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A retrospective analysis of anesthetic techniques and their related perioperative complications in children undergoing cochlear implant surgeries – our preliminary experience at a tertiary care referral centre

Raksha Kundal[1], Preeti Goyal Varshney[2], Vidhi Chandra[2], Kriti Puri[2]*, Maitree Pandey[2], Sunil Kumar[2]

[1]*All India Institute of Medical Science, Vijaypur,, Jammu and Kashmir, India*
[2]*Lady Hardinge Medical College, New Delhi, India*

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ABSTRACT

Background: Cochlear implants serve as a favorable option for treatment of hearing loss in children. However, there is limited data regarding the type of anesthetic techniques used and its associated complications in such patients. Hence, the primary objective of this study was evaluation of postoperative nausea vomiting (PONV) with three different general anesthesia techniques in pediatric cochlear implant surgeries. The secondary objectives included assessment of intraoperative and postoperative complications
Materials and Methods: A retrospective analysis of all children less than 13 years, who underwent cochlear implant surgery at our hospital between December 2019 to February 2022 was performed. Appropriate data were noted. Nine patients each were classified into three groups (Group A, B and C) on the basis of anesthetic techniques used in our institution. Group A received inhalational agent for induction and maintenance, with no Non-Depolarizing Muscle Relaxant (NDMR), Group B patients received Total Intravenous Anesthesia with NDMR and Group C received intravenous induction and inhalational agent for maintenance with NDMR.
Results: Twenty-seven patients were included. There were no major intraoperative complications. PONV was noticed in two patients of Group A and one patient of Group C. One patient belonging to Group A developed laryngospasm and desaturation. Delayed Awakening was seen in one patient each of Group A, B and C. Overall, four complications were noted in patients of Group A, one in Group B and two in Group C. All complications were mild and were managed successfully.
Conclusion: This preliminary study suggests that peri-operative anesthetic complications with all three anesthestic techniques were comparable and safe.

1. Introduction

Cochlear implant in children has become exceedingly popular in recent years due to advancement in technology and improved outcomes.[1] Cochlear implant surgeries pose apparent challenges to the anesthetist, and various anesthetic techniques have been described in literature.[2,3] However, evidence demonstrating the association between these anesthetic techniques and the incidence of perioperative anesthetic complications, is scarce.[4] Thus, we sought to study and compare three different anesthetic techniques and their associated perioperative anesthetic complications in pediatric cochlear implant patients. The primary objective was evaluation of postoperative nausea vomiting (PONV) with three different general anesthesia (GA)

* *Corresponding author*.
E-mail address: drkriti1207@gmail.com (K. Puri).

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techniques in pediatric cochlear implant surgeries. The secondary objectives include evaluation of intraoperative and postoperative complications (i.e., occurrence of hemodynamic instability, laryngospasm leading to desaturation, endotracheal tube dislodgement, delayed awakening (DA), hypothermia and assessment of Bispectral index (BIS) with various techniques of GA. We believe the results of this retrospective study will help in improving overall management and minimizing anesthesia related complications in pediatric patients undergoing cochlear implant surgeries.

2. Materials and Methods

A retrospective observational study was carried out from December 2019 to February 2022 after approval by the Institutional ethical committee (LHMC/IEC/2022/03/42) on 05/04/2022. The procedures followed were in accordance with the ethical standards of the institutional committee and with the Helsinki Declaration of 1975, as revised in 2000. Children less than 13 years of age belonging to the American Society of anaesthesia (ASA) physical status I and II, who underwent cochlear implant surgeries, between December 2019 to February 2022 were included in this retrospective analysis. Patients diagnosed with congenital syndromes like Usher syndrome, Pendred syndrome and Jervell and Lange – Nielson syndrome were excluded from the study. We retrieved perioperative data of these patients as our record sheets contain a column where these complications are documented in our routine practice. Thus, this retrospective study was planned after ensuring all the data could be retrieved from the patient records. Data was documented in a structured proforma for analysis. The analysis included retrieval of the following information: demographic data, indication and duration of surgery, co-morbid conditions, mode of anaesthesia induction, perioperative vitals including heart rate and blood pressure, any episode of bradycardia or tachycardia (drop or increase in heart rate >15% from baseline), Hypotension or Hypertension (decrease or increase of blood pressure >15% from baseline), temperature recordings, BIS readings and any episode of postoperative nausea and vomiting (PONV) . In addition, any untoward event related to inappropriate depth of anaesthesia such as delayed awakening (DA), endotracheal tube dislodgment or any episode of laryngospasm leading to desaturation was noted.

