



COCHLEAR IMPLANT SURGERY

HOW WE DO IT

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FOREWORD

by

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I am delighted that the authors have brought together this manual on Cochlear Implant Surgery. It is a very simple but practical and useful guide for surgeons embarking on their first few Cochlear Implant surgeries. While there can be no replacement for practical training in the temporal bone lab, this manual, nevertheless gives a step by step guide to the novice surgeon. The surgical steps are beautifully illustrated with clear photographs and the important anatomical landmarks are highlighted.

I am sure this will be a very helpful guide for many surgeons and I have no hesitation in recommending it to every surgeon interested in starting the long journey of Cochlear Implantation.

Prof. Mohan Kameswaran

INTRODUCTION

A Cochlear Implant (CI) is a surgically implantable device to provide hearing to profound or severely deaf individuals. Unlike hearing aids, CI bypasses the peripheral auditory system and directly stimulates the cochlear nerve.

A CI consists of a microphone to pick up the sound signals and a speech processor which converts sound signals into digital information. A transmitter sends power and processed sound signals across the skin to the internal device by radio frequency transmission. A receiver /stimulator receives the signals from the speech processor and converts them into electric impulses and sends the signal via the electrode array embedded in the cochlea.

INDICATIONS FOR COCHLEAR IMPLANTATION

- Bilateral severe to profound hearing loss and showing no significant progress with appropriately fitted hearing aids and adequate auditory training.
- If the aided response beyond 2Khz are falling outside the speech spectrum.
- Post lingual deaf children and adults along with aided speech discrimination score is less than 40% in the best year.

CONTRAINDICATIONS FOR COCHLEAR IMPLANTATION

A. Contra-indications

- Cochlear nerve aplasia
- Cochlear aplasia, Michel deformity
- Deafness of central origin

B. Relative Contra-indications

- Cochlear nerve hypoplasia
- Bilateral cochlear ossification
- Additional psycho social condition (autism spectrum disorder, ADHD, etc..)
- Neuro developmental deficit (cerebral palsy, apraxia, etc..)

PREOPERATIVE EVALUATION

1 Audiological & Speech Evaluations

- OAE - Otoacoustic emission
- BERA/ABR-Auditory brainstem response
- ASSR - Auditory Steady State Response
- Impedance Audiometry
- Pre-operative Hearing Aid Fitting and Auditory Habilitation
- Aided Audiometry with Hearing Aid

2 Speech & Language Evaluation

3 Radiological Evaluation: Request for CT and MRI for Cochlear Implantation

→ Checklist in CT

Location	Check
Mastoid	Pneumatization
7P	Position of the facial nerve
	Position of the middle cranial fossa dura
	Position of the sigmoid sinus
	Presence of ossicles
	Persistent stapedial artery
	Position of jugular bulb (High/dehiscent)
	Cortical Temporal bone thickness
	Mastoid-round window axis
	Aberrant /dehiscent carotid artery
Cochlea	Ossification
	Otosclerosis
	Morphology -Malformation
Internal auditory canal	Diameter
Vestibular aqueduct	Size / Dilation
Presence of pathology	Inflammation/ Cholesteatoma/ Tumour/Fracture etc.

→ Checklist in MRI

“One Nose and TWO watery eyes” (In T1W nasal mucosa will be hyperintense and in T2W the fluid within the eye will be hyperintense)

We need T2W images to look for

- Fluid compartment of cochlea, vestibule, SCC
- Presence of cochlea nerve in IAM
- Cerebral cortex
- Malformation
- Pathology- Inflammation/ Cholesteatoma

4 ENT Examination

- Tympanic membrane
- Mastoid area
- Nasal infection
- Nasopharynx-Adenoid

5 Pediatric Examination

- All systemic evaluation to rule out to classify syndromic and non-syndromic child with hearing loss
- Vaccination Care
- Metabolic (Hypothyroidism) and other developmental issues (CP child, Autism etc)
- Vaccination according to CDC guidelines

6 Psychological Evaluation

7 Routine Blood Investigation

8 Cardiological Evaluation

- Evaluation by pediatric cardiologist for conductive and structural cardiac issues.
- Test battery Includes-Chest x-ray+ ECG(calculated)+ Echo.
- Prolong QT interval with SNHL (JL syndrome) most dreaded cardiac issue in CI if not diagnosed and intervene pre-operatively.

