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Persistent stapedial artery

A. L. PAHOR, F.R.C.S., S. S. M. HUSSAIN, M.Sc., F.R.C.S. (Birmingham)

Abstract

Persistence of the stapedial artery is rare. A case is presented in which the stapedial artery was found over the footplate during stapes surgery. The technical problems encountered are discussed.

A wire prosthesis has previously been used in the presence of a persistent stapedial artery and we describe the use of an all Teflon prosthesis.

A subsequent CT scan demonstrated the vessel in the middle ear.

An outline of the embryology of the stapedial artery is given and the literature reviewed.

Case report

A 21-year-old man was seen in 1983 with a five year history of bilateral hearing loss which was worse on the right. He admitted to left sided tinnitus but denied any otorrhoea, vertigo or exposure to loud noise. There was no family history of deafness.

Examination was unremarkable except that the Rinne's test was negative on the right and positive on the left; Weber's test lateralized to the right.

A pure tone audiogram (Fig. 1a) confirmed a bilateral conductive hearing loss of about 45–50 dB. Impedance measurements showed normal curves with bilateral loss of the stapedial reflex. A clinical diagnosis of bilateral otosclerosis was made and the patient advised to have a right stapedectomy.

In January 1984, the patient underwent surgery under general anaesthesia. A tympanotomy incision was made, the posterosuperior bony rim of the meatus was drilled and the chorda tympani nerve cut to obtain exposure. Both the malleus and incus were mobile. The stapes was found to be fixed with an annular type II otosclerosis.

The stapedial artery was seen traversing across the footplate between the crura, lying more towards the anterior crus and estimated to be 1 mm in diameter (Fig. 2a).

The artery issued from a bony canal on the promontory, crossed the footplate giving two smaller branches. These branches formed a rhomboid-shaped plexus in front of the posterior crus (Fig. 2b).

After crossing the footplate, the artery was seen to enter a foramen in the facial canal. The course of the facial nerve appeared to be normal.

A small fenestra was made in the footplate posterior to the artery (Fig. 2b) and the incudostapedial joint was disrupted. The superstructures were then fractured, but failed to separate following both downward (towards promontory) and upward pressure. The superstructures remained attached by the mucosa which felt 'tougher' than usual and excessive manipulation was not used for fear of injury to the submucosal arterial plexus; consequently the superstructures were mobilized towards the promontory.

A 4.5 mm Teflon prosthesis obtained a 'good fit' in the fenestra and round the incus. Perichondrium was used as a seal around the prosthesis and the chain was noted to be mobile; the tympanic membrane was replaced.

The post-operative recovery was uneventful. A month after surgery a pure tone audiogram (Fig. 1b) showed closure of the air-bone gap on the right side. This was consistent with the patient's own impression.

A CT scan was subsequently performed; this showed an

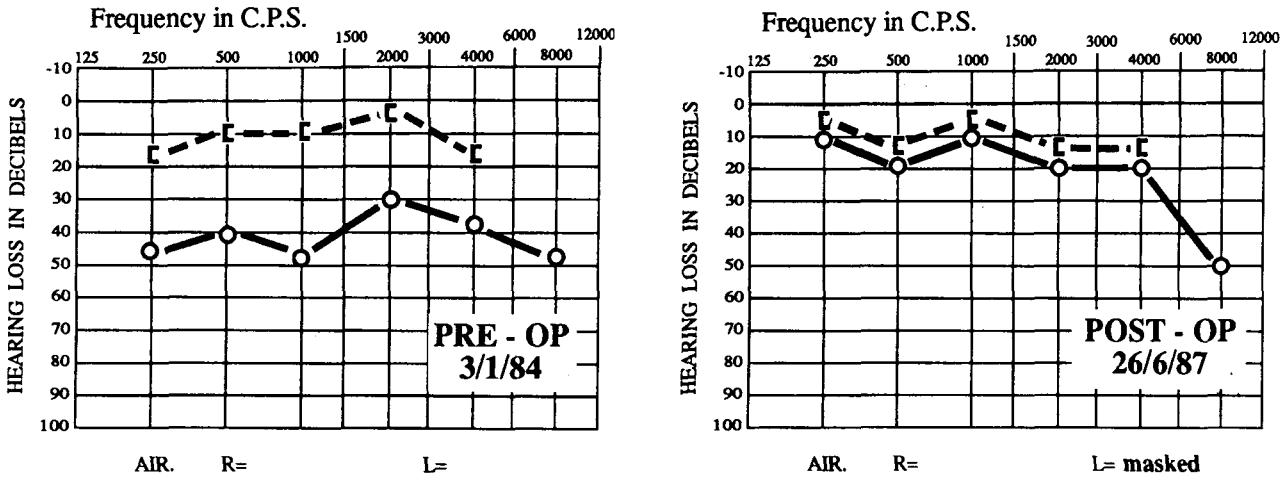

FIG. 1

(a) pre-operative and (b) post-operative pure tone audiograms.

