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Original article

CSF Gusher in Cochlear Implant Surgery–does it affect surgical outcomes?

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ABSTRACT

Objectives: The purpose of this prospective study was to measure surgical outcomes in cases of cerebrospinal fluid gusher in cochlear implant surgery.
Materials and methods: Demographic, radiological, neurophysiological and surgical results were evaluated in nine cases of patients with cerebrospinal fluid gusher during cochlear implant surgery, out of 164 unilateral cochlear implant procedures. Review of literature and our management technique is discussed.
Results: Nine cases had cerebrospinal fluid leak during surgery. Out of three cases of incomplete partition type II, two had cerebrospinal fluid gusher while one had milder ooze. Two cases with large vestibular aqueduct syndrome had intraoperative cerebrospinal fluid gusher. Four cases of gusher had no predictable risk factors on clinical history, examination or preoperative radiology. All cases were managed with meticulous packing of round window site without any other additional measures such as lumbar drain or use of tissue glue. These cases showed no symptoms or signs of cerebrospinal fluid leak in the follow-up period.
Conclusion: We recommend careful meticulous packing of the round window around the electrode using periosteum until cerebrospinal fluid leak is controlled in all cases of cerebrospinal fluid gushers. We also recommend a very conservative approach to managing these patients in the immediate postoperative period.

1. Introduction

Cochlear Implant surgery is regarded as a very safe surgical intervention with less than 1.6% complication rates [1]. Major complications reported are CSF leakage, skin necrosis, postoperative meningitis, facial nerve damage, hemorrhage and device failure needing explanation [2,3]. These complications are reported to be more frequent in cases with congenital anomalies like common cavity, incomplete partition deformity and large vestibular aqueduct syndrome [4]. Management of CSF leak in particular has a wide range of suggestions in literature ranging from conservative management to revision surgery.

We have reported our series of cochlear implant surgery in cases with congenital anomalies of the cochlea and our management of CSF leak in particular.

2. Materials and methods

Between December 2013 and July 2015, 146 cases of unilateral cochlear implantation were operated in children in the age group of 1 to 12 years in a tertiary care hospital at, Delhi, India. Nine cases had intraoperative CSF leak during surgery. All these 9 cases were prospectively followed up for an average of 7 months (6 months–13 months).

All the cases with intraoperative CSF leak were evaluated for:

- incidence of postoperative extrusion of electrodes based on intraoperative (surgical observation, impedance measurement, and neural response telemetry) and postoperative (impedance measurement, maps, and NRT) findings;
- incidence of postoperative complications like CSF otorhinorrhoea and symptoms and signs of meningitis;
- outcome measurement by Category of Auditory Performance-II scores [5]. It measures a vast range of auditory performance abilities in children of all ages in everyday situations, also taking into consideration their different developmental rates (Table 1).

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Table 1
Categories of auditory performance-II (CAP-II).

Category	Criteria
9	Use of phone with unknown speaker in unpredictable context
8	Follows group conversation in a reverberant room or where there is some interfering noise, such as a classroom or restaurant
7	Use of telephone with known listener
6	Understanding of conversation without lip-reading
5	Understanding of common phrases without lip-reading
4	Discrimination of some speech sounds without lip-reading
3	Identification of environmental sounds
2	Response to speech sounds (e.g. "go")
1	Awareness of environmental sounds
0	No awareness of environmental sounds

All the surgeries were performed with a small postauricular incision (less than 6 cm), cortical mastoidectomy and posterior tympanotomy via facial recess. Cochleostomy was carried out using round window or extended round window approach. One to three pieces of periosteum harvested locally were used to seal the CSF leak by packing them around the electrode in the round window until leakage completely stopped. X-ray mastoid (modified Stenver's view) was done to verify position of the electrode array in the postoperative period. Intravenous antibiotics were started prior to skin incision and continued for 24 hours. Water tight wound closure in 3 layers with mastoid pressure bandage was applied for 24 hours and removed before discharge, next day after surgery.

Cochlear implants with straight electrodes were used. Implanted cochlear devices included Nucleus CI 24RE (ST) ($n = 6$) by Cochlear, ABHiRes 90k HF 1J ($n = 2$) by Advance Bionics and Digisonic SP ($n = 1$) by Neurelec.