9 Anesthetic Evaluation

- Details Pre-Anaesthetic Checkup (PAC) by experienced anaesthesiologist is very much important

SURGERY

1 Pre-operative Antibiotic, Shaving and LA Application

- Antibiotic should be injected 3-hour prior surgery.
- Shaving should be done in OT after inducing the child.
- LA (2% Xylocaine with adrenaline) should be injected in post auricular area before hand wash.



Fig 1A: Shaving after Induction



Fig 1B: LA Application



Fig 1C: 1st Betadine Scrub

2 Template Marking



Fig 2: Template Marking

- Before making incision, proper measurement and marking of the external processor placement with the template provided by the Implant company should be made.
- The Implant should not be too close to the pinna so that there is an optimal gap between implant and the processor.

3 Incision

- We mostly used Lazy S and Normal retro auricular incision.



Fig 3: Normal retroauricular incision

- Bleeding points should be cauterised with bipolar cautery. Try to avoid the monopolar cautery during skin incision and flap elevation as much as possible to avoid flap necrosis.
- In younger children less than 1 year, more than 60ml blood loss may cause gross haemodynamic change. So every skin bleeding should be taken care of. Care should also be taken to avoid bleeding from mastoid emissary vein.
- In children care must be taken to avoid the mastoid tip when using this incision, because of the more lateral position of the facial nerve at the mastoid tip.

4 Flaps

It is necessary to create a musculo-periosteal flap that adequately covers the cochlear implant and electrode arrays postoperatively.

Two flaps we use

1. Anteriorly based
2. Postero- superiorly based

**Most important point is that the implant should have covered and there should not be tight suturing so that the flap is not too tense over the implant.*

**Always release the retractor and to suture loosely the stitches used for retracting the flaps so that the flap not compromised their vascularity in prolonged surgery.*



Fig 4A: Anteriorly based flap (Right ear)



Fig 4B: Posterior superior based flap (left ear)

5

Cortical Mastoidectomy

Cortical Mastoidectomy delineating the important structures like dura, sinus plate, LSC. The edges of the cortical bone can be left along the cavity to hold the electrode array. After getting the antrum and aditus ad antrum we should look for incus shadow. Posterior external canal wall should be thinned as much as possible. A very little portion of lateral EAC can be removed to get microscope light through posterior tympanotomy.



Fig 5A: Cortical Mastoidectomy with large cutting burrs, keeping the lateral overhang



Fig 5B: Getting into the antrum (the largest mastoid air cell)

6

Posterior Tympanotomy

Delineate the vertical portion facial nerve and chorda tympani. Keeping a bridge of bone just below short process of Incus posterior tympanotomy should be performed between the facial nerve canal and chorda tympani in magnified view with continuous irrigation with saline. It should be widened keeping view on facial nerve so that round window niche is visualized properly, also facilitating microscope light and instrumentation.

