INTRODUCTION

Congenital hearing loss in the Pakistani population may be as high as 13 per 1000. The cochlear implant (CI) is an FDA approved device for the treatment of congenital profound sensorineural hearing loss (SNHL). Implantation at early age result in better auditory comprehension outcomes. The surgical approach for the cochlear implant electrode insertion should aim to minimize intracochlear trauma and ensure entry into the scala tympani. The two most popular techniques for electrode insertion are round window membrane (RWM) insertion and bony cochleostomy; the former is considered to be less traumatic and more likely to preserve residual hearing.

There might be anatomic variations in the RWM area that may render it a challenging approach. The RWM is located in a small niche called fossula fenestrae rotunda and often hidden behind overhanging bony ridges from superior, posterior and anterior, which regularly limits the visibility of the RWM during surgery. The surgical technique consists of drilling a space for the receiver/stimulator then performing a cortical mastoidectomy, followed by a posterior tympanotomy. Posterior tympanotomy is an approach to access the middle ear by drilling a space between the facial nerve and chorda tympani. This is required to access the round window and promontory. The insertion of CI electrode via RWM is considered more difficult in children, compared to adults. Cochleostomy for type IIB, and bony cochleostomy for type III.

Currently there are no practical guidelines to help surgeons choose the surgical approach for CI and most decisions are made peroperatively based on the surgeon's judgment and preference. Although the STH classification can be used as a reference for operating surgeons to decide the most appropriate technique, inter observer variability may lead to differences in surgical approach. In view of these gaps in practice, the purpose of our study was to evaluate the utility of STH classification in predicting the appropriate route of CI electrode insertion in a Pakistani pediatric population, and whether there is any significant inter observer variability in applying the STH classification and assessing the extent of surgical exposure.

METHODOLOGY

A cross sectional study was conducted on consecutive pediatric patients who had received clearance from Multi Disciplinary Team (MDT; consisting of
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Otologists, pediatricians, psychologists, audiologists and speech therapists) to undergo cochlear implantation. The study was carried out at Combined Military Hospital Rawalpindi, from April 2019 and December 2020, which is a large tertiary care hospital located in the north of the country.

Ethical approval was obtained from institutional review board prior to commencing study, and informed consent was obtained from patients' parents.

**Inclusion criteria:** Pediatric patients with congenital sensorineural hearing loss, documented with Auditory brainstem response (ABR) audiometry, normal structure of external, middle and inner ear and normal CNVII and CNVIII on CT scan and MRI, physically fit for general anesthesia and those in whom full insertion of the electrode was possible.

**Exclusion criteria:** Patients above the age of 5 years, with structural anomalies of the ear or Cranial nerves VII/VIII, with hearing serviceable by conventional hearing aids, those in whom full electrode insertion was not possible or in whom surgery was abandoned /postponed due to anesthetic/surgical complications, those undergoing revision surgeries and those expected to have low compliance to speech therapy or follow up after surgery and those who had not received approval for cochlear implant by MDT.

The St Thomas Hospital classification (figure-1) is based on multiple per op findings of adult and pediatric cochlear implants. It grades the visibility of the RWM into four types. After an "optimal" posterior tympanotomy, the round window niche bony overhang is drilled without breaching RWM. An "optimal" posterior tympanotomy is defined as an operating surgeon's best surgical effort to achieve the widest posterior tympanotomy whilst preserving the integrity of the facial nerve, chorda tympani, posterior canal wall and bony annulus, so being able to dissect out the best exposure possible of the RWM by removing the round window niche bony overhang.11

Four surgeons separately classified the RWM type at time of posterior tympanotomy and also commented on whether the posterior tympanotomy was "optimal" in their opinion. Verbal response were collected from operating surgeons and recorded by the researcher at time of surgery. If of all 4 surgeons were in agreement, it was considered as "full consensus", if 3 out of 4 surgeon were in agreement it was considered as "majority consensus", and if 2 out of 4 surgeons agreed, it was considered as "half consensus". In cases of "half consensus" the opinion of the senior most surgeon was considered final. We defined 75-100% "full consensus" as minimum inter observer variability, 50-74% "full consensus" as moderate inter observer variability and less than 50% "full consensus" as substantial inter observer variability.

Based on the round window type, the electrode insertion technique was finalised: round window insertion (membranous cochleostomy), extended RW approach or bony cochleostomy. The preferred method was membranous cochleostomy, if that was not possible then extended RW approach, and if that was not possible, or if no part of the RW was visible, then bony cochleostomy was performed. The cochlear implant used in the study was MED-ELTM synchrony (Figure-2). The data was analyzed with SPSS version 25.

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**Figure-1:** STH Round window classification, used with permission from AC Leong.
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Figure-2: Cochlear implant: MED El synchrony.

Figure-3: Electrode in round window, through posterior tympanotomy.

RESULTS

One hundred consecutive pediatric patients who met the inclusion criteria and underwent cochlear implant surgery were included in the study. All underwent CI in right ear. Out of 45 patients were females and 55 were males. Mean age of the patients was 3.8 years.