3. Results

Out of 146 cochlear implantations, 17 cases had congenital anomalies of inner ear and rest 129 were without any radiological detection of abnormalities. Five out of these 17 congenital malformation cases had intraoperative CSF leak during surgery (29%). Four cases out of 129 cases without radiological abnormalities also had CSF leak during surgery (3%).

Three cases were incomplete partition type II (IP-II). Two cases had large vestibular aqueduct syndrome (LVAS). Four children had normal inner ear anatomy on HRCT and MRI of Inner ear. Eight cases of congenital inner ear malformation did not have any CSF leak during surgery (Table 2).

One case of incomplete partition type II had oozing of CSF, which stopped spontaneously in 5 to 10 minutes whereas remaining eight cases had profuse leak of CSF gusher, which required 15–20 minutes of waiting and stopped completely only after packing of the round window site.

Table 2
Distribution of CSF Gusher and Oozing during Cochlear Implantation in cases with Normal Anatomy (129) and Inner ear malformations (17).

	Gusher	Oozing	No CSF leak	Total
Common Cavity				
IP-I				
IP-II	2	1	3	6
IP-III				
LVAS	2		1	3
Dysplastic SCC			7	7
Narrow IAC				
Dysplastic Stapes			1	1
Normal Anatomy	4		125	129

IP-I: incomplete partition type I; IP-II: incomplete partition type II; IP-III: incomplete partition type III; SCC: semicircular canals; IAC: internal auditory canal; CSF: cerebrospinal fluid.

All the 9 cases of CSF leak had complete insertion of active electrodes as documented by the surgeon (Table 3). Patient 3 with LVAS demonstrated neural response telemetry in all active electrodes except basal three at the time of surgery. Postoperative measurement done three weeks later at the time of switch on had responses in all the electrodes including basal three. Patient 9 with normal anatomy also demonstrated impedance and neural response telemetry measurements in all except the basal electrode, but subsequently at switch on, demonstrated normal responses in all electrodes including the basal one.

A tight tissue (Periosteum) seal was effective in plugging the CSF leak intraoperatively as noted at the time of surgery. No additional measures like changing the patient position, hyperosmolar agents, lumbar puncture etc were required at the time of surgery or later.

No migration/extrusion of electrodes was seen in any of the cases in the follow-up period varying from 6 months to 13 months (mean 7 months) measured by impedance and neural response in the active electrodes especially the basal electrode.

None of the children with CSF gusher or ooze suffered from any dizziness, excessive vomiting or CSF leak in the postoperative period. All children were discharge routinely, next day after surgery. There were no cases of CSF otorhinorrhoea or meningitis in the follow-up period. All cases demonstrated satisfactory progress in development of receptive/expressive language, as indicated by their CAP-II scores.

4. Discussion

The term 'gusher' is generally used in literature to describe the egress of profuse clear fluid upon making an opening into the inner ear [4,6]. A gentle flow of clear fluid is called 'oozing' and a profuse flow is termed 'gusher' [7].

Oozing is an intermittent flow of CSF in small quantities, which usually stops after a few minutes. It is possibly due to a small defect

Table 3
Patient demographics.

Patient	Age at implantation	Congenital anomaly	Device	Total no. of active electrodes in device	Surgical insertion documented in notes	Impedance/ Telemetry in last basal electrode-intraoperative	Status of basal electrode at the time of last follow-up visit	Average duration of follow-up in months	CAP-II score at follow-up
Patient 1	5 yr 6 mo	IP-II	AB	16	Full	Present	Active	8	4
Patient 2	5 yr 8 mo	LVAS	Cochlear	22	Full	Present	Active	6	4
Patient 3	4 yr 8 mo	LVAS	Cochlear	22	Full	Absent	Active	6	4
Patient 4	5 yr 7 mo	None	AB	16	Full	Present	Active	13	4
Patient 5	7 yr	IP-II	Cochlear	22	Full	Present	Active	7	3
Patient 6	4 yr 1 mo	IP-II	Neurelec	20	Full	Present	Active	7	3
Patient 7	2 yr	None	Cochlear	22	Full	Present	Active	6	3
Patient 8	6 yr	None	Cochlear	22	Full	Present	Active	7	4
Patient 9	10 yr 1 mo	None	Cochlear	22	Full	Absent	Active	6	7

IP-II: incomplete partition type II; LVAS: Large Vestibular Aqueduct Syndrome; AB: Advanced Bionics HiRes90k HF1J implant; CAP: categories of auditory performance.