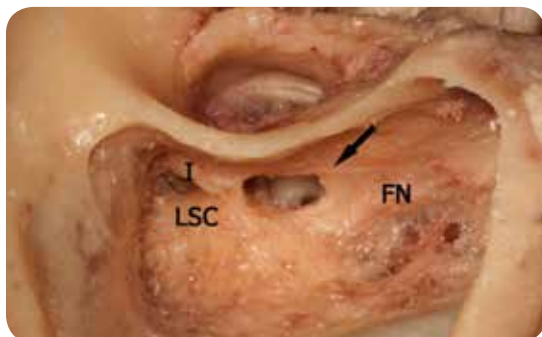


Fig 6A: The posterior tympanotomy in cadaver *



Fig 6B: Extended posterior tympanotomy

7 RW Exposure

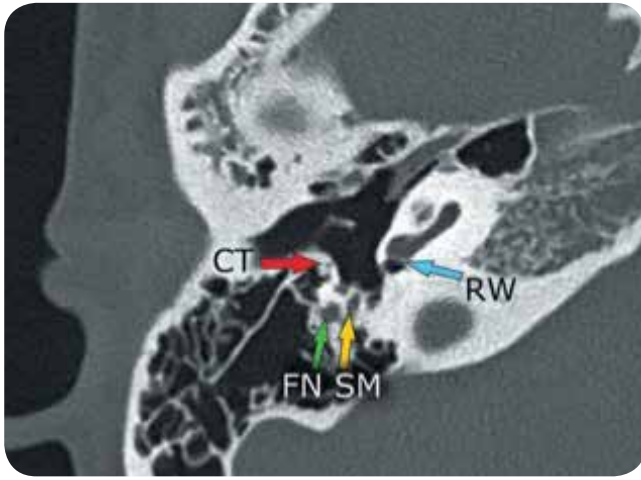


Fig 7A: Radiology of RW in CT sagittal cut before surgery



Fig 7B: RW area is visible only after extending posterior tympanotomy without injuring the facial and chorda tympani

The round window is usually covered by a bony overhang superiorly and a bony projection inferiorly called as Round Window Lip or Operculum. Sometimes a pseudo membrane maybe present which is whitish in color. The color of the actual round window is dark grey. We need to drill the superior overhang and inferior bony projection or lip to visualize the entire round window. Care should be taken not to injure the facial nerve by the shaft of the burr used for drilling the overhang through posterior tympanotomy.

8 Implant Bed



Fig 8A: Marking the receiver well



Fig 8B: Receiver well for internal processor and electrode lead canal.

A well is made for the receiver stimulator after proper measurement by the template provided by the implant company. Some implant does not require a well, only a subperiosteal pocket is sufficient. A tunnel need to be made for electrodes.

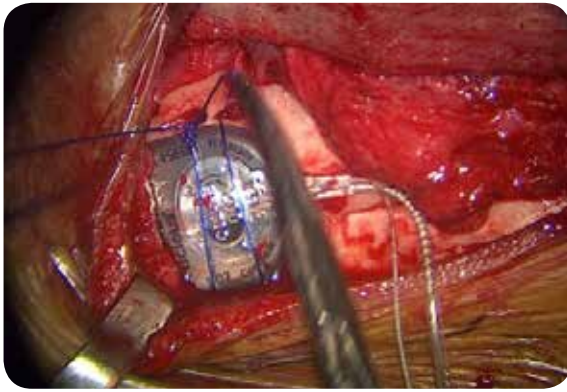


Fig 9: Fixation Implant in Bed with tie-down suture

Implant need to be fixed. We use prolene 1-0 or 2-0 suture to tie down the implant to the implant bed. Some implant come with fixation screw. Few new implant need not be fixed; they just need a tight periosteal pocket.

Cochleostomy & Electrode Insertion

RW insertion is the safest insertion of electrodes towards scala tympani. The direction of electrode insertion should be postero-superior to anterior inferior. The crista fenestrae, on the inferior inside border of the round window, also called the "hook" region, forms the narrowest anatomical point to the scala tympani. It may represent a sharp obstacle during the insertion of the electrode array, with the possibility of damaging the array.

Some surgeon prefers cochleostomy antero - inferior to round window or extended RW approach. But drilling should be very gentle and last part and endothelium should be exposed by hook. After exposing the scala tympani topical corticosteroid applied.

Electrode insertion should be slow and smooth to avoid intracochlear trauma.

CORRECT



INCORRECT



Fig 10 A: Showing correct & incorrect method of electrode insertion *



Fig 10 B: Electrode insertion through round window



Fig 10 C: Covering the round window with soft tissue plug

11 Closure

Wound repair should be done with total cover of implant. We do with 3-0 monocryl in two layers. Implant should tightly close by the flap to prevent haematoma.



12 Electro Physiological Test & X-Ray

Electro Physiological Test (NRT, Impedance Measurement) give information on the correct functioning and position of the electrode. We take C-Arm X-ray picture to know the position of the electrode inside the cochlear.



Fig 12A: NRT

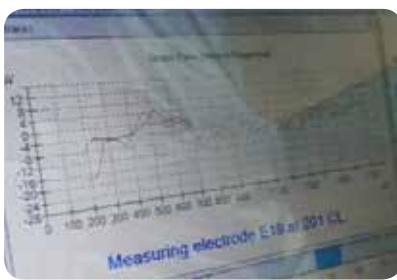


Fig 12B: Xray showing the bilateral implant inside the cochlea turn

13 Post-operative

Adequate mastoid bandage for minimum 3 days. Nowadays we give interrupted 3-0 Monocryl suture for post auricular wound closure so that there is no need of stitch removal in younger children.



