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The Suprameatal Approach: An Alternative Surgical Approach to Cochlear Implantation

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The suprameatal approach is an alternative method for performing cochlear implantation developed in the Sheba Medical Center in 1999. This technique eliminates the need for mastoidectomy and posterior tympanotomy. The middle ear is entered through a retroauricular tympanotomy flap, and the electrode is introduced into the cochlea via a tunnel drilled in the suprameatal region superior to Henle's spine. The suprameatal approach is a simple and safe technique that does not endanger the facial nerve nor the chorda tympani. A wide exposure of the promontory enables exact determination of scala tympani and smooth introduction of the electrodes into the cochlea. This technique may also be used in malformed or ossified cochlea. Until now 140 patients were operated in our department and an additional 48 patients were operated on in the department of Otorhinolaryngology at the University of Vienna employing the suprameatal approach technique. **Key Words:** Cochlear implant—Surgical technique—Suprameatal approach.
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The conventional technique for cochlear implantation is the mastoidectomy posterior tympanotomy approach (MPTA). Posterior tympanotomy was first described by Jansen (1) in 1957 as a means of approaching the middle ear. This approach was subsequently embraced by the cochlear implant surgeons as the accepted route of access to the round window and promontory. MPTA for cochlear implant surgery was first introduced by House in 1961 (2). Although it may be relatively easily performed, there have been reports in the literature describing temporary injury to both the facial and chorda tympani nerves (3–5). Only few alternatives to this classic approach have been described in the literature. The endomeatal approach was used by Banfai et al. (6), Schindler (7) and Chouard (8), but infection and electrode extrusion through the skin of the external auditory canal led to the abandonment of this approach. Colleti et al. (9) described an approach via the middle fossa, and Singh (10) used the canal wall down technique in cases of congenital anomalies. In 2000, Kiratzidis (11) described a technique using a tunnel drilled in the mastoid area without mastoidectomy to approach the middle ear. This technique has the advantage of avoiding mastoidectomy, but the tunnel for the electrodes is drilled in the mastoid and thus may endanger a high riding sigmoid sinus.

Although mastoidectomy is a commonly practiced technique, posterior tympanotomy is less universally practiced. The suprameatal approach (SMA) was developed as an alternative technique to the classic approach; it is based on the retroauricular tympanotomy approach as an access to the middle ear and cochleostomy site. The electrode is introduced into the middle ear via a suprameatal route thus avoiding mastoidectomy (12,13). This technique has so far been performed on 140 patients in our institution and 48 additional patients in the Department of Otorhinolaryngology at the University of Vienna.

PATIENTS AND METHODS

From 1999 to 2003, 140 patients, 111 children and 29 adults, underwent cochlear implantation using the SMA technique in our institution, and 48 additional patients, including 15 children and 33 adults, underwent SMA cochlear implantation at the University of Vienna between 2000 and 2003. The patients' ages ranged from 11 months to 80 years. Before surgery, an audiological profile and temporal bone computed tomography scans were obtained. All patients underwent cognitive, communicative, and psychosocial evaluations. The patients were followed-up between 8 and 44 months after surgery, with a mean follow-up of 22 months. Various types of cochlear im-

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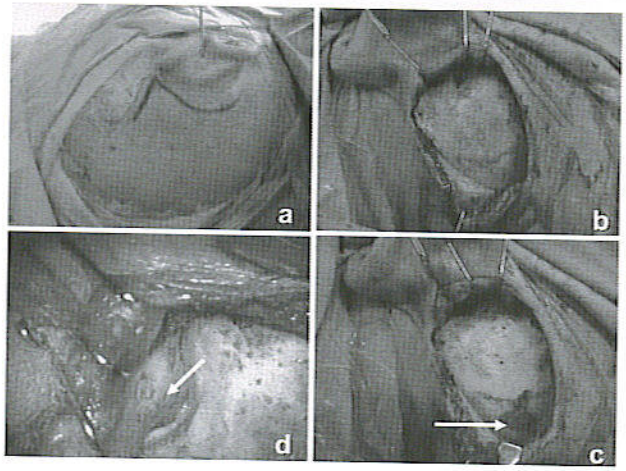

FIG. 1. (*A*) A retroauricular J shaped skin incision marked on the skin is followed by (*B*) elevation of a subperiosteal flap. *C*, A well is then drilled (*arrow*) to accommodate the implant body. *D*, A tympanomeatal flap is raised in a similar fashion to retroauricular tympanoplasty surgery.

plants were used; in the Sheba group, 49 implants were Nucleus 24, 50 Nucleus Contour, 34 Med-El, and 7 Clarion CII. In the Vienna group, 46 implants were Med-El, 1 Nucleus Contour, and 1 Clarion CII.

