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ORIGINAL ARTICLE

A Comparative Study of Surgical Outcomes in Children with Cochlear Implantation Using Posterior Tympanotomy & Modified Veria Technique

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Abstract

Purpose: To compare the two common approaches of cochlear implantations i.e., mastoidectomy with posterior tympanotomy approach (MPTA) and modified veria technique and to know whether veria technique and its later modifications are as efficacious as the classic approach in terms of duration of procedure, gain in hearing and acquisition and incidence of complications if any. Methods: A prospective comparative study was undertaken at a tertiary care teaching institute. 30 children were selected and randomised into 2 groups who then underwent surgery from the same surgeon after proper evaluation but with 2 different approaches. Their outcomes were then observed and compared in terms of surgical technique and complications and hearing outcomes. Results: 30 children were operated with 15 in each group. In the study, patients under Group A (MPTA) had mean surgical duration of 139.67 ± 16.53 min while Group B (modified Veria) had of 84.67 ± 11.72 min, which was statistically significant ($p < 0.05$). 1 patient in Group A suffered House Brackman grade 4 facial nerve injury that recovered over 3 months and another had discolouration of the skin flap. No complications were observed in group B. During follow-up CAP and SIR scores were compared and were found to be statistically non-significant between the 2 groups (p value > 0.05), but the paired differences within each group showed statistical significance (P value- <0.001). Conclusion: Veria Technique (and its later modifications) for cochlear implantation is a simple, safe and easy procedure, which is as efficacious as MPTA with added benefits of consuming lesser surgical duration.

Keywords Cochlear Implants · Modified Veria · Posterior tympanotomy · Cochlea, CAP

Introduction

Hearing loss is the most common sensory deficit in children. It could be pre-lingual or post-lingual deafness. Incidence of hearing loss is 1–3 in 1000 live birth per year, where half of these have profound hearing loss with deficit more than

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90db. [1] Sensorineural hearing loss (SNHL) affects the cochlea, which transforms sound vibration into a neural signal or the cochlear nerve, which transmits this signal to the auditory area of brain. Most SNHL is sensory and limited to the cochlea rather than neural. [2] Failure in development of the hair cells of cochlea is the major cause for hearing impairment in pre-lingually deaf children. In case of severe to profound SNHL, the best way for hearing and learning proper speech is represented by a cochlear implant . [3] A cochlear implant is an electronic prosthetic device that acts to convert external physical sounds to electrical impulses in place of the deficient hair cells. Development of cochlear implant have greatly improved the educational and professional prospects of profoundly deaf children. [4] There are several surgical techniques invented and described in the last few decades, including mastoidectomy and posterior tympanotomy (MPTA) which was introduced in 1979, is known as classical standard approach. [5] Though cochlear implantation with mastoidectomy and posterior tympanotomy approach is widely used and a successful approach, it has reported a few major and minor complications in which facial palsy is having current rate of 0.7% [6]. Additionally, in mastoidectomy and posterior tympanotomy approach, identifying and reaching facial recess becomes difficult in patients who have anatomic constraints like small mastoid cavity. [6] All these led to development of various modification to the classic approach in which there was no need of mastoidectomy.

Veria technique (VT) is one of non-mastoidectomy techniques for cochlear implantation, Trephen Kiratzidis introduced Veria Technique (transcanal approach) for cochlear implantation in order to improve the accessibility to the cochlea and reduce the surgical complications that can occur in classic technique due to trauma and also to reduce the operating time. [7] It is done through the endaural route for the cochleostomy with a transcanal tunnel drilled in the posterior canal wall. [7] Drilling the tunnel to the facial recess is the most critical step which makes veria technique different from classic approach and replaces mastoidectomy and posterior tympanotomy. [7] Later, in 2020, a modification to veria technique was introduced in order to reduce the extensive tissue dissection which was required during incision and elevation of mucoperiosteal flap in cochlear implantation [8]. This modification made cochlear implant surgery further more easy and less time consuming with faster post-operative healing along with less chance of facial nerve getting injured. The incision was changed from endaural to postauricular with posteriosuperior extension and thus obviating the need to cut the external canal skin.

The purpose of this study was to compare the two common approaches of cochlear implantations i.e., mastoidectomy and posterior tympanotomy approach and modified veria technique and to know whether veria technique and its later modifications are as efficacious as the classic approach in terms of duration of procedure, gain in hearing and language acquisition and incidence of complications if any.