Evidence of anaesthetic-related complications was sought from the anaesthetic chart, recovery room notes, and in the nursing and medical ward records.

2.1. Statistical analysis

Cochlear implant surgeries were started 2 years back itself at our institution. Thus, all the cases performed in the last 2 years were taken into consideration for sample size calculation. We identified PONV through medical records of the patients. Data were entered in MS Excel and analysis was done using SPSS 21.0 version. Data were presented as mean and standard deviation for continuous variables and as percentages for categorical variables. ANOVA test was done to compare three group means and Chi square test was done to find out association between categorical variables and the three groups. P value of less than or equal to 0.05 was considered significant.

3. Results

We identified 30 pediatric cochlear implant surgeries in the period studied and obtained case notes for all of them. Out of this, two patients were excluded due to coexisting syndromes and one was excluded due to a known congenital heart disease.

3.1. Mode of anesthesia

In our institution, three senior anesthesia consultants usually conducted pediatric cochlear implant surgeries. Since each one followed a slightly different technique, the same was studied in our analysis.

Out of 27 children analyzed, nine (33%) received inhalational induction with 8% sevoflurane with 50% oxygen and 50% nitrous oxide. After achieving intravenous access, fentanyl 2ug/kg was administered and intubation was facilitated with intravenous succinylcholine 2mg/kg. In these patients, anesthesia was maintained with sevoflurane 2-2.5% in 40:60 (O_2 and Air), intravenous fentanyl 0.5ug/kg/h achieving a MAC of 1.2 without any Non-Depolarizing Muscle Relaxant for facilitating the intraoperative location of facial nerve. The patients who received anesthesia as per the aforesaid protocol were categorized as Group A (Inhalational agent for induction and maintenance with no NDMR).

Nine children (33%) were classified into Group B (TIVA with NDMR) patients. They were induced with intravenous Fentanyl 2 μg/kg, intravenous propofol 2-3 mg/kg and paralyzed with intravenous Atracurium 0.5 mg/kg. These patients were ventilated with Oxygen, air and Sevoflurane for 3 minutes, and an appropriate sized endotracheal tube was inserted. Maintenance of anesthesia was by total intravenous anesthesia (intravenous Propofol infusion + intravenous Fentanyl infusion) and intermittent doses of intravenous Atracurium. The top-up dose of atracurium was omitted approximately 30 minutes prior to localization of the facial nerve.

Nine patients (33%) were induced with intravenous Fentanyl 2μg/kg, intravenous Propofol 2-3mg/kg and paralyzed with intravenous Rocuronium 0.6mg/kg. After ventilation with oxygen and air (50:50) and sevoflurane, patient was intubated with an appropriate sized endotracheal tube. Anesthesia was maintained with sevoflurane and

intermittent top-ups of intravenous Rocuronium. The top-up dose of intravenous Rocuronium was withheld 30minutes before localization of facial nerve. These patients were allocated to Group C (intravenous induction and inhalational agent for maintenance with NDMR).

Patients belonging to all three groups received intravenous dexamethasone 0.15mg/kg for anti-emesis after induction.