The SMA procedure involves placing the patient in a supine position similar to tympanoplasty surgery. A retroauricular skin flap is raised after a J-shaped skin incision (Fig. 1*A*). A large subperiosteal flap is raised, and the posterior wall of the external auditory canal is elevated (Fig. 1*B*). A well-defined cavity is then drilled in the temporoparietal calvaria to accommodate the implant body similarly to the classic technique (Fig. 1*C*). A tympanomeatal flap is incised 5 mm lateral to the tympanic annulus and a tympanomeatal flap is elevated to expose the tympanic cavity as in the retroauricular tympanotomy approach (Fig. 1*D*). The tympanomeatal flap may also be elevated without incision of the posterior canal wall skin. This technique was performed in 20 patients. The chorda tympani nerve is exposed,

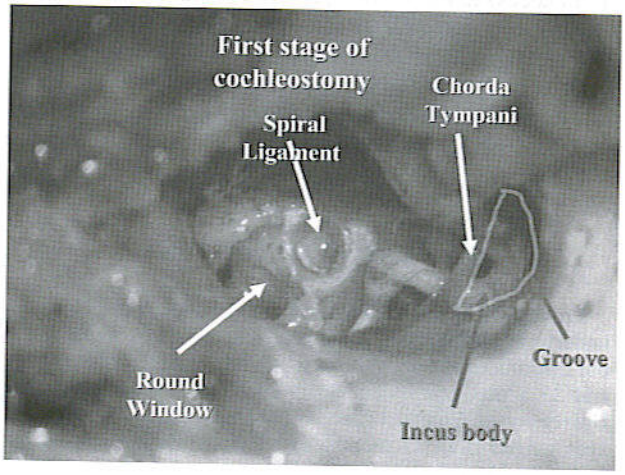

FIG. 2. A groove is drilled posterior/superior to the chorda tympani. The first stage of the cochleostomy is drilled in the promontory antero-inferior to the oval window until the spiral ligament of the scala tympani is seen.

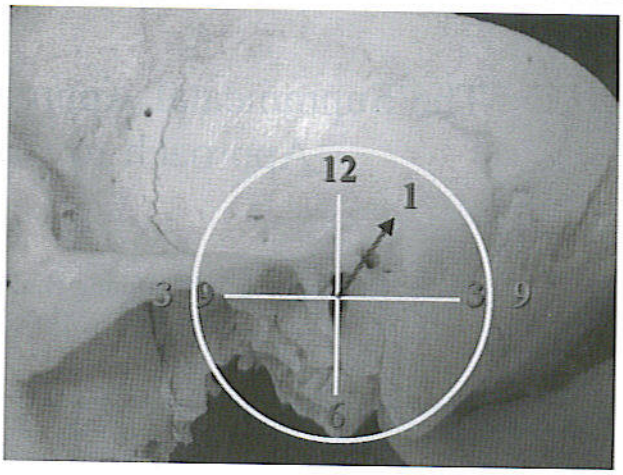

FIG. 3. The tunnel drilling is in the suprameatal region at 1 o'clock position to the canal in a left ear.

and a 1-mm-long groove is drilled in the wall of the middle ear cavity posterosuperior to the chorda tympani, lateral to the body of the incus until it is visualized. A cochleostomy is drilled in the promontory anteroinferior to the oval window, close to the overhang of the round window. Drilling is stopped when the spiral ligament of the scala tympani membrane is exposed to avoid entry of blood and bone dust into the cochlea (Fig. 2). A tunnel is drilled in the suprameatal region superior to Henle's spine at about 1 o'clock position to the canal (Fig. 3). The average length of the drilled tunnel in children is 7 mm and in adults is 12 mm. The middle cranial fossa dura is first visualized to avoid possible injury by drilling, and then the tunnel is drilled inferiorly to the dura in an oblique line from posterosuperior to anteroinferior, ending in the groove lateral to the incus body (Fig. 4). Drilling is stopped when the head of the drill is seen in the middle ear lateral to the incus and chorda tympani (Fig. 5). The cochleostomy is completed by opening the scala tympani. The electrodes are passed through the suprameatal tunnel and groove into the cochleostomy (Fig. 6). Small pieces of temporalis muscle are used to seal the cochleostomy and anchor the electrode array within the groove. The

FIG. 4. The direction of the tunnel is in an oblique line toward the middle ear.

