

Incus buttress approach as an alternative safe technique for cochlear implantation; preliminary results with review of literature

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Aim

Report our preliminary experience with an alternative technique for cochlear implantation.

Setting

Tertiary referral cochlear implant center.

Study design

Retrospective case series.

Subjects and method

Fifteen patients have been operated using incus buttress approach. The procedure involves classical cortical mastoidectomy and identification of short process of the incus. Bony incus buttress was removed moving inferiorly toward facial recess. Round window was identified then marginal cochleostomy was performed and finally insertion of the electrode into the cochlea via the widened aditus.

Results

Fifteen implants were performed on 15 patients. All were children (mean age of 3.2 years). All the children were pre-lingual. A Med-el SONATA implant (MED-EL, Innsbruck, Austria) was used in all patients. Mean duration of surgery was 12015 minutes. The minimum follow-up was 6 months. No complications were observed during the procedure or during postoperative follow-up.

Conclusion

Here, we describe a new alternative technique for cochlear implantation and report our preliminary results. The procedure has advantages over the existing alternatives techniques and avoids the potential complications of posterior tympanotomy.

Keywords:

alternative techniques, cochlear implant, surgical approaches

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Introduction

Indications for cochlear implants have been expanded over the past few years (younger age implantation, bilateral cochlear implantations, single sided deafness, residual hearing). Thus, the number of cochlear implant candidates has grown tremendously [1–4].

Cortical mastoidectomy with posterior tympanotomy has been used as the standard technique for cochlear implantation. The posterior tympanotomy approach is relatively challenging technique that need skillful otologist to perform, as it may have potential complications including facial nerve paralysis [5]. Many trials have attempted to develop alternative techniques, including the suprameatal and pericanal approach, but complications have been reported [6]. 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 [7].

Our aim is to present our modified transantral approach ‘incus buttress approach’ (IBA) outlining the technique, its advantages, and possible indications.

Patients and methods

A retrospective chart review of all patients underwent IBA between January 2013 and April 2016 was performed. The age, sex, reasons to use this technique, type of implants and duration of follow-up were studied. All cases were performed at a tertiary referral CI Center, Tanta, Egypt. All patients underwent a routine cochlear implant protocol and were deemed candidates for implantation. This alternative technique has been used due to particular surgical circumstances, to avoid obvious risk of complication or to overcome challenging anatomical situations.

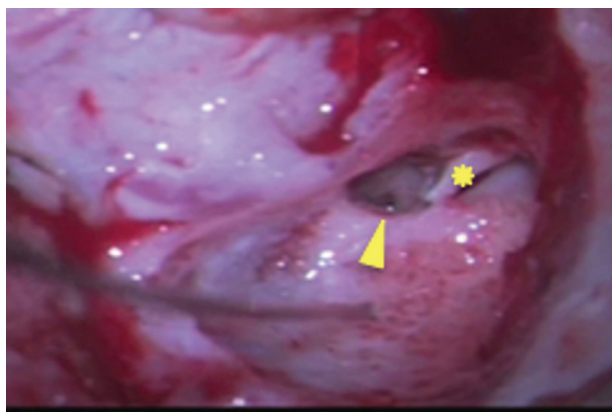
Surgical technique

Cochlear implantation was performed as follows:

- (1) Incision: the incision was an endaural incision.

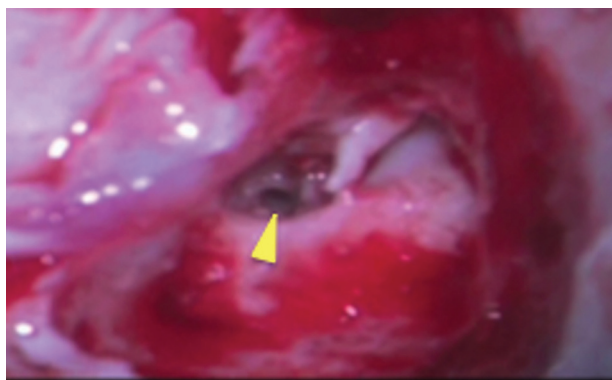
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Figure 1



Aditus is widen inferiorly by removing the bony buttress between the facial recess and fossa incudes. Short process of incus 'yellow streak', round window niche 'arrow head'.

Figure 2



Extended round window cochleostomy 'arrow head'.

Figure 3



Axial computed tomography, showing right temporal bone with anteriorly bulged sigmoid sinus 'arrow head'.

- (2) The incision was deepened to the periosteum.
- (3) Cortical mastoidectomy was carried out, and the antrum was exposed until the short process of the incus became visible.
- (4) Posterior incudal ligament was identified by drilling gently, just inferior to the tip of the short process, using low speed drilling (2000–3000 rpm) and 3 mm diamond burr. Then, aditus was widen inferiorly by identifying removing the bony buttress between the facial recess and fossa incudis (Fig. 1).
- (5) The niche overhang was drilled until the round window membrane is exposed. Then, extended round window cochleostomy was done using 1 mm diamond burr (Fig. 2).
- (6) The periosteal pocket for the receiver package was developed and the bed was drilled at an adequate location depending on the brand of the implant used. The site was determined so that the electrode run more or less in a gentle curve from the bed to the trough without kinks.
- (7) The round window niche was filled with hyaluronic acid and dexamethasone, which help to lubricate the electrode, and prevented air bubbles from forming during the advancement of the electrode. Afterwards the electrode was gently advanced in a superior to inferior direction. The round window was then sealed with muscle.
- (8) Testing was performed according to the implanted brand. Impedance testing, neural response telemetry, neural response imaging, or auditory response telemetry was performed.
- (9) The wound was closed in two layers and dressed.
- (10) Patients were usually discharged on the next day after surgery. The wound was exposed on the seventh day.

