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Clinical Study

The Modified Transcanal Approach for Cochlear Implantation: Technique and Results

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The aim of this work is to present a modified transcanal technique for cochlear implantation. It was a prospective study on 125 cochlear implant patients presenting to two tertiary referral hospitals between January 2010 and January 2013 and followed up for 6–30 months. Their age range was 2–56 (mean 3.4 years) and the male: female ratio was of 2.1 : 1. A modified transcanal technique was adopted through a small postauricular incision. A tympanomeatal flap is elevated, the middle ear is exposed, and the round window membrane is exposed by drilling the overhanging niche. The electrode is channeled in an open trough along the posterosuperior meatal wall, which is reconstructed by autologous cartilage. The round window was used for insertion in 110 patients and a cochleostomy in 15. The main outcome measures were technical steps, operative time, and ease and completeness of electrode insertion. The actual surgical time (excluding device testing) ranged between 25 and 40 minutes (mean 30.1 min). There were 115 complete insertions and 10 partials. There were 6 chorda tympani injuries, 2 electrode exposures with 1 requiring revision, and 2 cases with a tympanic membrane perforation which were grafted uneventfully. One case had severe infection with extrusion of the device 1 year after successful implantation.

1. Introduction

Cochlear implants have a well-established field track of hearing rehabilitation. In addition to severe and profound sensorineural hearing loss, the indications for cochlear implants have been extended over the past few years (younger age at implantation, bilateral implantations, single sided deafness, hearing preserving techniques, and electroacoustic devices) [1–4]. The number of cochlear implant candidates has thus grown tremendously [5, 6]. This will naturally lead to the need for more trained surgeons in more centers to be able to cope with this increasing workload. The standard mastoidectomy-posterior tympanotomy has been the gold standard for cochlear implantation for decades. However it does have its disadvantages and complications [7–11]. This stimulated many workers to modify their approach to a more "surgeon-friendly" approach which is adaptable to most of the possible situations with minimal morbidity, comparable efficiency, and shorter operative time [12–21]. We present our modification of the transcanal approach outlining the technique, its advantages, and our results.

2. Patients and Methods

This study includes 125 cochlear implant patients who were implanted between January 2010 and January 2013 and followed up from 18 to 50 months. Their age range was 2–56 (mean 3.4 years) and the male : female ratio was 2.1 : 1. All patients underwent a routine cochlear implant protocol and were deemed candidates for implantation. The four available brands were implanted (Cochlear (Nucleus Freedom), MedEl (Sonata), Advanced Bionics (His res 90 K), and Neurelec (Saphyr)).

2.1. Surgical Technique. This is a minimally invasive transcanal technique and it was as follows.

Figure 1: Limited postauricular incision.

(i) Incision: the incision was a small postauricular incision (Figure 1).

(ii) The incision is deepened to the periosteum. A strip of conchal cartilage 1 cm long and 2 mm wide is harvested.

(iii) The periosteal pocket for the receiver package is developed and the bed is drilled at an adequate location depending on the brand of the implant used. The site is determined so that the electrode runs more or less in a gentle curve from the bed to the trough without kinks.

(iv) A tympanomeatal flap is elevated through 210 degrees (on the right side from 1 to 6 around the posterior meatal wall) without intrameatal incisions. The round window niche and promontory and incudostapedial joint are exposed.

(v) When the round window niche is not adequately exposed, a limited canalplasty can be performed.

(vi) A trough is fashioned along the junction of the posterior and superior meatal walls parallel to the axis of the long process of the incus. The trough runs straight from inside out and is 2 mm deep. It must have straight walls with no bevel to prevent movement of the electrode. (Figure 2). A small bridge of bone is maintained at the medial end. It has a dual purpose: protection of the chorda and fixation of the electrode in place.

(vii) The trough may be extended from the meatus to the proposed site of the bed for the receiver but this is not always necessary.

