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Modifying radiology protocols for cochlear implant surgery in a government sponsored scheme: Need of the hour

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ABSTRACT

Cochlear implant radiology is an indispensable part of cochlear implant work up. Candidacy can be finalized only after complete radiology of the temporal bone and brain has been performed. In government sponsored program radiology is important not only in deciding candidacy but has immense role in pre-operative workup, surgical planning, implant selection and preparation for any surgical complication.

1. *To device a definite pre surgical and post-surgical radiology protocols for cochlear implant patients*
2. *To determine the role of radiology in candidacy, pre implant counselling, surgical planning, implant selection, and overall prognosis of cochlear implantation.*

10 patients of cochlear abnormality have been discussed where both HRCT and MRI played crucial role in successful cochlear implant surgery. All these children were worked up and planned after studying various aspects of cochlear radiology. Successful implantation with satisfactory results could be achieved with the help of radiology. We also modified our protocol for timing of implant. Repeat radiology is done if old radiology is more than 3 month old on the day of surgery. To cut costs no plates are issued and radiology is read on the K PACS system in the software format. Radiology is essential to decide CI candidacy. Radiology should be repeated if the previous radiology is more than three months old at the time of surgery. We can cut the cost by reading the radiology on the console and not printing out the plates.

Key words: Cochlear implant, radiology protocol, cochlear anomaly,

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INTRODUCTION

Cochlear Implant program has been a boon to all the hearing impaired people who cannot be rehabilitated by hearing aids alone. Government sponsored schemes have helped many patients who could not afford this surgery on their own. To ensure that these programs benefit majority of population in an optimal manner, proper planning and execution of this program is required. After audiological evaluation, radiological investigation is the single most investigation which decides the course of a cochlear implant.

Radiology is an indispensable tool to decide candidacy for cochlear implants. It not only helps in deciding candidacy but also in pre-operative surgical planning, for deciding the side of implantation, for predicting surgical ease and access and finally for evaluating post-operative implant status.

There are many centers in our country which are running government sponsored cochlear implant programs. Cost constraints are so high in these parts that many patients cannot afford even the basic radiological evaluation. These patients await financial help from various sources for this purpose. This has led to skewed system of cochlear

implant work up at many centers. Patients are being issued financial estimates of cochlear implants based on just audiological evaluations. Radiology is being done at a later date. This system often results in unforeseen scenarios wherein money for implant has been issued and radiology done at a later date reveals cochlear anomaly or its variants. These cases then would not be perfect cases for cochlear implants. This is lands both patients and doctors in unwarranted situation. Radiology protocols need to be devised for countries where cost is a factor for availing even basic medical facilities.

Aim

1. To device a definite pre surgical and post-surgical radiology protocols for cochlear implant patients
2. To determine the role of radiology in candidacy, pre implant counselling of parents, surgical planning, implant selection, post-operative complication prediction and overall prognosis of cochlear implantation.

MATERIALS AND METHODS

55 prospective cochlear implant recipients were evaluated from May 2013 to February 2016. Evaluation included detailed history taking, physical examination, audiological evaluation and radiological assessment. After a definitive audiological diagnosis of bilateral severe to profound sensorineural hearing loss patients were advised to undergo both CT scan and MRI. The protocols of radiology were as follows

a) HRCT temporal bones: 64 slice volume scanner in a straight axial plane: KV: 140, mA: 350, matrix 512 x 512. Slice thickness 0.625 mm/ 10.63, 0.531:1. Scan field of view (FOV) : 32 cm, display FOV : 9.6cm
b) MRI with 3 D reconstruction: 1.5 T MR with 8 channel head coil. Sedation is given in almost every patient. 3 D FIESTA axial sequences. Direct oblique sagittal for seeing the "4 dot" appearance of all the four nerves at the internal acoustic meatus.

All these patients were evaluated for normal middle ear and inner ear structures on radiology. HRCT was useful in evaluating normal bony anatomy of the middle ear and cochlea especially the round window niche. It is useful in evaluating anatomical aberrations like high jugular bulb, aberrant carotid, dehiscent facial nerve, abnormally enlarged mastoid emissary vein , thickness of temporal bone behind the mastoid, the status of cochlear and vestibular aqueduct. Pathologies of mastoid as mastoid sclerosis, middle ear disease, otosclerosis, Paget's disease, post meningitic stenosis of the round window niche and evidence of labyrinthitisossificans can be very well ascertained by a detailed HRCT of the temporal bones. Inner ear anomalies like cochlear dysplasias can also be seen on HRCT.

