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Original Research Article

Fossa incudis approach in cochlear implant surgery: safe and easy technique for facial nerve preservation during posterior tympanotomy

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ABSTRACT

Background: Cochlear implant surgery became worldwide operation used to manage patients with severe to profound sensory neural hearing loss that were not benefit from hearing aids. Facial nerve (FN) injury during the surgery still the most complication that the surgeons think about it during doing posterior tympanotomy.
Methods: A retrospective study including 76 patients complaining of severe to profound SNHL, get implanted in Misrata Medical Center, Misrata city, Libya, in the period between January 2018 and April 2020, using our new technique: Fossa incudis approach (FIA), in which and after cortical mastoidectomy performed, exposure of tip of short process of incus which situated in fossa incudis was done to become guide and help us to enter middle ear safe.
Results: After 76 operations performed on 76 patients with different anatomical situations, we report 0% FN injury. The time of surgery was relatively shorter (90 minutes±10).
Conclusions: Our technique (FIA) is safe and easy to learn; it helps us to minimize the incidence of FN injury and decrease the time of operation.

Keywords: Cochlear implant, Fossa incudis approach, Facial nerve injury

INTRODUCTION

The most common sensory deficit in children is the hearing loss with its incidence being 1 to 3 in 1000 live birth per year. Among these children, half of them will have severe to profound hearing loss.[1]

Cochlear implant operation provides people with their auditory ability and speech understanding.[2]

Cochlear implant is a device designed to stimulate the cochlear nerve and to translate acoustic information to electrical information.[3]

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).[4,5]

There are various surgical techniques for cochlear implantation, classical one being mastoidectomy and posterior tympanotomy which was introduced in 1979.[3]

Posterior tympanotomy is a procedure in which the surgeon can reach the middle ear cavity without removal of the posterior wall of the external auditory canal. The posterior tympanotomy was first described by Jansen in 1958 in which opening of the facial recess is the end result. The facial recess is a triangular space bounded medially by the mastoid segment of the FN, laterally by the chorda tympani nerve and superiorly by the fossa incudes.[7]

The two sides of this triangle, medial and lateral, cannot be seen from the posterior aspect during posterior

tympanotomy, and this is a problem facing the surgeon during bone drilling. Therefore, the mastoid segment of the FN and the chorda tympani nerve as will, can be injured in cases of abnormal anatomy during posterior tympanotomy step.[8]

This complication generally occurs due to incomplete understanding of the anatomy of the facial recess and its different related structures.[9]

During cochlear implant surgery, FN injury was reported at a rate of 1-3%. Understanding of the anatomical relationship of the FN with various adjacent landmarks in the surgical field may help the surgeon to avoid this undesirable complication.[10]

To minimize various disadvantages and surgical complications that are involved in standard procedure (especially FN injury), and to make the surgery easier and simpler for the surgeon, various modifications in cochlear implantation surgical technique has been taken which includes, for example introduction of Veria (transcanal, non-mastoidectomy) technique.[11]

Any surgical operation has complications. In cochlear implant the complications divided into minor and major complications. The minor complications defined as those complications which resolved spontaneous or conservatively, while major complications is the complications that need hospitalization and sometimes surgical intervention.[12]

Our aim in this study, FIA technique, which is a trans mastoid approach, is to outlining the technique, its advantages, and its role in avoiding operative complications especially FN injury during cochlear implant surgery.

METHODS

A retrospective study including 76 patients complaining of bilateral sever to profound sensory neural hearing loss, 61 patients were children (pre lingual), the mean age was 3.8 years and 15 patients were adults (post lingual), 37 of the patients were males while 39 of them were females.

All the patients underwent cochlear implantation using FIA between January 2018 and April 2020.

The age, sex, types of incision, type of device implanted, number of electrodes respond, duration of surgery, healing of incision postoperatively, intraoperative and postoperative complications, and state of FN postoperatively were studied. All cases were performed at Misurata Medical Center, Misurata city, Libya. All patients underwent a routine cochlear implant protocol and were deemed candidates for implantation. The two available brands were implanted: Cochlear brand (profile CI 512) and MED-EL brand (Mi1200 SYNCHRONY 1).

All patients or their relatives were informed about the study protocol before surgery, and a written, informed statement consent were obtained.

All ethical approvals were obtained from Misurata medical center's (MMC) ethical committee.