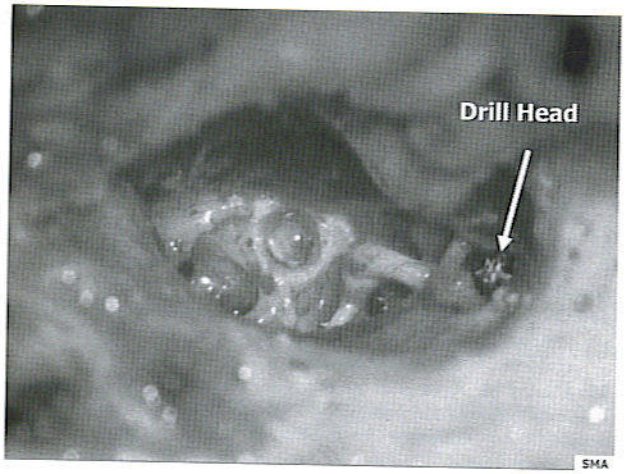

FIG. 5. The drill head is seen in the end of the tunnel drilling lateral to the incus and posterior to the chorda tympani. The facial nerve is well protected by the incus.

implant body is secured by two to four tie-down sutures, the tympanomeatal flap is placed back and fixed by small pieces of gel foam, and the subperiosteal flap is used to cover the implant.

RESULTS

There were no postoperative complications, including facial nerve injury or electrode extrusions into the external auditory canal, noted in any of the patients. In two of the Sheba group patients who suffered from chronic otitis media with tympanic membrane perforation before surgery, there was a persistent perforation of the tympanic membrane after surgery. In two additional patients in whom the tympanomeatal flap was elevated without incising the posterior wall of the external auditory canal skin, perforations of the tympanic membrane developed which were later repaired with tympanoplasty surgery. No cases of tympanic perforation occurred in patients who underwent tympanomeatal flap elevation with incision of the posterior canal wall skin. In the Vienna group no complications were seen during the follow-up time. Initial observations suggest that there are no significant differences in the speech perception results obtained in the patients implanted via SMA compared with MPTA. The results obtained from both the Sheba Medical Center and the Vienna group were identical.

FIG. 6. The electrodes are inserted via the tunnel and groove medial to the chorda tympani into scala tympani.

DISCUSSION

The surgical technique for cochlear implantation as described by House et al. (5) has been accepted as the preferred approach for cochlear implantation by most surgeons. The main steps in this procedure include mastoidectomy and posterior tympanotomy. The facial recess, bordered posteriorly by the mastoid segment of the facial nerve and anteriorly by the chorda tympani, develops to a mean width of 2.6 to 4.1 mm (14,15). Drilling through the facial recess during posterior tympanotomy endangers the facial nerve and the chorda tympani. The risk of facial nerve palsy due to drilling of the facial recess, even if being relatively low and temporary, still exists (3,4). The SMA is safe and simple, and none of the temporal bone structures have been injured in any of the patients. The facial nerve is a safe distance from the groove and the suprameatal tunnel and is protected by the body of the incus (Fig. 5). The chorda tympani nerve is exposed and thus preserved. The creation of the suprameatal tunnel begins with exposure of the middle fossa dura to avoid possible injury. There are no additional structures in the drilling path that may be injured in this technique. The path of drilling is securely visualized via the tunnel orifice. The exclusion of mastoidectomy and posterior tympanotomy in the SMA shortens the duration of surgery. The elevation of the tympanomeatal flap requires approximately 5 minutes, and the tunnel drilling requires another 5 minutes. The procedure is otherwise similar in time to the MPTA with the exclusion of the mastoidectomy and posterior tympanotomy. SMA improves the aesthetic results with no retroauricular bony defect, which may exist in some cases after mastoidectomy. Perforation of the tympanic membrane occurred in two patients who were operated using the tympanomeatal flap elevation without incision of the posterior external auditory canal skin. This change from the original technique that included incision of the external auditory canal was initiated to avoid contamination of the surgical field with the content of the external auditory canal. We reverted to the original technique of incising the external auditory canal following our experience with the two perforations and the lack of postoperative infection after exposure to the external auditory canal content.