(viii) The round window approach is used for electrode insertion [22–24]. The niche overhang is drilled until the round window membrane is exposed. Sometimes the edge of the ponticulus is smoothened out to allow a gentle direction of the electrode (Figure 3).

Figure 2: Trough in posterosuperior meatal wall and bony bridge.

(ix) The round window niche is filled with hyaluronic acid and dexamethasone which helps lubricate the electrode and prevents air bubbles from forming during the advancement of the electrode. The electrode tip is positioned and the membrane is gently punctured. Afterwards the electrode is gently advanced in a superior to inferior direction and it is the direction of the cochlea which guides it. The round window is then sealed with muscle (Figure 4).

(x) Testing is performed according to the implanted brand. Impedance testing, neural response telemetry (NRT), neural response imaging (NRI), or auditory response telemetry (ART) is performed. Electrical stapedial reflex can be tested with direct observation but it was performed in only 10 cases.

(xi) The electrode is tucked in the depth of meatal trough (Figure 5). It is then covered by the strip of cartilage which should fit snugly in the trough so that it does not project into the external meatus. The tympanomeatal flap is replaced. The meatus is then packed with ointment impregnated gelfoam and a merocel ear wick. The electrode is fixed by a drop of calcium hydroxide paste beyond the external meatus. This prevents the elastic recoil of the electrode which can displace it into the meatus until healing is complete.

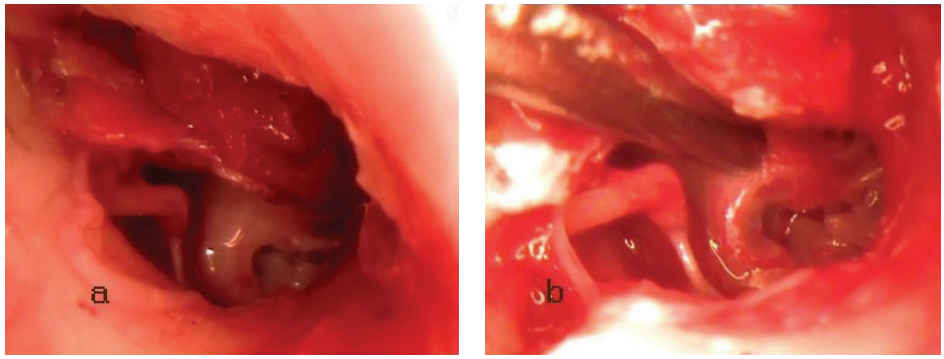
(xii) The wound is closed in two layers and dressed.

(xiii) Patients are usually discharged on the same day or stay overnight. The wound is exposed on the 5th day.

3. Results

In all cases the exposure of the round window and promontory and identification of landmarks was complete. The electrode was inserted through the round window in 110 patients. A cochleostomy was performed in 15 patients with difficult exposure of the round window or basal calcification. Partial insertion was achieved in 10 patients.

We encountered 5 gushers: two patients with EVAS (enlarged vestibular aqueduct syndrome) and 3 patients



(a) (b)

Figure 3: (a) Round window niche. (b) Niche drilled out and smoothened.

Figure 4: Electrode through tunnel (a), past the bridge (b), and into RW (c).

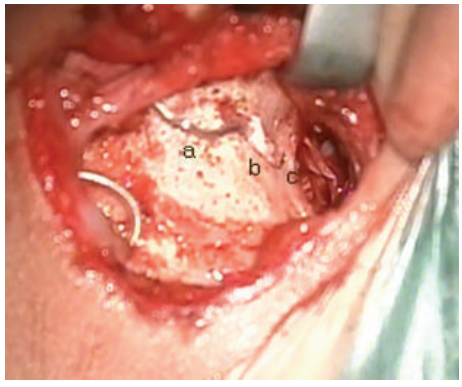


Figure 5: Electrode fixed with Ca hydroxide (a), covered with cartilage (b), and under the bridge (c).

with IP2 malformations. All were easily controlled intraoperatively by plugging and did not present any particular problems afterwards.