Surgical technique

Using post auricular approach and Lazy S post auricular incision. Then cortical mastoidectomy was carried out, after that the posterior tympanotomy: was done as following:

Using a 2- or 3-mm diamond burr, the lateral bony edge of the epitympanum is drilled to explore the short process of incus and its tip which situated in the fossa incudis. The tympanic portion of the FN was identified medial to the incus and inferior to the lateral semicircular canal by changing the viewing angle of the microscope. The FN never extends lateral (above) the level of short processes of incus in the mastoid area. By identifying the tympanic segment of FN, we became oriented to its position in the mastoid portion. Thinning of the posterior wall of the external auditory canal is important to make FN away from our surgical field during posterior tympanotomy. Usually, the drilling area is defined by the sulcus tympanicus lateral to the expected position of FN and inferior to the tip of the short process of incus; we left a 2 mm bony bridge below the incus tip (Figure 1). Then using a 2 mm diamond burr, we drill 2 mm inferior to the short process of incus, leaving incus buttress intact (half of the burr lateral to the tip of incus), and drill parallel to the FN (from superior to inferior direction) with saline irrigation (Figure 1).

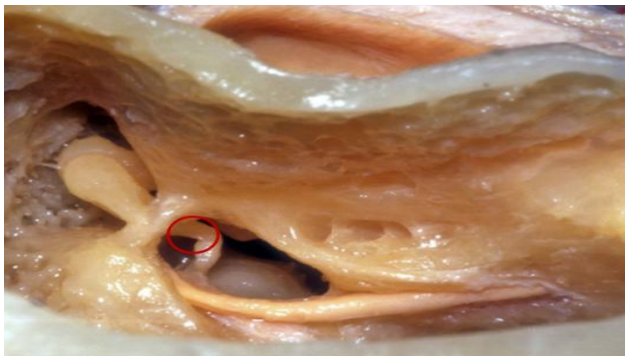

Figure 1: Site of drilling during posterior tympanotomy to avoid mastoid part of the FN.

By changing the size of the burr to 1 or 1.5 mm we complete the posterior tympanotomy. Injuring to the ossicles was avoided when we get inside the middle ear by avoiding extra force during drilling. Irrigation with saline is extremely important to avoid thermal injury to the FN. Once we get inside the middle ear; we faced the stapes and its tendon directly. Then we start to dilate the opening with a suitable size of diamond burr toward

inferior and medial until we explore the round window (RW). Identification of cochleostomy site and RW: The incudostapedial joint is an important landmark for RW. Widening of posterior tympanotomy inferiorly and medially is important to find the RW. It is easily to identify the RW by identifying the incudostapedial joint and from this joint 3 mm inferior then 3 mm medially we will find the RW. Figure 2 (A and B) remove mucosa and soft tissue at this area to facilitate the finding of RW.

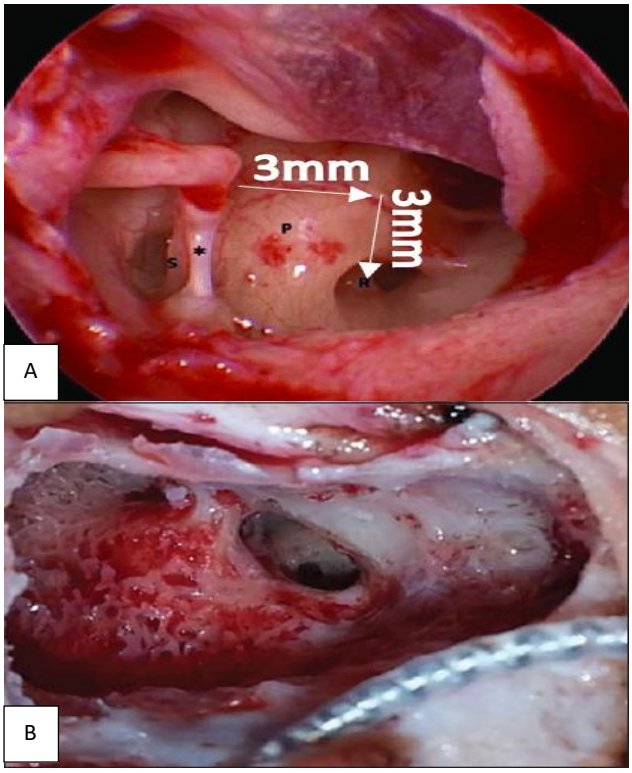

Figure 2: Relations between the icudostapedial joint and RW (A=seen from perforated TM, and B=seen from posterior tympanotomy).

Cochlea opening

There are two approaches to open the cochlea: cochleostomy or RW approaches. RW Approach is the best and much easy than cochleostomy Using 0.6-0.8 mm diamond burr and angled hand piece, drill out the bony niche over the RW membrane to explore it without tearing it.

Preparation of the implant bed

We drill at the posterior superior flat area of the skull behind the mastoid cavity. (10-15 mm from the posterior end of the mastoid cavity), drilling of the electrode tunnel done as will.

Partial bridge

During drilling of the electrode tunnel and at the end of the tunnel near the mastoid, we leave 2 mm of bone and drill medial to it; this will make a bridge over the tunnel. Then open this bridge superiorly and leave the rest. This will create a partial bridge that facilitates holding the electrode in position after insertion and minimizing the failure due to trauma post-operative (Figure 3).