The direct access to the middle ear in this approach provides a wide exposure of the promontory and better cochleostomy site localization compared with the classic MPTA. In contrast to the wide exposure provided by SMA, MPTA is a keyhole approach limited by the vari-

able distance between the chorda tympani and the mastoid segment of the facial nerve. A narrow facial recess may hinder the surgeon's view of the middle ear. The location of the scala tympani can be easily determined when drilling is performed close to the round window overhang. To prevent additional inner ear injury, the scala tympani is opened in juxtaposition with the insertion of the electrode array. The wider exposure of the promontory enables easier instrument maneuverability, and therefore this approach may also be more suitable for ossified cochlea that require cochlear drill out. The angular difference between the electrode insertion in the SMA and MPTA was found to be 30 degrees superiorly. Despite this difference, in all of our patients, the electrode insertion proceeds smoothly into the cochlea without impediment or friction. The SMA technique is different from the previously practiced transcanal approaches that were practiced in the past (6–8). Contrary to those techniques, in SMA the electrode is well protected within its respective tunnel and is not in contact with the tympanic membrane or external auditory canal skin. No facial or chorda tympani nerve injury was seen in our series. All patients were examined to rule out electrode extrusion and perforation of the tympanic membrane. There were no extrusions of the electrodes into the external auditory canal. In one patient who suffered from recurrent otitis media with perforation of the tympanic membrane before surgery, there was a persistent perforation 8 months after surgery.

The SMA is recommended as an alternative effective, quick, simple, and safe procedure for cochlear implantation. It provides a wide exposure of the middle ear content and cochleostomy site. It may be applicable for all of the spectrum of cochlear implant types.

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EDITOR'S COMMENTARY

During the peer review process, this paper proved to be highly controversial. From its three reviewers it received both praise and substantial criticism. Given the innovative nature of the authors' proposal, the decision was made to publish the paper but simultaneously present an abstract of the concerns expressed by the expert peer reviewers.

COMMENTS FROM THE PEER REVIEWERS

This author describes a boutique technique for the placement of cochlear implant internal prostheses. Other unique techniques have been described in the literature as the author details in his paper. While the diversity of approach and the innovative management of a surgical problem is interesting, such an approach should not be advocated for all cases. This procedure has several difficulties: it includes skills not usually exercised by otologic surgeons, it appears to be a blind dissection, it includes the placement of electrodes and other devices in a grove in the ear canal, and finally, insertion of the electrode into the scala tympani is done without direct visualization along the axis of the basal turn, precluding observation of the status of the interior of the cochlea.

Surgeons do well those procedures that they do frequently. The majority of surgeons today are trained in the standard retroauricular and mastoidectomy approaches, either canal wall up or down. The described approach in this paper uses a retroauricular approach and a tympanomeatal flap, both well-known techniques. The author proceeds to drill a grove in the ear canal and a tunnel in the calvarium of the skull. While neither technique is difficult on the surface, they both require skills developed exclusively for this procedure. Thorough training in a unique technique is a prerequisite to avoiding complications

Halstead taught that good exposure of the operative field is the key to good surgery. Even today, endoscopic surgeons emphasize that the surgery they do would not be possible without good lighting and video cameras. After exposure of the middle fossa dura, the drilling of

the suprameatal tunnel in this case is done without exposure of landmarks. Because of the concentration of vital anatomic structures in this area, it is wise to be extremely careful when doing any dissection without adequate landmark identification in otologic surgery.

Others have attempted to place devices into the middle and inner ear via the ear canal. All have been confounded by the thin, mobile skin of the ear canal. Often such problems will not be apparent in the short term, but appear slowly over time, as the skin rejects a foreign body underneath it. Thus, I would caution those considering this approach to be certain to adequately protect the device.

One of the principle advantages of approaching the round window via a facial recess (posterior tympanotomy) route is being able to see into the basal turn of the cochlea. The direct exposure of the scala tympani allows discovery of pathologic anatomy such as ossification or fibrous obliteration. The route of electrode insertion is along the axis of the basal turn, allowing for early observation of correct placement and bending of the device. This approach seems to permit only perpendicular observation of the basal turn, making observation within the cochlea difficult.

An individual with deafness has an invisible disability, and has many hurdles to overcome in their life's struggles. It would seem prudent to avoid saddling them with any other disabilities induced by applying new techniques to their maladies before adequate consideration of the risks that are acquired.

Robert K. Jackler, Editor