CLINICAL REPORT

Perioperative complications of cochlear implant surgery in children

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Abstract Cochlear implant is a commonly performed surgery for hearing loss in pre-school and school children. However, data on anesthesia management and anesthesia-related complications are sparse. We retrospectively reviewed the data of our institute from January, 2007 to December, 2012. Medical records and anesthesia charts of all the patients who had undergone cochlear implant under general anesthesia between this period were reviewed. Information related to the demographic profile, preoperative evaluation, anesthetic techniques, and perioperative complications were collected and analyzed. A total of 190 patients underwent cochlear implant surgery for pre-lingual (175) and post-lingual (15) deafness. General endotracheal anesthesia with inhalational agents was used in all the cases. Difficult intubation was encountered in three patients. Anesthesia-related complications were laryngospasm at extubation (4.73 %), emergence agitation (2.63 %), and postoperative nausea and vomiting (1.05 %). Major surgical complications were CSF leak without meningitis (3.15 %), device migration/failure (1.05 %), and flap infection (1.57 %). Cochlear implant under general anesthesia in small children is safe and anesthesia-related complications were minimal. Surgical complications, although more frequent, were predominantly minor and self-limiting.

Keywords Anesthesia · Cochlear implant · Complications

Introduction

A cochlear implant (CI) is an electronic device that transforms speech and other sound into electrical energy, which stimulates the surviving auditory nerve fibers. The internal processor component is surgically implanted in the mastoid antrum. Most of the patients are young children with hearing loss and impaired communication ability and pose significant challenges in the perioperative period [1].

Recently, more CIs are being performed in small children including infants [2], as children having CI performed before 2 years of age have improved language and speech outcome, intelligence, and a better quality of life [3, 4]. Moreover, CI at early childhood was not associated with increased surgical risk and complications [5]. However, data on anesthesia management techniques, risks, and complications in children for CI is limited [2]. In the present study, we tried to identify the anesthesia technique and associated risk of various complications in children undergoing CI. We hypothesized that anesthesia-related complications in this special group of children coming for CI will be minimal and acceptable.

Patients and methods

After institutional ethics committee approval, this study was conducted in the Department of Anesthesia and

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Study design: retrospective anesthesia chart review

Inclusion criteria: All the patients of ASA I−II physical status aged <18 years who underwent cochlear implant surgery from January, 2007−December, 2012.

Data collection

The following perioperative details were obtained from the hospital-maintained database:

1. Demographic parameters (age, sex, weight)
2. Etiology, any associated syndromes
3. Any co-morbidity, any recent illness
4. Difficult airway (Cormack–Lehane grading)
5. Premedication received (yes/no), if yes, which medication
6. Anesthesia induction and maintenance technique, analgesic used
7. Duration of surgery, blood loss
8. Any intra-operative complication and
9. Any postoperative surgical and anesthesia-related complications.

The following patients were excluded from analysis:

1. ASA status III or more
2. Insufficient availability of data

Data analysis

Statistical analysis was performed using SPSS 17 software. Descriptive quantitative data were presented as mean ± SD, range of values, and quantal data were presented as percentage.

Results

A total 190 CIs were performed in patients <18 years of age. Idiopathic cause was the most common etiology found. Mean age at implantation was 3.44 years and the majority was female children. Etiology, co-morbidities, and patient demographics are shown in Table 1.

Anesthesia protocol

Anesthesia-related and surgical data is shown in Table 2. Each patient was examined in a pre-anesthesia clinic at least 1 week before the scheduled surgery and again evaluated on the day before surgery. All children fasted for 8 h for solids

Table 1 Etio-pathology, co-morbidities, and patient demographics

Etiology and pathogenesis	Number of patients n (%)
Idiopathic	90 (47.4)
Familial	5 (2.6)
h/o Birth asphyxia (cerebral palsy)	21 (11.1)
Low birth weight	4 (2.1)
h/o Prematurity	13 (6.8)
Oligohydramnios	1 (0.5)
Kernicterus	8 (4.2)
h/o Meningitis	11 (5.8)
Infective (otitis media)	6 (3.2)
Ototoxicity	12 (6.3)
Inner-ear defect	3 (1.6)
Maternal TORCH infection	8 (4.2)
Syndromes	8 (4.2)
Waardenburg	4
Usher's	2
Biotin deficiency	2
Patient demographics	
Age	3.44 ± 2.08 years
Infants (0−1 year)	8
Children (1−8 years)	162
Adolescents (>8 years)	20
Weight	16.32 ± 8.06 kg
Sex (M/F)	60/130
ASA status I/II	160/30
Cormack–Lehane grade I/II/III	86/101/3
Pre lingual/post lingual deafness	15/175
h/o Upper respiratory tract infection/ bronchial asthma	18
within last 2 weeks	0
>2 weeks but <4 weeks	18