14 Switch On

After 2 weeks or as early as possible after healing of post auricular wound.

ANNEXURE

A. BASIC IMPLANT PARTS

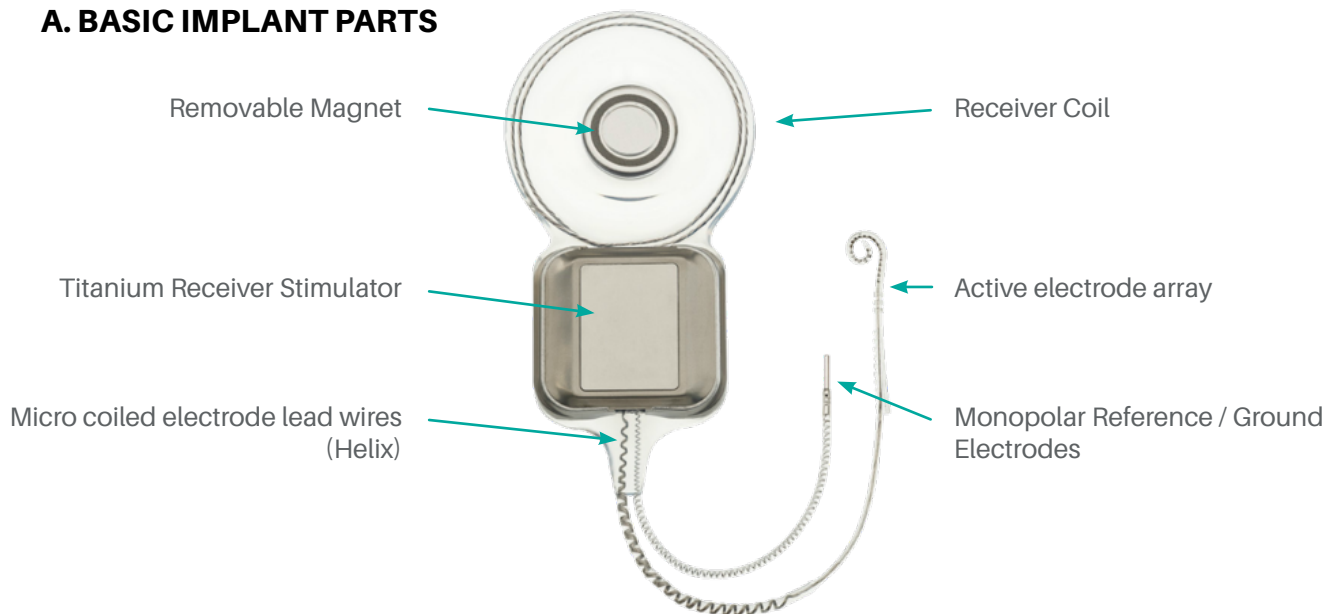


Fig : Showing basic parts of Cochlear Nucleus profile implant

B. SURGICAL KIT

- All microear surgery instruments
- Motor drill handpiece
- Burrs - all burrs for mastoid surgery (4mm, 2mm, 1mm diameter both cutting and diamonds)
- Burrs for cochleostomy
- Microscope, bimsplitter, camera, recorder and cover and sterile handle
- Special kit instrument by company



Fig: From left to right: two implant templates; two contour electrode claws (gold and silver); two recess gauges (with and without electrode channel); one processor (BTE) template; one spacer for intraoperative testing (black), AOS forceps. (Surgical kit of Cochlear Nucleus implant)

C. IMPLANT KIT

- Internal Implant Kit
- Processing Unit
- Disposable / Rechargeable Battery
- Transmitting Coil and Coil Cable
- Charging Unit
- Magnet
- Supporting Accessories for Retention (Ear hook, snug fit, clips, etc..)
- Supporting Accessories for troubleshooting and maintenance
- Warranty Papers & Documents

REFERENCES:

* Surgery for Cochlear & Other Auditory Implants by Prof. Mario Sanna (2016 Thieme Publication)

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