3.1. Operative Time. The actual surgical time ranged between 25 and 40 minutes (mean 30.1 min) depending on the drilling time for the receiver package. Extra time spent in intraoperative testing is excluded and depends on the used brand.

3.2. Complications. There was chorda tympani injury in 6 cases. Only two patients complained of loss of taste on the ipsilateral tongue.

There were 2 cases with electrode exposure with 1 requiring revision. Two other cases had a small tympanic membrane perforation. Both were eventually grafted uneventfully without compromising the activation of the device. One case had severe infection with extrusion of the device 1 year after successful implantation.

All patients proceeded to activation 2–4 weeks after surgery. All are in rehabilitation programs.

4. Discussion

Indications for cochlear implantation have increased over the years to include patients of a wide age range, hearing preservation strategies, simultaneous bilateral implantations, single sided deafness, implanting ears with chronic otitis media, and so forth [1–4, 11]. At the same time social awareness on the potentials of cochlear implantations has increased and there is increasing pressure on the medical community for more and more implantation. This is not limited to certain geographical locations and cochlear implant surgery has become a universal exercise. Where training is highly variable, outcomes and complication rates are likewise variable. This means that more and more surgeons need to be trained to perform the surgery adequately within reasonable operating room time. Current standard cochlear implantation technique involves a transmastoid approach with posterior tympanotomy and an oblique approach to the round window or basal turn of the cochlea. This approach has a number of disadvantages and complications: facial paralysis, taste disturbances, misplacement, carotid injury, injury to the external canal, dural injury, or sigmoid injury. In some difficult anatomical situations (sclerotic mastoid, prominent sinus, and low placed dura) it may be impossible or extremely difficult [7–11, 19, 25]. Alternative techniques have been suggested in order to minimize complications, shorten operative times, and improve electrode insertion.

Anterior approaches have the advantage of being familiar to all otological surgeons giving a direct clear view of the target area without encountering important structures [14–21]. Previously described techniques involve either a blind tunnel through the attic or complex trough design or reconstruction with bone pate or cement [12–15, 26]. The main differences in our technique include the simpler incisions, drilling of the straight trough under direct vision, the constant orientation of the trough providing direct access to the round window, preservation of all anatomical structures, and the reconstruction technique. A small amount of calcium hydroxide beyond the meatus maintains the electrode in position. This prevents its elastic recoil that seems to be the main cause of extrusion. Secure isolation of the electrode from the meatal skin is performed by autologous cartilage which has a proven track record for otosurgical reconstruction [13, 17, 20, 26]. Operative times are minimized making it a suitable approach for simultaneous implantation, for patients with comorbidities, and in given situations it can be performed under local anaesthesia like any standard middle ear surgery [16, 27]. With attention to detail, insertion is usually straight forward and in difficult cases a basal drill out or a middle turn insertion can be easily performed as all target areas are visualized. Misplacement is not an issue as there are no hidden spots. There is no danger of injury to the facial nerve as it is not within the operative field. Similarly the carotid artery is protected even in cases with ossified basal turns as the direction of drilling follows the cochlea and is not directed anteriorly. The only structure at risk is the chorda tympani injury during flap elevation and drilling of the trough. Keeping a bridge of bone while drilling the most medial end of the trough will protect the chorda tympani and shield it from any manipulations. Careful dissection of the mucosal folds and gentle electrode transit from the trough to the middle ear will prevent any shear of the chorda.

Electrode extrusion in the meatus can be due to inadequate deepening of the trough or by the recoil of the electrode [16, 18]. This may be managed by deepening the trough and repositioning of the electrode without interfering with the inner ear insertion. It may be even managed conservatively if there is no infection with a properly functioning device [28].

5. Conclusion

The modified transcanal technique with autologous cartilage/fascia reconstruction is a versatile, easily reproducible technique. It does not require extra skills for the properly trained otological surgeon. It has minimal operative risk, reduced operation time, and minimal morbidity. It can be used for the implantation of all available devices and can be adapted to all anatomical and pathological situations.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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