Demographic parameters are demonstrated in Table 1 and are comparable. Patient recruitment is expressed in a Strobe flow diagram attached as Table 1. Among intraoperative parameters, temperature, BIS, Blood pressure and heart rate were studied and illustrated in Table 2. Among complications, PONV was noted in two patients of Group A and one patient of Group C and was statistically comparable (P = 0.325). One patient belonging to Group A developed laryngospasm and desaturation during induction (P= 0.354). DA was noticed in one patient of Group A, B and C each and did not have statistical significance (P = 1.0). No patient had dislodgement of endotracheal tube intraoperatively. Among intraoperative vitals, hypothermia occurred in one patient belonging to Group A only. This was not clinically or statistically significant (P = 0.354). Low BIS readings were observed in two patients of Group A and one patient of Group B and was statistically not significant (P = 0.325). Hypotension was reported in one patient of Group B and C each (P = 0.583). Bradycardia was seen in one patient each of Group A and B respectively whereas tachycardia occurred in one patient of Group C. These hemodynamic parameters were statistically comparable (P= 0.583 and 0.354 respectively). Overall, there were four complications (2 cases of post-operative nausea vomiting, 1 case of delayed awakening and one case of laryngospasm occurring during induction) observed in patients of Group A, one complication in a patient of Group B and two complications in patients of Group C. These were statistically not significant (P = 0.259) and are summarized in Table 3.

4. Discussion

Our review of 27 patients suggests that all techniques of GA administration used in our study were safe and well tolerated. No serious complication or mortality was reported. PONV was noticed in two patients of Group A and one patient of Group C. One patient belonging to Group A developed laryngospasm and desaturation. DA was seen in one patient each of Group A, B and C. Overall, four complications were noted in patients of Group A, one in Group B and two in Group C.

Recently, an increase in cochlear implant surgeries in children is being witnessed. The technique of anaesthesia plays a key role in the success of cochlear implant surgery as the anaesthesiologist has to create conducive settings facilitating use of facial nerve stimulation intraoperatively and treat troublesome complications such as PONV, DA etc post-operatively.[5,6] However, evidence regarding various techniques of administration of GA and its impact on incidence of anesthesia related complications is scarce. To our knowledge, this is the only study corelating and comparing the techniques of GA administration with occurrence of perioperative anesthesia-related complications in pediatric cochlear implant surgeries.

In our study, we found PONV in two patients of Group A and one patient of Group C.

The incidence of PONV does not seem to corroborate the findings of Yeh et al who retrospectively studied 123 pediatric patients undergoing cochlear implant surgeries.[4] They reported that out of 123 patients only one patient developed PONV and was exposed to inhalational induction. This was in contrast to our results of 3 cases of PONV among 27 patients (two patients in Group A and one patient of Group C). Nevertheless, both the studies highlight the propensity of PONV in patients undergoing inhalational induction. It is well recognized that inhalational agents are emetogenic agents and probably the same reflected in our study also.[7] Furthermore, Yeh et al. reported no case of PONV in 18 of their patients who had undergone intravenous induction. This fairly concurs with our results of only one patient having PONV in 18 of our patients belonging to group B and C who had undergone intravenous induction. It is noteworthy to observe that none of the patients of Group B developed PONV. This can be possibly explained by the antiemetic action of intravenous Propofol infusion administered as a component of Total intravenous Anesthesia (TIVA).[8] The severity of PONV in all 3 patients was mild to moderate and symptoms subsided after supportive treatment.

We found an overall risk of 3.7% of laryngospasm in our study. One patient belonging to Group A developed laryngospasm leading to desaturation to 88% during induction and responded to corrective measures instantaneously. This is in agreement with the observations of Yeh et al who had a similar risk of 2.4% in their study. Moreover, similar to our findings, the patients who developed laryngospasm had all undergone inhalational induction. Our results were also fairly consistent with those of Hawkworth et al and Darlong et al who demonstrated a 1.1% and 4.7% risk of laryngospasm respectively in their analysis.[9,10] However, the details of anesthesia induction and maintenance of these patients particularly were not discussed. Thus, analogy regarding risk factors and techniques with their research cannot be established.