The results of the Round window type and consensus on "optimal" posterior tympanotomy are summarized in Table-I & II respectively.

<table>
<thead>
<tr>
<th>Round Window Type</th>
<th>No. of Patients (n=100)</th>
<th>Consensus on Round Window Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3</td>
<td>Full Consensus 100% (3/3)</td>
</tr>
<tr>
<td>II A</td>
<td>76</td>
<td>Majority Consensus 17% (13/76)</td>
</tr>
<tr>
<td>II B</td>
<td>15</td>
<td>Full Consensus 87% (13/15)</td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>Full Consensus 100% 6/6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round Window Type</th>
<th>No. of Patients (n=100)</th>
<th>Consensus on &quot;Optimal&quot; Posterior Tympanotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3</td>
<td>Full consensus 100% (3/3)</td>
</tr>
<tr>
<td>II A</td>
<td>76</td>
<td>Majority consensus 18.4% (14/76)</td>
</tr>
<tr>
<td>II B</td>
<td>15</td>
<td>Half consensus 4% (3/76)</td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>Majority consensus 26.6% (4/15)</td>
</tr>
</tbody>
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Table-I: Round windows types

Table-II: Round window Types with consensus on Optimal posterior tympanotomy

All patients with type I RWM had round window (membranous cochleostomy) insertion of electrodes. In patients with type IIA RWM, 85.5% had round window (membranous cochleostomy) insertion and 14.5% required extended round window insertion. In patients with Type IIB RWM, 13.3% had round window (membranous cochleostomy) insertion, 60% had extended round window insertion and 26.6% had bony cochleostomy. All patients with type III RWM required bony cochleostomy.

All electrode insertions were confirmed by post operative skull x-ray. Three patients developed post op temporary facial paresis, all of whom recovered completely within 4 months. There were no cases of permanent facial palsy. Four patients complained of slight bleeding from the nose, which resolved within 2-3 days. There were 2 cases of electrode displacement, discovered on post operative X ray, both cases were re explored within 24 hours.

DISCUSSION:

In our study, full consensus on the type of RWM was found in 83 out of 100 patients, majority consensus in 15 patients and half consensus was present in only 2 patients. Hence there was minimum inter observer variability in defining the RW type. With regards to extent of "optimal" posterior tympanotomy, full consensus was reached in 75 out of 100, majority consensus in 20 and half consensus in 5 patients. The inter observer variability is also minimum, although it is more than it is with RWM type (75% vs 83%). One possible explanation for variability in extent of "optimal" posterior tympanotomy is that the operating surgeon could be erring on the side of caution and thus compromised ideal exposure for the sake of preservation of structures. In comparison, Leong et al. have also stated that Inter and intra-observer variability of the grading of RW type was minimal in their study.11 Our study adds to the evidence that STH classification is a fairly robust method to classify RWM types.

In our study, type I RWM was not as common as reported by Leong et al, (3% vs 46%).11 Our study had higher percentage of type IIA RW (76% vs 47%). Similar to Leong et al, and Stuermer et al, majority of our patients had more than 50% of the round window visible (i.e Type I and Type IIA); 79% in our study, 78% in Leong et al, and 86% in Stuermer et al.11,12 This indicates that majority of the patients had favorable anatomy and that RW insertion, via membranous cochleostomy is feasible in most cases.

Based on the RW type, the route of electrode insertion could be predicted. Although bony cochleostomy enables residual hearing preservation, however multiple studies have shown that RW approach has better residual hearing outcomes compared to bony cochleostomy.13,14 Furthermore, cochleostomy is associa-
In present study, one unexpected complication encountered was postoperative nose bleed. This is not widely reported in the literature. One possible explanation for this complication is leakage of blood or blood tinged saline via the Eustachian tube into the nasopharynx and nasal cavity.

To ensure the standardization of results, our study included CIs of only one brand in all our patients, whereas in both Leong et al., and Steurmer et al., CI of different brands were used in the same study. Previous studies had included both adult and pediatric populations whereas our study only included pediatric population.

One of the limitations of the STH classification is the subjective nature of the classification, hence we suggest that to reduce the amount of inter observer variation and the subsequent decision for the surgical approach, a method similar to the one used in our study can be applied whereby a majority consensus of a team of otologists can be used to determine the most appropriate RW type and surgical approach.

ACKNOWLEDGMENT

Special thanks to Dr. Iqbal Khan (Bradford Teaching hospital/Yorkshire Cochlear implant Services, United kingdom) for overseeing and mentoring our cochlear implant program.

LIMITATION OF STUDY

Optimal posterior tympanotomy is still subjective and we had not defined it's exact anatomical boundaries or size. Long term complications and outcomes were not included in our study. Blinding and randomisation of the cases was not done.

CONCLUSION

The STH classification is a useful predictor of route of CI electrode insertion and most patients can undergo RW insertion. There is minimal variation between surgeons when applying the STH classification as well as when deciding the extent of surgical exposure. Obtaining consensus can provide better confidence to the operating surgeon and promote better decisions regarding optimum surgical technique.

Conflict of Interest: None.

Authors’ Contribution


REFERENCES