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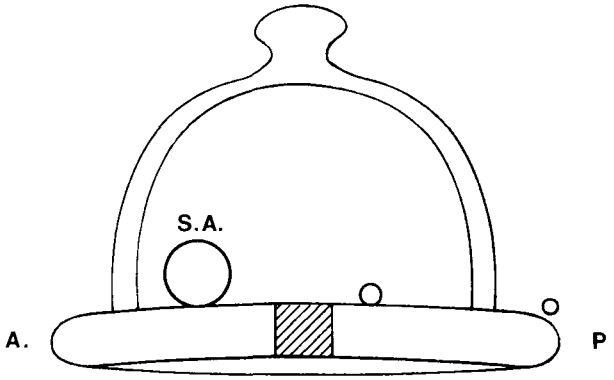
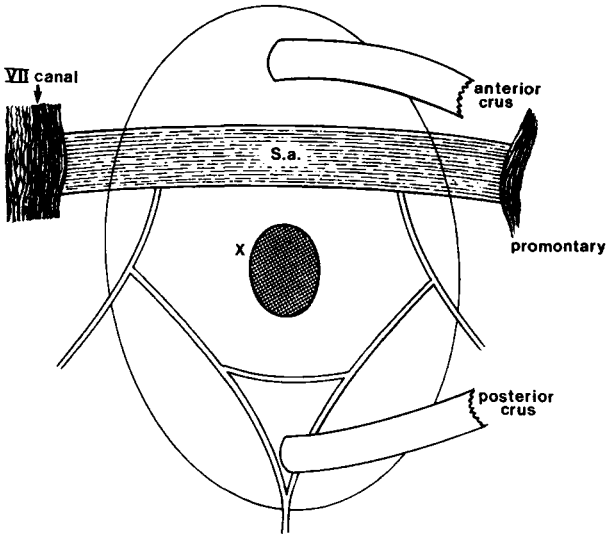


(a)

FIG. 2a
Schematic diagram of the position of the artery on the footplate of the stapes. A—anterior, P—posterior, S.A.—persistent stapedial artery.



(b)

FIG. 2b
Schematic diagram of the stapedial artery and branches. X = site of microfenestration.

unusual bony canal in the floor of the middle ear in its anterior part. This probably represents the vessel coming from the internal carotid artery to run across the promontory before passing through the stapes and up to the facial nerve (Fig. 4). A soft tissue mass was also seen on the promontory although the second part of the facial nerve did not appear wide.

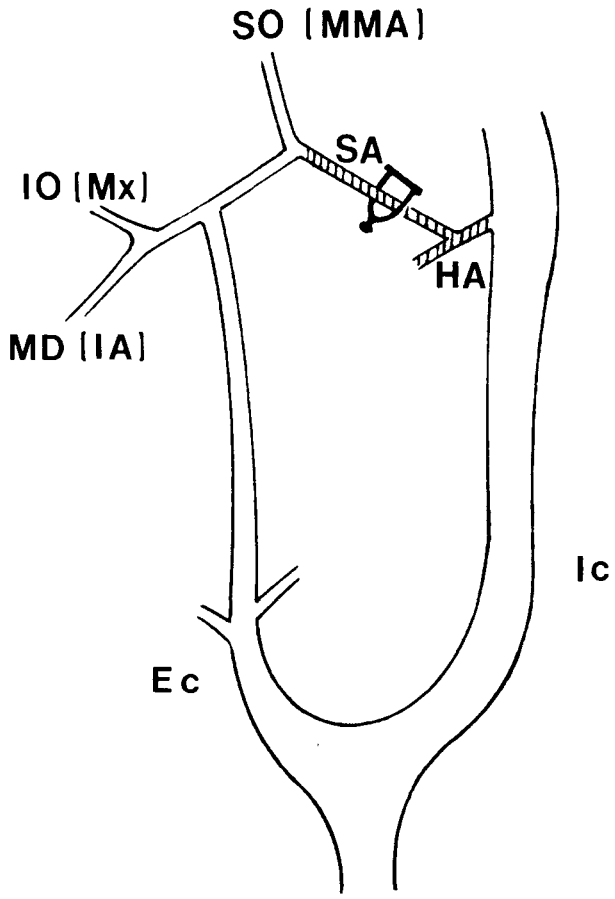


FIG. 3
Diagram showing the embryology of stapedial artery in man (modified from Guinto *et al.*). Ic: Internal carotid artery; EC: External carotid artery; MD: Mandibular branch; Mx: Maxillary branch; MMA: Middle meningeal artery; SO: Supra-orbital branch; SA: Stapedial artery; HA: Hyoid artery.