Material & Methods

A prospective, comparative study was conducted in the Department of Otorhinolaryngology at SMS Medical College & Hospital, Jaipur.

The study included 30 children having severe to profound SNHL. The children were pre-ligually deaf and aged between 2 to 6 years. After obtaining informed consent from their parents', detailed history was taken and thorough examination was done. CT scans and MRI of the patients were studied to rule out any malformations. Routine investigation for surgery along with baseline OAE & BERA to assess hearing loss was done. Audiological and psychological assessments were done for all the patients. Patients who were fit for both the techniques were included in the study. Patients were randomised by computer generated numbers into into 2 groups. Group A included children who underwent cochlear implantation with classic approach and group B included children who underwent cochlear implantation with modified veria technique.

The surgery was performed by an experienced faculty of E.N.T. department, S.M.S Medical College who followed the patients throughout the study. Patients were discharged and were asked to come at 1st week for suture removal then at 3rd month and 6th month and 12 months post-operative period for follow up. Pre & post-operative data was collected by a separate observer to minimise bias in the study, who was blind to the procedure. Similar postauricular incision with posterosuperior extension was used in all the procedures and similar pre and postoperative protocol was followed. Duration of surgery was calculated from the incision till last suture placement.

Data thus generated was recorded and analysed statistically.

Parameters Observed

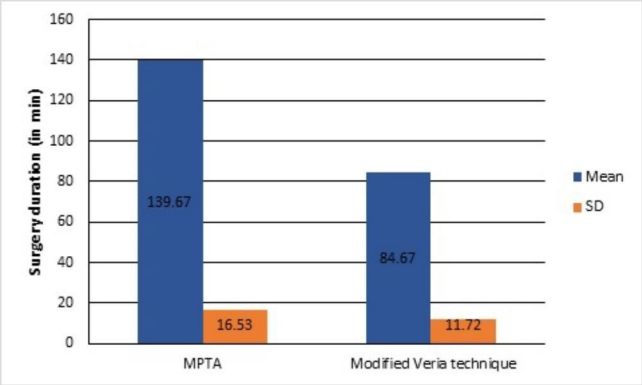
Intraoperative parameters that are observed are exposed facial nerve, chorda tympani injury, difficulty in round window exposure (type of RW), difficult insertion of electrode, problems related to recording of neural response or stapedial reflex. Early postoperative complications like, fever, vomiting, facial nerve paralysis, hematoma, vestibular signs/symptoms. Late postoperative complications like, wound

Table 1 Mean age (in years)

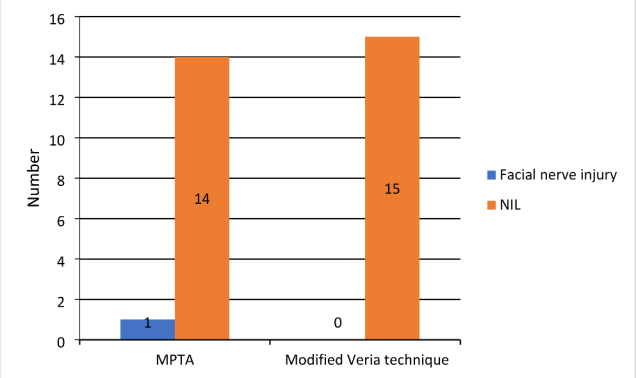
Procedure	N	Mean	SD	Median	Minimum	Maximum	P value
MPTA	15	3.53	0.92	4.00	2	5	0.365
Veria technique	15	3.87	1.06	4.00	2	6	
Total	30	3.70	0.99	4.00	2	6	

Table 2 Surgery duration (in min)

Procedure	N	Mean	SD	Median	Minimum	Maximum	P value
MPTA	15	139.67	16.53	140.00	115	170	< 0.001
Modified Veria technique	15	84.67	11.72	85.00	65	100	
Total	30	112.17	31.31	107.50	65	170	