MRI on was useful in evaluating the soft tissue structures especially the status of fluid in the cochlearturns and the vestibular apparatus. MRI also helps in determining size of internal acoustic meatus and the cochlear aperture, the presence or absence of cochlear nerves and the pathological conditions like early stages of labyrinthitisossificans. Inner ear dysplasia and intracranial anomalies are also ascertained better with MRI.

Both CT scan and MRI are indispensable tool in deciding candidacy for cochlear implant. HRCT further finds its role in detailed surgical planning as well as implant selection. It also helps in modifying our surgical approach depending on anatomical aberrations of the temporal bones. Post-operative HRCT shows the position of cochlear electrodes.

Out of 55 of our patients, 10 patients were found to have abnormal radiology

Table 1 : Showing the list of congenital anomalies of cochlea and other radiological findings in our patients

Michel's aplasia	2
Mondini's aplasia	1
Cystic cochleo-vestibular anomaly	1
Partial ossification	2
High jugular bulb	1
Leukodystrophy	1
Hydrocephalus	1
Thin temporal bone	1

These abnormal radiology patients were counselled accordingly for candidacy and prognosis. Surgical planning was done accordingly. All these patients had a software version of radiology which was stored and read on the K- PACS DICOM reader. Surgical planning using different cuts, angulations and reformatting of images was possible on the K- PACS DICOM software.

Table 2 : Factors affected by radiology in our cochlear implant patients

Anomaly	Prognosis	Surgical Planning	Implant and electrode selection	Post-operative complication prediction
Michel's aplasia	C.I not indicated	-	-	-
Mondini's aplasia	Sub optimal results explained	• CSF Gusher (surgical difficulty) • Electrode insertion around the walls • Electrode may go to IAC due to thin bony septa • Misplaced electrode		Chance of meningitis
Cystic cochleo-vestibular anamoly	Poor prognosis	• CSF Gusher (surgical difficulty) • Electrode insertion around the walls • Electrode may go to IAC due to thin bony septa • Misplacedelectrode	Regular electrode which would lie around the wall of the cavity	Chance of meningitis
Partial ossification	Poor prognosis	• Prepare for modification of technique • Drill out may be required • Complete insertion of electrode may not happen	Compressed electrode	
High Jugular bulb	-	• Prepare beforehand • Very high jugular bulb may hide the round window niche • RW insertion may be difficult • Modification in cochleostomy site may be required	Normal electrode	May lead to profuse bleeding if unawares or not careful
Leukodystrophy	May have poor prognosis in long term if progressive lesion	• Surgical technique remains essentially same	Normal electrode	
Hydrocephalus	In compensated cases prognosis may be fine	• No modification in surgical technique per se • Should take care of shunt	Normal electrode	Chance of meningitis is there in post-operative period
Thin temporal bone	Normal prognosis	• Implant bed to be drilled carefully • Chances of CSF leak if bone is very thin	Normal electrode	Chances of meningitis is there of CSF leak persists

Radiology helped us plan our surgery in a meticulous way. All these patients did well post operatively and performed as per expectation during their auditory and speech rehabilitation program. Radiology of temporal bones both CT and MRI are important not only to counsel the patient but helps in detailed surgical planning.

Modifying timing of radiology:

Under the normal protocol work up for cochlear implant, radiology is an indispensable investigation. Both CT scan and MRI are of equal importance. Cochlear implant can be planned only after a normal radiology is ensured. In our country average time to arrange money and to get government sanction is around 6 months to one year. By the time patient is prepared for surgery, radiology becomes old. As per literature six month old radiology is acceptable if no adverse event like fever or meningitis has been reported in between. Few literature suggest a 3 month old radiology can be accepted before surgery. Since CT and MRI plates are costly for the patients repeating radiology often adds financial burden to the patient. Hence a definite protocol is required when we are planning a CI surgery in a government sponsored program.

Following traditional protocols, we planned to go ahead with cochlear implantation in a child who had bilateral cochleo-vestibular anomaly and left sided congenital facial palsy (figure 1, 2)

Figure 1:Figure showing coronal cuts of bilateral cochleo- vestibular anomaly

Figure 2:Figure showing 3 D reconstruction of bilateral cochlea vestibular anomaly

Right sided cochlear implant was planned. Radiology on the day of surgery was 5 month old. As no adverse events were noted in between we did not repeat the scans. At the time of surgery, extensive ossification was found around the cochleostomy site and further drilling was commenced. Only a small area of patent cochlear duct could be found adjacent to the oval window. A compressed cochlear electrode (MEDEL- SONATA device) was inserted and telemetry was performed. We were able to get a viable neural response telemetry. The child is performing well in rehabilitation. Post operatively a CT scan was performed which showed increased area of ossification around the round window area and the electrode was seen in the patent cochlear duct area (figure 3, 4).