Figure 3: Partial bridge.

Electrode insertion

After completing all the bony work, we wash and clean the implant bed, mastoid and middle ear with saline. Then we opened the RW membrane. Injection of dexamethasone inside the RW was done before insertion. Insertion technique will be done according to type of electrode. Closure of the RW using small piece of muscle was done. Audiological testing including Impedance teste, stapedial reflex, neural response telemetry, auditory response telemetry was performed before closure of the wound. Closure of the wound in layers and patient discharged in the next day

RESULTS

Seventy-six operations were performed, the indication was bilateral sever to profound sensory neural hearing loss, all the patients under went unilateral cochlear implantation, majority of them implanted in the right ear (left ear only in 3 cases due specific indications).

The 61 patients were children, the mean age was 3.8 years and 15 patients were adults. The 37 (48%) of the patients were males while 39 (52%) of them were females.

Fifty-five of the patients were implanted using Med El brand (synchrony 1) and the rest twenty-one implanted with cochlear brand (profile CI 512).

Eleven of the patients have contracted mastoid, and six of them with anterior displacement of FN which making the surgery more difficult.

Three operated patients were having bilateral secretory otitis media. In only five patients we need to do cochleostomy, the rest of the patients implanted using RW approach. The mean duration of operation was 90±10 minutes. FN paralysis post-operative (immediate and late) was 0%.

There are some intra operative complications were occurred, Figure 4, and other complications were occurred post operatively (Table 1).

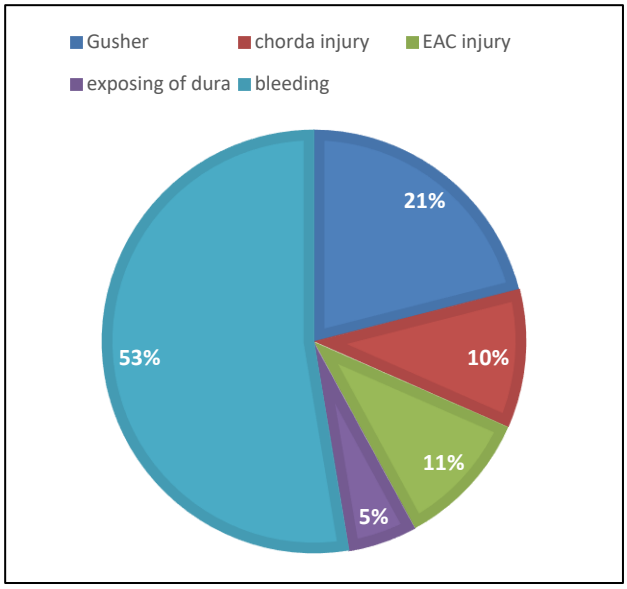

Figure 4: Intraoperative complications.

Table 1: Postoperative complications.

Type of complication	N	Percentages (%)
Wound dehiscence	1	1.3
Vertigo	2	2.6
FN palsy	0	0

DISCUSSION

FN injury during performing posterior tympanotomy step still the most important complication in cochlear implant surgery, which majority of the surgeons a fried from it.

Anomaly of FN and contracted mastoid increase the risk of FN injury.

The incidence of FN paralysis or weakness is different from study to other. Migiroy et al reported only 2 cases (0.66%) develop FN paralysis post operatively in a study including 300 patients underwent cochlear implant surgery.[13] Brito et al reported 12 patients (2.2%) develop FN paralysis post operatively from 550 cases under went cochlear implant surgery.[14]

Ajalloneyan et al reported only 3 patients (1%) develop FN paralysis in his study on 262 cases of cochlear implant surgery.[15]

In our study using FIA technique, we were operating 76 patients with different anatomical situations.

This technique helps us to minimize and avoid FN injury during posterior tympanotomy, so the percentage of FN injury in our study was 0%.

The mastoid part of FN always lies below and medial to the level of short process of incus.

On the other hand, entrance of the middle ear near the tip of the short process of incus (fossa incudis), decrease risk of FN injury.

This is why we do not have FN injury in this study, because we always working in area away from the mastoid part of the FN which start appear more laterally in its course toward the mastoid tip.

In our study we have 2 patients (2.6%) with injury of external auditory canal wall. We have 2 cases (2.6%) with chorda tympani nerve injury. Jeppesen et al in his study including 308 cases operated for cochlear implant, reported 30.8% of chorda tympani nerve injury (transient chorda tympani syndrome).[16]

CONCLUSION

Fossa incudis technique is safe approach and easy to learn. It decreases the risk of FN injury and it decrease the time of operation during cochlear implant surgery. Based on our findings, we strongly recommended using the proposed technique. However, further researches on other population are recommended.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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