Graph 1 Surgery duration of both the approaches

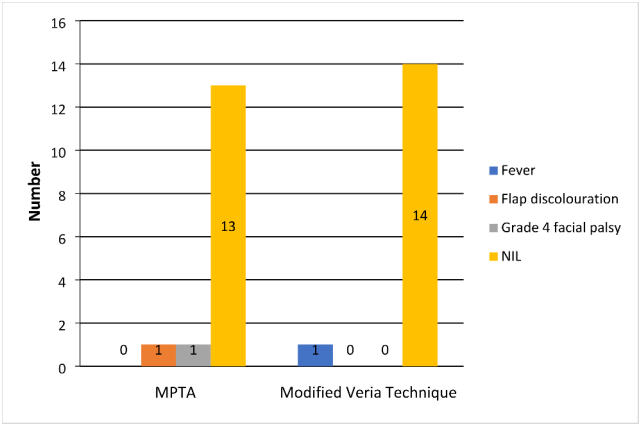


Graph 2 Intra-operative complications observed in both the techniques

infection, migration, extrusion, EAC stenosis, granulation, residual TM perforation, cholesteatoma formation.

Results

All 30 cases were randomised and were categorised into 2 groups. 15 cases in each group i.e. group A- cases who underwent cochlear implantation with mastoidectomy and posterior tympanotomy approach & group B- cases who underwent cochlear implantation with modified veria technique.



Graph 3 Post-operative complications observed in both the techniques

In our study, age ranged between 2 and 6 years with mean age of 3.53 years in group A and 3.87 years in group B. Overall mean age is 3.7 years. The age in this study was not statistically significant between the two groups ($P > 0.05$) (Table 1 and 2).

In a total of 30 cases we studied, 19 were males in which, MPTA had 66.7% males, while veria technique had 60% males.

In the study, patients under Group A had mean surgical duration of 139.67 ± 16.53 min. While patients under Group B had mean surgical duration of 84.67 ± 11.72 min, which was statistically significant ($p < 0.05$).

There was only one intra-operative complication i.e., 1 patient who underwent cochlear implantation under Group A suffered House Brackman grade 4 facial nerve injury which was recognised postoperatively and recovered over 3 months. This must have happened due to some pressure injury over exposed nerve by the shaft of the bur. While under Group B, no intra-operative complications were seen. P value was > 0.05. Intra-operative complications were not statistically significant between the two groups.

In our study, among patients who underwent cochlear implantation under Group A, 1 patient had discolouration of the skin flap and 1 patient had grade 4 facial palsy as mentioned earlier accounting for 6.7% of early post-operative

complications each. Rest 86.7% of patients had their early post-operative period uneventful.

Among patients who underwent cochlear implantation under Group B, 1 patient had fever in the early post-operative period accounting for 6.7% of the cases under Group B.

All the patients were followed at 3rd month (follow-up 1), 6th month (follow-up 2) and after 1 year (follow-up 3) post-operatively. 1 patient of Group A, who had early post-operative grade IV facial palsy improved over 3 months but another patient with skin flap discolouration developed skin flap necrosis and repeated infection and ended-up with explanation, although not related to the technique used.

CAP score and SIR score were recorded during all the 3 follow-ups between the 2 groups and compared. During follow-up 1, patients under Group A had mean CAP score of 2.33 and Group B had 2.07. During follow-up 2, patients under Group A had mean CAP score of 3.27 and Group B had 2.87. During follow-up 3, patients under Group A had mean CAP score of 4.20 and Group B had 4.07.

During follow-up 1, patients under Group A had mean SIR score of 1.87 and Group B had 2.00. During follow-up 2, patients under Group A had mean SIR score of 2.33 and Group B had 2.6. During follow-up 3, patients under Group A had mean SIR score of 3.47 and Group B had 3.47. Both the scores were found statistically non-significant between the 2 groups (p value > 0.05), but the paired differences within each group showed statistical significance (P value- <0.001).

Discussion

Cochlear implantation with mastoidectomy and posterior tympanotomy approach is the most commonly used approach worldwide but this approach is associated with some of the drawbacks in terms of complications like facial nerve/chorda tympani nerve injury and comparatively more surgical time as per our observation.

This study compares the 2 different techniques of cochlear implantation i.e., MPTA and modified veria technique in 30 children with bilateral severe to profound SNHL.

Age of cochlear implantation is one of the frequently studied factors in the field of cochlear implantation. Many data in literature suggest that children with SNHL who underwent cochlear implantation at an early age may have a better auditory performance and development of language. Kim L S et al. suggested early intervention in children with congenital SNHL for better speech and language acqisition. [9] Similarly, Fortune, C. A. de u et al. in his analysis on post-implanted children, concluded that children who had early implantation with longest use of cochlear implants and least time of sensory deprivation had highest scores on Reynell Developmental Language Scales (RDLS) – verbal expression scale. [10].