There was no indication for angiography.

In June 1987, the patient was reviewed in the clinic. The right ear remained normal, with no air-bone gap between 0.25 and 4 Hz. The left ear was unchanged with a conductive loss of 45–50 dB. The patient enquired about the possibility of surgery on the other ear, but this he was advised against.

Embryology

The evolution of the stapedial artery has been described in detail by Congdon (1922) and Padget (1948).

In 1968, Steffen studied the vascular anomalies of the middle ear and showed that at 5 mm embryo stage there is a regular conformity of the cranial nerve roots and the aortic arches to each pharyngeal bar and pouch.

The primitive mandibular and hyoid arteries replace the first and second aortic arches. The mandibular artery regresses, whereas the hyoid artery remains prominent and gives rise to the stapedial artery near its origin from the internal carotid artery.

By the 18 mm stage the stapedial artery has formed its two divisions, the dorsal and ventral branches. The dorsal branch

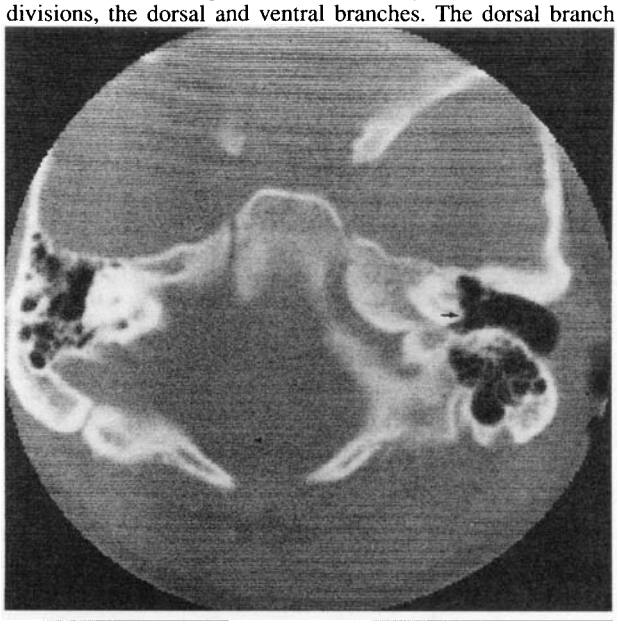


FIG. 4
CT scan showing a soft tissue mass over the promontory. An unusual bony canal is seen in the floor of the anterior part of the middle ear, which represents the stapedial vessel.

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TABLE I

Author(s)	Year (s)	Location	Origin	Comments
Hyrtl (2 cases)	1836 and 1845	Enclosed within a bony canal on promontory.	Internal carotid.	In the first case it was assumed that the vessel arose from the internal maxillary artery. Noted to cause tinnitus.
Zukerkandl	1873	Enclosed within a bony canal on promontory.	Undecided.	
Alexander	1899	Enclosed within a bony canal on promontory.	Internal carotid.	
Lewin	1906	Enclosed within a bony canal on promontory.	Undecided.	
Brock	1922	Enclosed within a bony canal on promontory.	Internal carotid.	
Adachi	1928	Enclosed within a bony canal on promontory.	Undecided.	Internal ramifications: the vessel divided itself into a medial branch which supplied the inner surface of the greater wing of the sphenoid and anastomozed widely with the orbital vessels and a lateral branch which substituted the missing meningeal artery.
Altmann	1947	Enclosed within a bony canal on promontory.	Internal canal.	Artery proceeds upwards between the crura of the stapes and enters the facial canal through a dehiscence just behind the processus cochleariformis. 2 mm behind the geniculate ganglion the artery leaves the facial canal and proceeds between the dura and inner surface of the middle fossa, forward and upwards. Before leaving the facial canal the artery gives off two branches, one running forward with the greater petrosal nerve and one backwards and downwards with the facial nerve.
Keleman	1958	Enclosed within a bony canal on promontory.	Unable to trace the origin of the vessel as it occurred below the limits of the sectioned block.	Stapedial vessel found in the neighbourhood of the Eustachian tube where it formed its canal by deep excavation of the cochlear capsule before winding its way in the direction of the tympanic floor.
Baron	1963	Enclosed within a bony canal on promontory.	Not given.	Stapedectomy: difficult technical problem, wire used for prosthesis as the use of a tube was not possible in his case.
House and Patterson (2 cases)	1964	Enclosed within a bony canal on the promontory.	Not given.	Two cases for stapedectomy: difficult technical problem. Prefabricated wire prosthesis used in both cases with good results. Authors felt that a wire prosthesis was more adaptable to the obstructing presence of the artery.
Maran	1965	Uncovered over the promontory.	Internal carotid.	Vessel divided at the lower side of the footplate into two branches which anastomozed over the facial nerve. A case of thalidomide deafness with global malformation.
Garfield Davies	1967	Enclosed within a bony canal on the promontory.	Internal carotid.	
Stallings and McCabe	1969	Aneurysm of the internal carotid which extended to the middle ear via the stapedial artery.	Internal carotid.	
Guinto *et al.*	1972	Enclosed within a bony canal on the promontory.	Internal carotid.	Demonstrated persistent stapedial artery on angiography and showed it piercing the temporal bone to appear in the middle cranial fossa as the middle meningeal artery.
Pascual-Castroviejo	1973	Enclosed within a bony canal on the promontory.	Internal carotid.	Case of unilateral facial dysplasia. Artery demonstrated on angiography.
Teal *et al.*	1973	Enclosed within a bony canal on the promontory.	Internal carotid.	A case of congenital absence of the internal carotid on the left side and the external carotid on the right. Angiography of the right side showed the usual branches of the external carotid to arise from the internal carotid and a persistent stapedial artery which formed the middle meningeal.
Pashley and Shapiro	1978	The stapedial artery and vein passed directly between the anterior and posterior crurae.	Not given.	A case of spontaneous perilymphatic fistula.
Yamamoto and Hirono	1988	Running over footplate of stapes from hypotympanum to the promontory.	Not given.	Division led to considerable bleeding controlled with pressure. Whole footplate came off on attempted removal of the anterior portion. Reconstructed with Teflon wire prosthesis.
Pahor and Hussain	1992	Issued from bony canal on promontory crossed the footplate giving two smaller branches.	Internal carotid.	Stapedectomy: Difficulty technical problem. All Teflon prosthesis with good results.