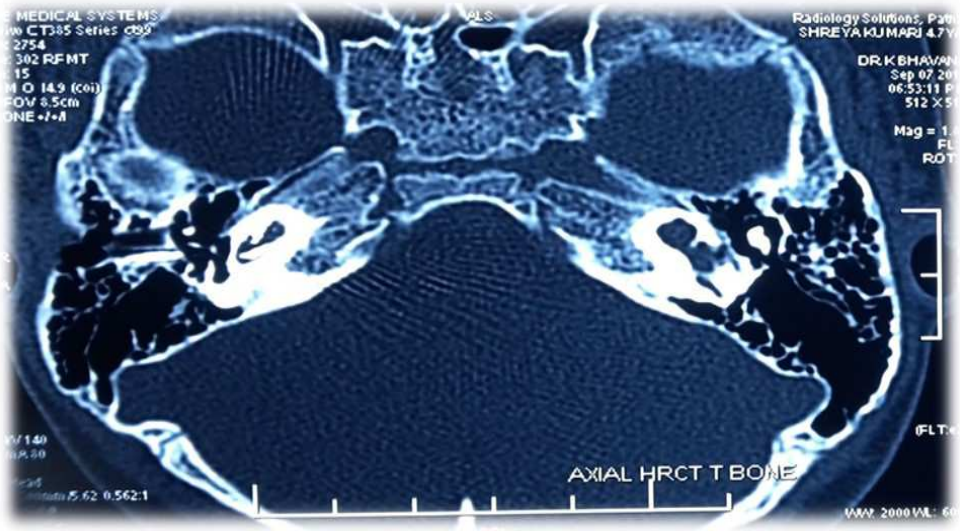

Figure 3:Figure showing post-operative axial CT scan of the same patient showing increased ossification on the operated site with cochlear electrode lying in the short patent cochlear duct area

Figure 4:Figure showing post-operative coronal CT scan of the same patient showing increased ossification on the operated site with cochlear electrode lying in the short patent cochlear duct area

Observing above scenario we decided to modify our radiology protocols. To avoid chance occurrences of these kind, it is advisable to go for a radiology especially MRI (to see any early ossificans). We now follow a protocol in which an MRI is repeated just before the surgery in case the previous scan are more than three months old. If there is documented fever or history of any infections immediate pre-operative scans are mandatory in our program.

Keeping in view the fact that cost of radiology lies mainly in the plates, hence we prefer taking a CD of the images and view it on our K- PACS DIACOM reader. This not only cuts the procedure cost but also helps us read the scan by various formatting methods in different angulations. Immediate pre-operative scans thus rules out any ongoing pathology of the ear which may have adverse effect on our overall result.

Thus now we have a CT scan and a MRI done during our work up of implant and one MRI scan (CD format) just a week before surgery. Repeat scans are performed if last done scans are more than three months old or there has been a report of any adverse event in between like fever, ear pain, facial palsy etc.

No patients are given any certificate of financial estimates without a detailed radiological evaluation. Only after radiology, final candidacy is decided and we issue them financial estimate certificates. In a country like India where government sponsors these programs, it is imperative that candidacy for cochlear implant is decided with utmost care.

Post-operative scan
All the cochlear implant patient then undergo a post-operative x ray wherein the position of electrode and the implant is ensured.

DISCUSSION

Radiological work up to evaluate the temporal bone and the brain forms the basis for cochlear implant work up. Once a patient has been diagnosed with severe to profound hearing loss and one contemplates cochlear implant, a radiology of the temporal bones and brain including the nerves help us decide which patients can be implanted. CT has been the predominant imaging modality for evaluation of the temporal bone and has previously been the primary modality for evaluation of cochlear implant candidates (1). However, with the emergence of high-resolution MR imaging of the temporal bone, the role of CT in work-up is continually being reevaluated (2). Nevertheless, useful and unique information can still be obtained with CT, particularly in pediatric implant candidates (3, 4). Recent advances in MR imaging technology have added to the importance of this modality in the evaluation of cochlear implant candidates (1)

Main aim of pre-operative scan is (5)
1. Are there congenital anomalies which preclude implantation
2. Is there evidence of labyrnthitisossificans
3. Is there any other anatomical aberrations which would complicate surgery? (6)

Radiology check list for cochlear implant can be broadly classified in to two sections .Findings that are relevant from surgical point of view and findings that are relevant from prognosis or candidacy point of view.