and for 2 h for clear fluid. All the patients received premedication on the morning of surgery. Promethazine was most commonly used. One of the parents was allowed inside the theatre during shifting the child. In the operating room, routine monitors were placed. Inhalation induction with sevoflurane in oxygen was more commonly used than intravenous (IV) induction with propofol 2−3 mg/kg. Atracurium or vecuronium was used for muscle relaxation and the trachea was intubated in all the patients. On direct laryngoscopy, three patients had Cormack–Lehane grade 3 view. However, all three could be intubated with the help of a gum elastic bougie. Combination of fentanyl and morphine along with intravenous paracetamol was most commonly used analgesic technique. Regional analgesia was not used in any patient. After implantation, electrical impedance and neural response telemetry were performed before extubation. Following extubation, patients were observed in the post-anesthesia care unit (PACU) for 2 h

Table 2 Anesthetic data

Anesthetic and surgical data	Number n (%)
Premedication	190 (100 %)
(a) Promethazine	100 (52.6)
(b) Midazolam	10 (5.26)
(c) Diazepam	80 (42.10)
Induction	
(a) Inhalational	130 (68.4)
(b) Intravenous	60 (31.6)
Maintenance	
(a) Inhalational (nitrous oxide/air)	190 (120/70) [63.1/36.9]
(b) Intravenous	Nil
Analgesia	
(a) Fentanyl + paracetamol	85 (44.74)
(b) Morphine + paracetamol	15 (7.89)
(c) Fentanyl + Morphine + Paracetamol	90 (47.37)
Antiemetics	
(a) Ondansetron	190 (100.0)
(b) Dexamethasone + ondansetron	100 (52.63)
Duration of surgery	3.08 ± 0.7 h
Duration of anesthesia	4.08 ± 1.02 h
Blood loss	26.84 ± 12.26 ml
Fluids administered	380.50 ± 160.40 ml

Table 3 Complications

Complications	n (%)
Anesthesia related	16 (8.42)
(a) Laryngospasm	9 (4.73)
(b) Emergence agitation	5 (2.63)
(c) Postoperative nausea and vomiting	2 (1.05)
Surgical	47 (24.73)
(a) Magnet-related minor skin erythema	30 (15.78)
(b) Flap necrosis and infection mandating re-intervention or re-exploration	3 (1.57)
(c) CSF leak	6 (3.15)
(d) Facial nerve palsy (transient/persistent)	5/1 (2.63/0.52)
(e) Device migration/failure	2 (1.05)
(f) Meningitis	0

before being shifted to a special clinical isolation area. In the PACU, one of the parents or the main caregiver of the child was allowed to stay with the patient.

Postoperative anesthesia-related complications were observed in 16 patients (8.42 %). Nine patients had laryngospasm during extubation. Among them, six patients had h/o upper respiratory tract infection (URI) between the last 2 and 4 weeks and the remaining three children did not have any h/o URI. Emergence agitation and postoperative nausea-vomiting (PONV) were other noted adverse effects (Table 3). Postoperative pain was assessed by trained nurses by visual analogue scale (VAS) in children >6 years and by objective pain scale (OPS) in children <6 years and those who were not able to communicate. Intravenous paracetamol 6 h was provided for postoperative analgesia for 48 h and intravenous opioids were provided when VAS or OPS score was >3. However, none of the children required any supplemental opioids in the ward after discharge from PACU. Patients were discharged on postoperative day 5−7. Initial device stimulation with the external component was performed 4 weeks postoperatively.

