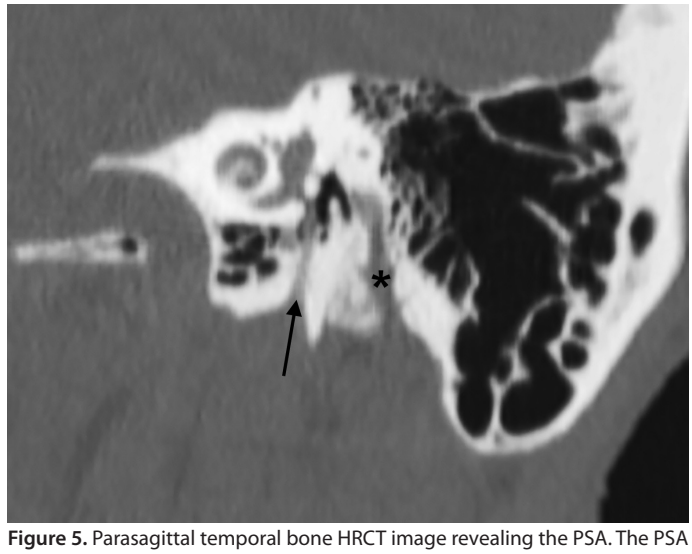


**Figure 5.** Parasagittal temporal bone HRCT image revealing the PSA. The PSA (arrowhead) obscures the patient's round window niche. Facial nerve (*) is found lateral and posterior to the artery.

orado) was used "on-stylet" to achieve complete insertion, and the stylet was then removed (Figure 4). Intraoperative x-rays confirmed proper electrode placement, and neural response telemetry elicited good responses without open circuits.

The patient recovered from surgery without complication and went on to develop open-set speech discrimination. A retrospective review of the patient's HRCT imaging revealed the PSA (Figure 5). Interestingly, the PSA was best visualized using the "invert" HRCT function, which allowed for better contrast and resolution of the artery than the normal CT image (Figure 6).