gives off the supraorbital, frontal, anterior ethmoid and lacrimal arteries; at this stage the stapedial artery is the primary blood supply to the orbit except for the eye. The ventral, or maxillomandibular division, links up with the external carotid (a third arch derivative) to form the precursors of the adult middle meningeal, infraorbital and inferior alveolar arteries.

At a later stage the connection between the supraorbital division of the stapedial (now middle meningeal) and the ophthalmic arteries is interruped near the orbital margin. With this change, the adult derivatives of the stapedio-hyoid artery have become definitive (Fig. 3).

Discussion

The various anatomical variants of persistent stapedial artery are shown in Table I.

There is little doubt that the stapedial artery originates from the internal carotid artery. The artery is enclosed within a bony canal on the promontory in the majority of reported cases.

The presence of the stapedial artery may be associated with other pathology. In a case of thalidomide deafness reported by Maran (1965) the vessel was found with other abnormalities. Stallings and McCabe (1969) described a case of aneurysm of the internal carotid which extended to the middle ear via the stapedial artery. Pascual-Castroviejo (1973) reported a persistent stapedial artery in a case of unilateral facial dysplasia.

Hyrtl (1836) postulated the presence of the stapedial artery as a cause of habitual tinnitus. This has been quoted by several authors, although there has been only one case where the patient complained of tinnitus in the 23 cases hitherto reported (Guinto *et al.*, 1972). In our own case the tinnitus was on the contralateral side.

Stapedectomy in the presence of a persisent stapedial artery poses a difficult technical problem. Baron (1963) recommends wire as the most suitable material for prosthesis in this situation. House and Patterson (1964) used a prefabricated wire prosthesis in their two cases with good results. They felt that a wire prosthesis was more adaptable to the obstructing presence of the artery. In our case it was possible to use an all Teflon prosthesis with satisfactory results.

The diagnosis of the presence of a persistent stapedial artery is always accidental (Maran, 1965), there are no symptoms that would lead one to suspect its presence prior to tympanotomy (House and Patterson, 1964). However, Guinto *et al.* (1972), Pascual-Castroviejo (1973) and Teal *et al.* (1973) were able to demonstrate the artery on angiography. This investigation was undertaken for other reasons and the stapedial artery was an incidental finding. With the benefit of hindsight, Guinto *et al.* (1972) were able to correlate their angiograms with the plain films. They state that the first clue to the diagnosis is the absence of the foramen spinosum on the base of skull view implying a pathological process or anomaly of the meningeal artery. They further state that a widened facial nerve canal and a widening of the space between the crura on tomography is diagnostic of a persistent stapedial artery.

Conclusion

Persistent stapedial artery is rarely encountered in routine surgery. As the average present-day Otolaryngologist may not have been widely trained for stapedectomy due care should be taken with these cases. It may be prudent to abandon the procedure if in doubt about the technical feasibility. A small fenestra is the method of choice, the procedure should be modified to suit the case, as in this report where the suprastructures were fractured but not removed.

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Address for correspondence:
Mr Ahmes L. Pahor,
Consultant ENT Surgeon,
Sandwell General Hospital,
West Bromwich,
Birmingham,
B71 4HJ.

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