Table 3: List of significant radiological findings for cochlear implant surgery

Surgical point of view	Result point of view
▪ Mastoid sclerosis ▪ Middle ear and mastoid disease ▪ Thickness of temporal bone ▪ High jugular bulb ▪ Aberrant carotid ▪ Dehiscent facial ▪ Emissary veins ▪ Evidence of otosclerosis ▪ Labyrinthitisossificans	▪ Inner ear dysplasia ▪ Labyrinthitisossificans ▪ Size of IAC & cochlear aperture ▪ Presence of cochlear nerve ▪ Any intracranial pathology

Cochlear implants are absolutely contraindicated in cochlear aplasia, complete labyribthitisossificans and absent cochlear nerves. Poor results are seen on cochleo-vestibular anomaly, thin cochlear nerves, and features of hypoxic brain.

In our series of patients who had abnormal radiology, many aspects of cochlear implant surgery were studied and findings were incorporated in the management protocols. Taking help from radiology not only helped modify our management protocol but also made our surgical results better. Prognosis in all these patients has been good. Parents were satisfied as counselling had been done keeping the radiological finding in mind. As far as cochlear implant program is concerned especially in a government set up where money is being given for the implant, no financial estimates should be issued in the absence of complete radiological work up. Once a patient has been diagnosed with bilateral profound hearing loss and age is favorable for cochlear implant, only radiology can decide final candidacy for implant. Ignoring radiology can make cochlear implant surgery not only difficult but also can land the surgeon in embarrassing situations.

CONCLUSION

Radiology is an integral part of a cochlear implant program. After audiology it is one of the most important investigations needed to decide upon candidacy for cochlear implant.

1. Any financial estimates for cochlear implant surgery should be given after complete workup which includes complete radiological workup. Both HRCT scan of temporal bones and MRI ear and brain with 3 D reconstruction of cochlea along with views of auditory nerves are necessary.
2. Radiology helps not only in deciding candidacy but also in detailed surgical planning, implant selection, complication prediction and overall success of the surgery. In all our 9 cases this held true
3. Radiology should be repeated if the scans are more than three months old at the time of surgery. Repeat radiology is imperative in all cases where there has been an adverse event like fever , vomiting, meningitis etc has been reported in between the timing of old radiology and date of surgery. Preferably MRI is done as it is the modality of choice to rule out early labyrinthitisossificans.
4. In a country like India where cost is a major factor for patients, we can plan to reduce the overall cost by not taking a print of radiology plates. We can just read the plates on PACS system of a DVD. This not only cuts the cost but also allows the surgeon to read radiology in different angles and reformatted images.

REFERENCES

[1] Robert J. Witte, MD, John I. Lane, MD, Colin L. W. Driscoll, MD, Larry B. Lundy, MD, Matt A. Bernstein, PhD, Amy L. Kotsenas, MD, and Armen Kocharian, PhD. Pediatric and Adult Cochlear Implantation. EDUCATION EXHIBIT - Continuing Medical Education RSNA Radiographics. September 2003 Volume 23, Issue 5

[2] Ellul S, Shelton C, Davidson H, Harnsberger H. Preoperative cochlear implant imaging: is magnetic resonance imaging enough? Am J Otol 2000; 21:528-533. Medline

[3] Alexander A, Caldemeyer K, Rigby P. Clinical and surgical application of reformatted high-resolution CT of the temporal bone. In: Tanenbaum L, eds. CT in neuroimaging revisited. Philadelphia, Pa: Saunders, 1998; 631-650.

[4] Fishman A, Holliday R. Principles of cochlear implant imaging. In: Waltzman SB, Cohen NL, eds. Cochlear implants. New York, NY: Thieme, 2000; 79-115.

[5] A Chaturvedi, C Mohan, SB Mahajan ,VipinKakkar. Imaging Of Cochlear Implants. Ind J RadiolImag 2006 16:3:385-392.

[6] Fishman AJ, Holliday RA. Principles of Cochlear Implant Imaging. Cochlear Implants. Thieme Medical Publishers Inc: 2000.pgs 79-103.