In our study, children were aged between 2 and 6 years. The mean age in group A was 3.53 ± 0.92 years and in group B, it was 3.87 ± 1.06 years. The age in our study was not statistically significant between the two groups (p value > 0.05).

Gender is also one of the currently discussed factors about its effect on the outcome of cochlear implantation. Mendes et al. (2012) and Rezende et al. (2005) analysed the influence of gender on the development of linguistic skills in the hearing children and found that gender was statistically not significant [11] [12]. Daniela Ramos et al. (2015), concluded that gender had no significant influence in the development of linguistic skills in children with congenital SNHL after cochlear implantation. [13].

Similarly, in our study, there were 33.3% females & 66.7% males in group A and 40% females & 60% males in group B. The CAP & SIR scores recorded during follow-ups till one year with respect to gender between the two groups was not statistically significant. Thus, in our study, we conclude that the gender as a factor in CI in both the techniques doesn't affect the outcome of the surgery.

Among various modifications of cochlear implantation, suprameatal approach is also one. In 1999, Kronenberg et al. developed suprameatal approach for cochlear implant surgery to reduce facial nerve injuries [14] [15]. In 2006, Kronenberg et al. described 188 patients who underwent cochlear implantation with suprameatal approach and reported no facial nerve or chorda tympani nerve injuries or other major complications but minor complication (Tympanic membrane perforation) in 2% of the patients. [16].

Similar to our study, Alaa-El-Din M El-Feky et al. (2014), compared cochlear implantation with MPTA and suprameatal approach (SMA) upon 30 patients and concluded that CI with SMA has benefits of less operating time and reducing the incidence of facial and chorda tympani nerve injury. [17].

In our study, during intra-operative period, one patient (6.7%) from group A suffered facial nerve injury while patients from group B had no intra-operative complications suggesting modified veria technique as a safe procedure but the intra-operative complications between the two groups were not statistically significant (p value = 1), may be because of the limited sample size of this study.

During post-operative period, 13.4% of the patients from group A had major complications like explantation and facial palsy. One patient from group B had minor complication like fever in the post-operative period (6.7%). Though there were no major complications seen in patients with Modified Veria Technique, the results were also not statistically significant (p value > 0.05) as compared to MPTA which can be attributed to limited sample size.

Another study did by Hans J M et al. used Veria Technique for cochlear implantation in over 1400 cases and concluded that Veria Technique is a simple, less time-consuming procedure with less chances of facial nerve palsy. [18] Our study found similar results with the study of Pawan Singhal et al. (2020) in terms of surgical duration, who proposed a modification for veria technique which included 9 patients with SNHL, aged between 1 and 6 years. In this modification, the incision was given just in the post-aural region with superiorly based musculoperiosteal flap resulting in minimal soft tissue dissection and less bone work. Thus, making cochlear implant surgery easy, consuming less operating time, minimal morbidity and faster post-operative healing along with reducing complications such as facial nerve injury and others. [8].

In our study, the mean surgical time of group A patients was 139.67 ± 16.53 min and group B was 84.67 ± 11.72 min. The results were statistically significant (p value < 0.001). Thus, Modified Veria Technique consumes less surgical time compared to classical approach.

The outcomes of the cochlear implantation and speech therapy can be measured by various parameters including CAP and SIR scores. Huiqun Zhou et al. did a study on 34 children who underwent cochlear implantation to assess the importance of speech therapy by comparing CAP and SIR scores between post-implanted patients with speech therapy and those without. Their study showed that the auditory performance and speech intelligibility of trained children were almost the same as those of untrained children with early implantation. The CAP and SIR scores of both the groups increased with increased time of implant use during the follow-up period and at each time point, the median scores of the two groups were about equal. [19].

Similarly, in our study, the CAP and SIR scores improved over the period of time as the duration of cochlear implant usage increased along with speech therapies which was showed by statistically significant paired t test within each group. (p value < 0.001)

Limitations

- It is a single center and single surgeon study with limited sample size. A larger multicentric randomized controlled trial is required to conclude with certainty.
- It is difficult to conclude that one technique is superior to other in terms of post-operative outcomes as follow up for the patients is only one year till now.