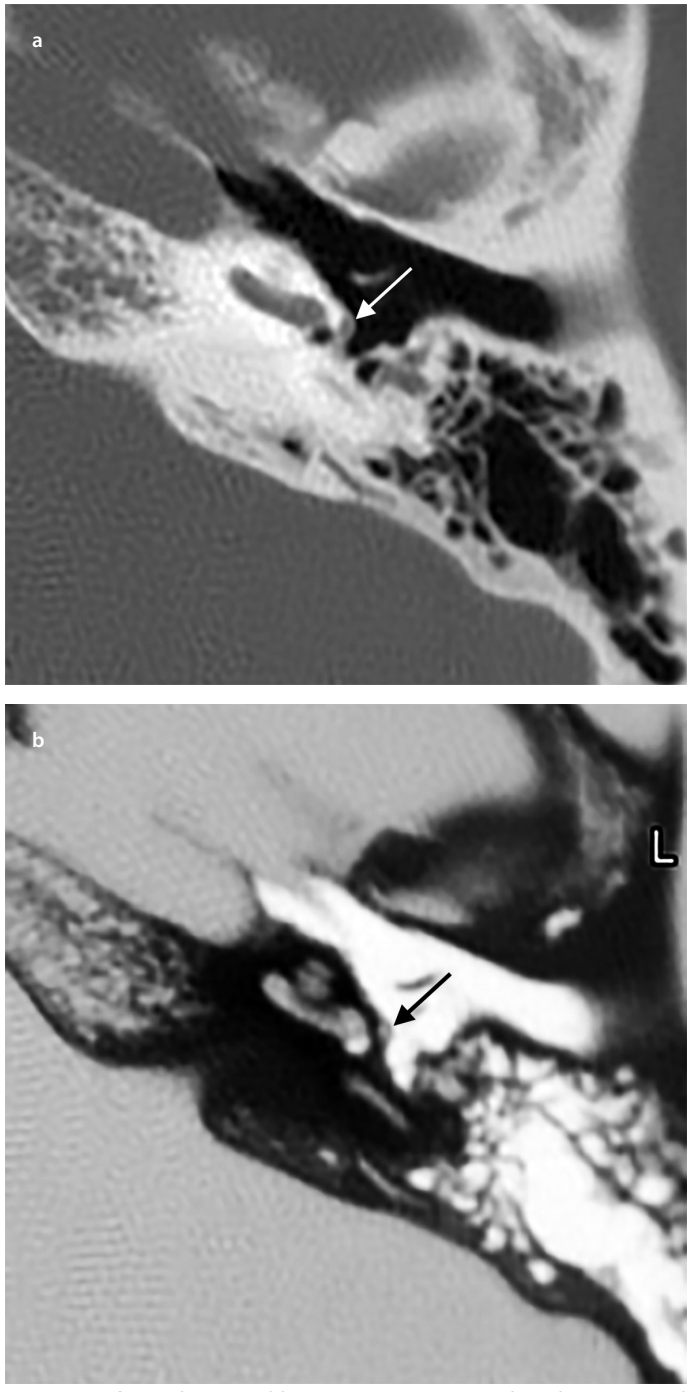


**Figure 6. a, b.** Axial temporal bone HRCT images revealing the PSA. a and b) Typical HRCT image (left) with poor PSA (*arrowhead*) edge resolution and contrast to surrounding structures. "Inverted" HRCT image (right) with enhanced PSA (*arrowhead*) edge resolution and contrast, distinguishing it from surrounding structures.

## DISCUSSION

The persistent stapedial artery is a rare and most often benign anomaly, usually discovered incidentally during middle ear surgery. A study of 1,045 human temporal bones found the incidence of PSA to be 0.48%, noting that previous surgical observations reported the incidence of PSA between 0.01% and 0.02% [3]. Imaging may reveal the PSA and absent foramen spinosum before surgery; however, these are difficult to visualize without prior clinical suspicion [4, 5]. The adult PSA most often originates from the internal carotid artery and enters the skull base via the middle ear cavity. The artery runs along the cochlear promontory, through the obturator foramen of the stapes, and enters the facial canal [4, 6]. The PSA exits the facial canal just posterior to the geniculate ganglion to supply the middle cranial fossa as the middle meningeal artery [4, 6, 7]. As a result, the foramen spinosum does not develop.

Historically, the management of an encountered PSA was conservative. PSA damage could theoretically result in facial palsy, hearing loss, vestibular impairment, or hemiplegia [4, 7, 8]. The only previously reported case of a PSA encountered during cochlear implantation was abandoned for this reason [9]. However, more recent reports suggest that middle ear surgery in the presence of a PSA is safe and that the presence of a PSA should not preclude surgery [4, 7, 8].

Although the course of a PSA complicates the middle ear surgery, it does provide several unique imaging features for potential preoperative diagnosis. A temporal bone HRCT scan may show absent foramen spinosum, a small canaliculus leaving the carotid canal, the artery passing over the cochlear promontory, and an enlarged or duplicate facial nerve canal (Figure 5) [5, 10]. In this case, an absent foramen spinosum was identified intraoperatively (Figure 2), whereas the artery within the middle ear was identified retrospectively (Figures 5 and 6). We observed that the "invert CT" function proved to be particularly useful for visualizing the patient's PSA. Inverted HRCT offered better PSA edge resolution and greater contrast from surrounding structures than normal HRCT (Figure 6). A close review of inverted HRCT imaging may aid PSA diagnosis before surgery. Looking for a PSA is now part of our checklist while planning cochlear implant surgery.

Successful cochlear implantation was achieved using a cochleostomy technique to avoid the patient's PSA, which obscured the round window. We do not believe this could have been achieved without the special cochleostomy burr whose sheath protects its rotating shaft (Figure 3). In our limited experience with this condition, a cochleostomy technique is preferable to PSA ablation followed by round window electrode insertion. A cochleostomy minimizes the risk of intraoperative bleeding from the artery and preserves blood flow to the middle cranial fossa without compromising postoperative outcomes. To date, no neurological complications have been reported after PSA ablation or transection during middle ear surgery [4, 7, 11]. The ablation of a PSA to allow round window electrode insertion may also be safe [4, 7], although we have no experience with this technique. However, the risk of neural compromise and bleeding is real, and it is our opinion that this should be avoided if at all possible.

## CONCLUSION

We report the first successful case of cochlear implantation in the presence of a PSA. Inverted HRCT imaging may aid preoperative visualization of the artery by enhancing edge resolution and contrast from surrounding structures. A cochleostomy technique is recommended for electrode insertion because it minimizes the chance of intraoperative bleeding from the PSA. Although transection of the PSA carries a theoretical risk of postoperative neurological complications (see the previous report of aborted cochlear implantation [9]), ablation of the artery followed by round window electrode insertion may be a safe alternative approach but could result in troublesome bleeding and poor visualization. In the absence of experience, we would not recommend ablation of the PSA during cochlear implantation.

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**Conflict of Interest:** The authors have no conflict of interest to declare.

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