We report approximately 11% of our patients had DA i.e three patients out of 27 patients. It was rather surprising to find that in most of the previous research done in pediatric cochlear implant surgeries, DA has not been studied. We would like to emphasize here that pediatric age group

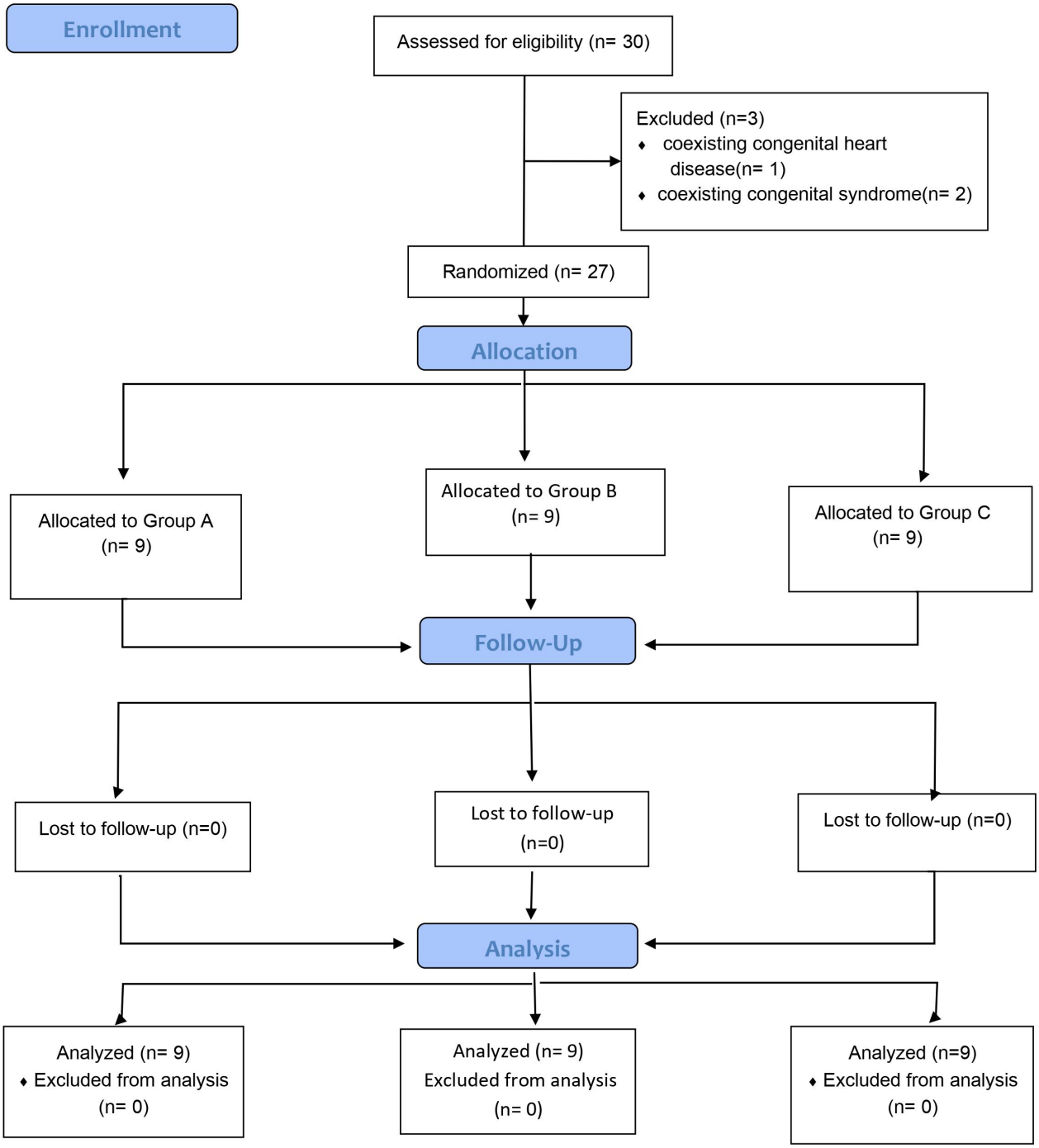

Figure 1: Represents the strobe flow diagram

Table 1: Demographic parameters

Variables	Group A	Group B	Group C	p value *
Age (in years) Mean ± SD	8.4 ± 2.7	5.6 ± 1.5	7.8 ± 3.4	0.07
Weight (in kg)	19.6 ± 4.2	14.9 ± 2.2	17.3 ± 5	0.064
Sex (M/F)	4/5	4/5	4/5	1.0
Duration of surgery (in hours)	211±6.7	215 ± 4.9	213± 5.27	0.344