Discussion

In the present series, 190 children underwent CI over a period of 6 years. The major cause of sensory-neural hearing loss was idiopathic. Eight patients (4.2 %) had associated syndromes with Waardenburg's syndrome being the commonest. Most of the associated syndromes with deafness have difficult airway (Treacher Collins syndrome, Klippel–Feil syndrome), metabolic and endocrine abnormalities (Pendred and Alport syndrome) and cardiovascular problems (Jarvell and Large-Nielsen syndrome) [1, 6–10]. However, none of the syndromes in our series had any significant systemic abnormality.

Communication with these children is difficult because of deaf-mutism and possible poor cognition due to cerebral palsy in some children. Therefore it is important to develop a good rapport with these children and good counseling of the parents to have a smooth perioperative management. These children should be preoperatively familiarized with in-OT procedures like blowing a balloon, opening eyes with tapping shoulder, etc., to have easy anesthesia induction and recovery [1]. All children in the present series received premedication.

Inhalational induction was more preferred over the intravenous route as some of the children did not have intravenous access preoperatively. Although parental separation was smooth with premedication, one of the parents was allowed inside the theatre. Total intravenous anesthesia (TIVA) was not used in any of the cases. The role of TIVA becomes essential if facial nerve monitoring is done to avoid muscle relaxant [11]. However, in this series, facial nerve monitoring was not done.

Fentanyl at induction followed by morphine along with intravenous paracetamol was the commonest analgesic technique used. The role of paracetamol in decreasing opioid requirement is well established [12] and it was used in all the cases. Regional anesthesia with great auricular nerve block has limited potential in children with tympano-mastoid surgery and was not used in any of the cases [13]. Adequate postoperative analgesia is of utmost significance

in these non-communicating children. For optimum pain management, parent- or nurse-controlled analgesia may be used [14, 15]. Moreover, the presence of parents ensures a calm and comfortable child in PACU. At the end of surgery, brainstem auditory-evoked response testing or stapedius reflex response of the electrode array was evaluated to check the integrity and proper functioning of the implant. Anesthetic depth and end-tidal CO_2 were kept constant at that time as these are known to affect the measurement of electrically evoked auditory responses [16, 17].

Anesthesia-related complications were found in 8.4 % patients. The most common complications were laryngospasm (4.7 %) and emergence agitation (2.6 %) followed by postoperative nausea-vomiting (PONV 1.05 %). In a similar series, Yeh et al. reported 6.5 % anesthesia-related complication [2]. All were respiratory complications (postoperative wheeze, bronchospasm, laryngospasm). The presence of mild URI may sometimes go unnoticed and increases the risk of respiratory complications. In our series, 18 children had URI within the last 4 weeks before surgery and six of them had laryngospasm at extubation (33 %). On the contrary, only three of the remaining 172 patients had laryngospasm (1.74 %). Extubation in these patients is challenging due to poor communication ability with the child, possibility of difficult airway, and the risk of dislodgement of the electrode array by excessive coughing and bucking at extubation [1]. The suggested approach at extubation is to ensure adequate reversal of neuromuscular blockade and then extubating the trachea at a deeper plane of anesthesia and keeping the child in lateral decubitus position [1]. Prevention of PONV is one of the most important goals of anesthesia management. Different approaches like adequate anxiolysis by premedication, TIVA, avoidance of nitrous oxide, and administration of ondansetron with or without dexamethasone have been suggested to prevent PONV. In the present series, PONV was found in only two patients. We used premedication and ondansetron in all the patients. Nitrous oxide was, however, used in 63 % patients. As it is still not clear if single-dose dexamethasone increases the risk of postoperative infection [18], it was not routinely used (52 % of patients).

Minor surgical complications including mild erythema at magnet site were fairly common and did not require any intervention. Major complications were rare and included flap necrosis requiring re-exploration, device migration/failure, and persistent facial nerve palsy. There were six cases of CSF leak; however, none required redo surgery or developed meningitis. Though perilymph leakage is more frequent with pre-operatively detectable cochlea vestibular abnormalities, it can occur in apparently normal anatomy as well.

To conclude, cochlear implant surgery in children under general anesthesia is safe and incidence of anesthesia-related complications is minimal. However, the role of careful planning and vigilance in the perioperative period need not be overemphasized. Surgical complications, although more frequent, were mainly minor and self-limiting.

Conflict of interest   None.

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