Results

Fifteen implants were performed in 15 patients. All were children (mean age of 3.2 years). Nine patients were males and six were females. All the children were prelingual and were having bilateral profound sensorineural hearing loss.

Six patients had a very contracted mastoid cavity with anteriorly bulged sigmoid sinus and very narrow facial recess that made facial recess approach quite difficult with increased risk to facial nerve injury (Fig. 3). Seven cases had difficult posterior tympanotomy due to lateral displacement of mastoid portion of facial nerve (four cases) or due to compact 'poorly pneumatized' facial recess (three cases). IBA was electively performed in the other two patients.

A Med-el SONATA implant (MED-EL, Innsbruck, Austria) was used in all patients. Mean duration of

surgery was 120±15 min. No complications were observed during the procedure or during postoperative follow-up.

Discussion

With the technical advances, the rate of facial nerve injury during cochlear implantation using the facial recess approach has decreased. However, under certain anatomical situations, such injury is unavoidable [8]. Moreover, as cochlear implantation has been more widely practiced, the natural learning curve with growing surgical experience may have some contribution for decreasing the facial injury during implantation [7].

Classical posterior tympanotomy approach for cochlear implantation has not been changed since its introduction at 1979 by Clark *et al.* [9]. Incidence of reported facial nerve palsy during cochlear implantation have varied in the literature. It was reported to be 1.7% in one study, while in the Melbourne and Hanover study, the rate was 2% [8,10].

Proper facial recess exposure may be hindered by anatomical aberrations. A poorly developed mastoid with an anterior sigmoid sinus may limit access to the facial recess. Also, access to the middle ear and round window niche via the facial recess may be compromised by an aberrant facial nerve. Moreover, cochlear dysplasia may obscure anatomical landmarks [11].

Alternative techniques have been developed and advocated in attempt to avoid facial recess approach and to provide a safe route to middle ear and round window. The suprameatal approach is an alternative, nonmastoid, approach for cochlear implantation in which the middle ear is exposed from the external auditory canal, and electrodes are inserted into the cochlea through a closed suprameatal tunnel [12]. However, working in a closed tunnel, narrow field and the risk of facial nerve injury, as the tunnel is drilled blindly into the posterior canal wall, have been disadvantages for such technique [13]. To overcome the risk of blind drilling and the closed tunnel, Hausler [14] has developed the pericanal technique. It involves drilling an open-tunnel into the posterior-superior region of the bony external auditory canal from immediately above the incus body towards the outer border of the external auditory canal. Also, the transmeatal approach has been described as an alternative technique to the classical facial recess approach. It provides an excellent view to the round window and involves

drilling a tunnel visibly in the external canal [15]. However, electrode extrusion, external infection with persistent otorrhea, and cholesteatoma are complications that may arise from the pericanal and transmeatal approaches.

The IBA eases the implantation technique by simply identifying the short process of the incus, then taking buttress down in the direction of the facial recess with no need to identify the retrofacial air cells 'sentinel cell'. It provides a wide approach with proper exposure of middle ear and round window area that allow proper safe manipulation.

The posterior meatal wall and the sigmoid sinus identify the limits of the visual field through the posterior tympanotomy. So, anterior displacement of the sigmoid sinus has a significant constricting impact on the surgical field view. Similarly, lateral displacement of the mastoid portion of facial nerve limits the accessibility via posterior tympanotomy. From an anatomical standpoint, as we move upward toward the tegmen, the sigmoid sinus becomes more posterior and the meatal wall curves anteriorly toward root of zygoma. Also, the mastoid segment of the facial nerve transits to the more medially seated tympanic segment. Subsequently, surgical exposure from superior lateral visual axis 'provided by IBA' conveys wider surgical field than the direct posterolateral visual axis of posterior tympanotomy.

Wide exposure with direct access, provided by IBA, give it privilege over both the transmeatal and suprameatal approach by overcoming any anatomical variations in the round window area that may make cochleostomy and electrode insertion challenging and, in some cases, quite difficult.

The transaditus approach is a quite similar approach that has been described [16]. However, it includes an additional step of elevating a tympanomeatal flap to gain access to middle ear in order to separate incudostapedial joint to remove the incus. In the IBA, the short process of the incus is protected by identifying the whitish posterior incudal ligament as a landmark that form upper limit of drilling. Theoretically, the posterior incudal ligament serves as a soft tissue pillow that protects the ossicular chain from the vibrating effect of rotating burr. An issue that might represents an essential prerequisite for hearing preserving techniques for CI. However, such hypothesis could not be confirmed as all cases in our series had profound hearing loss with no serviceable residual hearing.

Furthermore, the duration of the IBA procedure compared to classical techniques is shortened by about 20 min, which might be of particular importance during bilateral simultaneous cochlear implantation in young children.

A limitation of the case report presented here is the relatively the small number of cases. So, a prospective study with larger population may overcome this limitation.

Conclusion

IBA is a simple, quick, and safe alternative technique for cochlear implantation. The procedure has advantages over the existing alternative techniques and avoids the potential complications of posterior tympanotomy, transcanal, and transmeatal techniques. Although, IBA hypothetically has assumed to guard ossicles and inner ear from mechanical trauma of the burr, we do not advocate it as a hearing preservation technique till further study to confirm its safety on residual hearing.

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Conflicts of interest

There are no conflicts of interest.

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