*-ANOVA test, SD- standard deviation

Table 2: Intraoperative parameters

Parameters		Group A	Group B	Group C	p value *
Temperature	Hypo-mild	1	0	0	0.354
Bispectral index (BIS)	30-45	2	1	0	0.325
BP	Hypotension	0	1	1	0.583
HR	Bradycardia	1	1	0	0.583
	Tachycardia	0	0	1	0.354

*Chi square test

Table 3: Complications

Parameters	Group A	Group B	Group C	p value*
Laryngospasm and desaturation	1	0	0	0.354
Tube dislodgement	0	0	0	NA
Delayed awakening	1	1	1	1.000
PONV	2	0	1	0.325
Overall Complication	4	1	2	0.259

*Chisquare test, PONV- Post operative nausea and vomiting

and long duration of surgery have been implicated as independent risk factors for development of DA.[11] Thus, making it pragmatic to study the same. Interestingly, we found that DA was observed in one patient each of Group A, B and C. The patient who belonged to Group A had a surgery which was of unusually long duration due to surgical technical difficulties and lasted 400minutes. The same patient also predictably developed hypothermia and reported low BIS scores. Thus, in this patient all these findings were probably attributed to the long duration of the surgery rather than the technique of GA. The patient who developed DA in Group B was also found to have low BIS scores (30-40) and an episode of mild hypotension and bradycardia. The authors feel that these findings were ascribed to the delivery of intravenous Propofol infusion via conventional syringe pumps which led to a probable higher plasma concentration in this particular patient. The use of highly accurate Target Controlled Infusion (TCI) pumps are demonstrating promising results and could in fact curtail such complications.[12]

Few surgeons check the integrity of cochlear implant intraoperatively by doing electrically evoked stapedius reflex threshold (ESRT), which defines the loudest sound tolerated without pain. ESRT can be affected by the level of hypnosis and the use of volatile anesthetic agents leading to wrong estimate of the maximum comfort level for sound.[13] Propofol has minimum effect on ESRT and can be used safely while avoiding inhalational anesthetic agents.[14] Sevoflurane was freely used at our institution for cochlear implant surgery as intraoperative ESRT is not done routinely. However, due to the described interference in ESRT by volatile anesthetic agents and with fewer complications in group B, TIVA may be considered as a better alternative for maintenance in such surgeries as compared to other anaesthesia techniques.[15]

Nevertheless, our study was subject to some limitations. First, the sample size was small due to the nature of the surgery, which itself is limited and costly. Future comparative studies incorporating larger number of patients could help consolidate our findings. Secondly, due to limited resources, age-appropriate TCI pumps were not available for our study. Thus, manual intravenous propofol infusion was administered and titrated as per patient response, through conventional syringe pumps. This could have potentially led to inaccurate (lower or higher) peak plasma concentration of drug and hence influenced the results.[6] Further studies could use TCI pumps for better and precise results.

5. Conclusion

Our preliminary report suggests that overall peri-operative anesthetic complications (including PONV) in children undergoing cochlear implant surgeries with all three techniques of anesthesia used at our institution were comparable and safe. No major complications occurred with any technique and the minor complications were treated with standard treatment. Further, the need for careful monitoring and vigilance and establishing effective communication with the patient and caregivers in such surgeries is indispensable. Future studies with large sample size are required to establish the superiority of one anesthetic technique over the other.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Author biography

Raksha Kundal, Associate Professor https://orcid.org/0000-0002-5729-3348

Preeti Goyal Varshney, Associate Professor https://orcid.org/0000-0002-7118-0403

Vidhi Chandra, Associate Professor https://orcid.org/0000-0002-0928-9571

Kriti Puri, Assistant Professor https://orcid.org/0000-0002-0917-9655

Maitree Pandey, Director, Professor and HOD

Sunil Kumar, Director Professor

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