Conclusion

Veria Technique (and its later modifications) for cochlear implantation is a simple, safe and easy procedure, which is as efficacious as MPTA with added benefits of consuming lesser surgical duration.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12070-022-03399-1.

Conflict of Interest All Authors declare that they have no conflict of Interest. This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent Informed consent was obtained from all individual participants included in the study.

References

1. Copeland BJ, Pillsbury HC (2004) Cochlear implantation for the treatment of deafness. Ann Rev Med 55:157–167
2. Goller Y (2006) Cochlear implantation in children: implications for the primary care provider. J Am Acad Nurse Pract 18:397–408. https://doi.org/10.1111/j.1745-7599.2006.00157.x
3. Vincenti V, Bacciu A, Guida M et al (2014) Pediatric cochlear implantation: an update. Ital J Pediatr 40:72
4. Nadol JB (1997) Patterns of neural degeneration in the human cochlear and auditory nerve: implications for cochlear implantation. Otolaryngeal Head Neck Surg 117(3):220–228
5. Jappel A, Bumgartner WD, Kronenberg J, Grogschmidt K, Frei K, Stach M, Plen H (2004) Histological evaluation of suprameatal approach (SMA) in cochlear implant surgery. Int Congr Ser 1273:115–117
6. El-Anwar M, Waheed, ElAassar A, Foad YA (2016) Non-mastoidectomy Cochlear Implant Approaches: a Literature Review. Int Archives Otorhinolaryngol 20(2):180–184
7. Kiratzidis T, Arnold W, Iliades T (2002) Veria operation updated. I. The trans-canal wall cochlear implantation. ORL J Otorhinolaryngol Relat Spec 64(6):406–412
8. Singhal P, Nagaraj S, Verma N et al (2020) Modified Veria technique for Cochlear Implantation by Postaural Approach. Indian J Otolaryngol Head Neck Surg 72:370–374
9. Kim L-S, Jeong S-W, Lee Y-M, Kim J-S (2010) Cochlear implantation in children. Auris Nasus Larynx 37(1):6–17
10. Fortunato CAU, Bevilacqua MC, Costa MPR (2009) Análise comparativa da linguagem oral de crianças ouvintes e surdas usuárias de implante coclear. Rev CEFAC 11(4):662–672
11. Mendes JCP, Pandolfi MM, Carabetta Júnior V, Novo NF, Colombo-Souza P (2012) Fatores associados a alteração da linguagem em crianças pré-escolares. Rev soc bras fonoaudiol 17(2):177–181
12. Rezende MA, Beteli VC, Santos JLF (2005) Avaliação de habilidades de linguagem e pessoal-sociais pelo Teste de Denver II em instituições de educação infantil. Acta Paul Enferm 18:56–63

13. Ramos D, Jorge JX, Teixeira A, Ribeiro C, Paiva A (2015) Language development in children with cochlear implant: does gender have any influence? Revista CEFAC 17(2):535–541 10.1590 / 1982-021620155214
14. Kronenberg J, Migirov L, Dagan T (2001) Suprameatal approach: new surgical approach for cochlear implantation. J Laryngol Otol 115(4):283–285
15. Kronenberg J, Baumgartner W, Migirov L, Dagan T, Hildesheimer M (2004) The suprameatal approach: an alternative surgical approach to cochlear implantation. Otol Neurotol 25(1):41–44 discussion 44–45
16. Kronenberg J, Migirov L (2006) The suprameatal approach: an alternative surgical technique for cochlear implantation. Cochlear Implants Int 7(3):142–147
17. Alaa El-Din M El-feky;Mohamed Kamal Mubashir,Badr Eldin mostafa and Yaseer a fouad. Comparative study between suprameatal approach and posterior tympanotomy approach in cochlear implantation.Z.U.M.Jvol.20;N.4; july 2014
18. Hans JM, Prasad R (2015) Cochlear Implant surgery by the Veria technique: how and why? Experience from 1400 cases. Indian J Otolaryngol Head Neck Surg 67(2):107–109. doi:https://doi.org/10.1007/s12070-015-0863-2
19. Zhou H, Chen Z, Shi H, Wu Y, Yin S (2013) Categories of Auditory Performance and. Speech Intelligibility Ratings of Early-Implanted Children