Update on implantable hearing devices: they still need us (for now)

Advanced Cochlear Course 2020

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Global impact of hearing loss

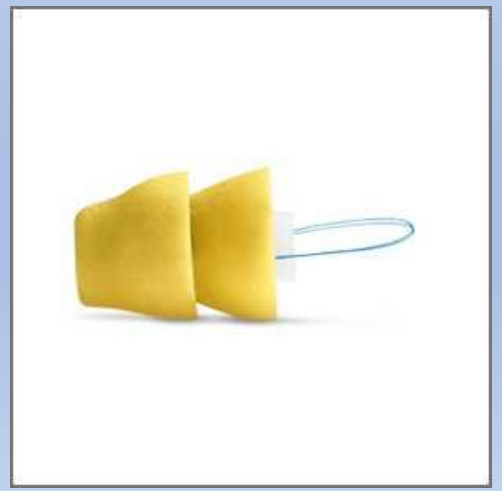
- Over 5% of the world's population – or 466 million people – has disabling hearing loss
- 1/3 over 65 years have a disabling hearing loss: greatest in South Asia, Asia Pacific and sub-Saharan Africa
- Children under 15 years of age, 60% of hearing loss is attributable to preventable causes

WHO Report 2018

- Global production of hearing aids meets less than 10% of global need and less than 3% of developing countries' needs
- Cost of hearing aid batteries in of in itself a huge impact on compliance

Hearing Aids

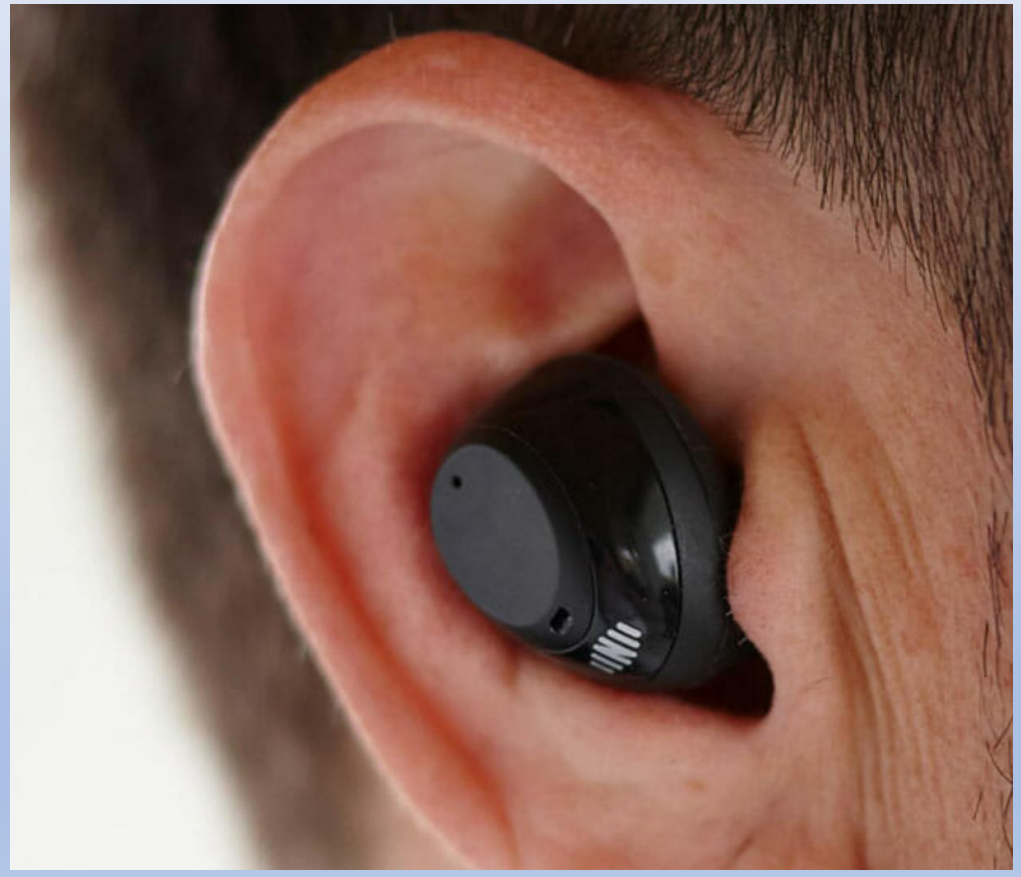
- Invisible in the canal (IITC)
- Completely in the canal (CIC)
- In the ear (ITE)
- Receiver in the ear (RIE)
- Behind the ear (BTE)



“The ear is the next wrist”

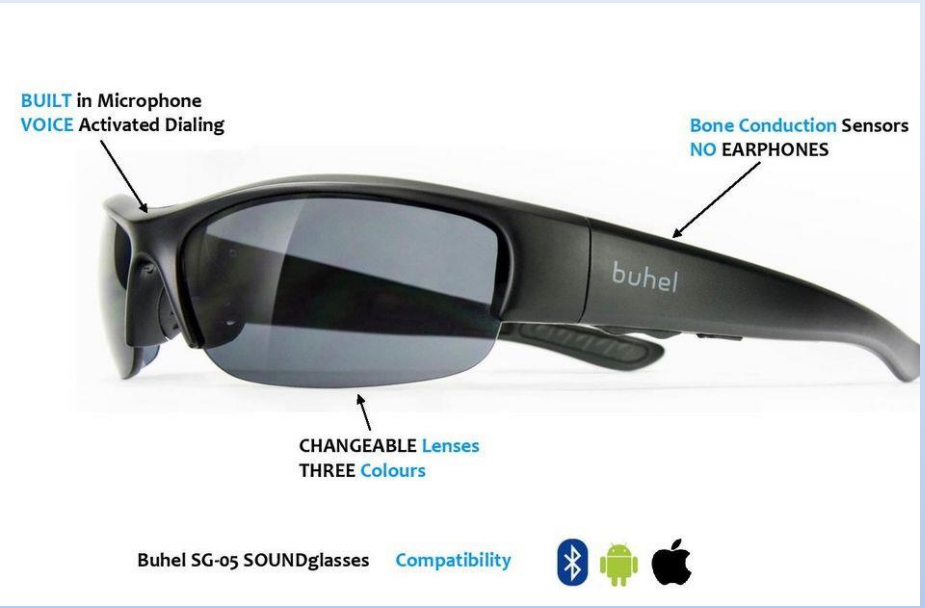
- Translator: Babel fish (pity about replying)
- Biometric data
- Fall detector

Hearable vs Hearing Aids



NuHeara IQ buds

Bone conducting hearing devices (aids)



The Elephant in the room !!

Selective Hearing Loss

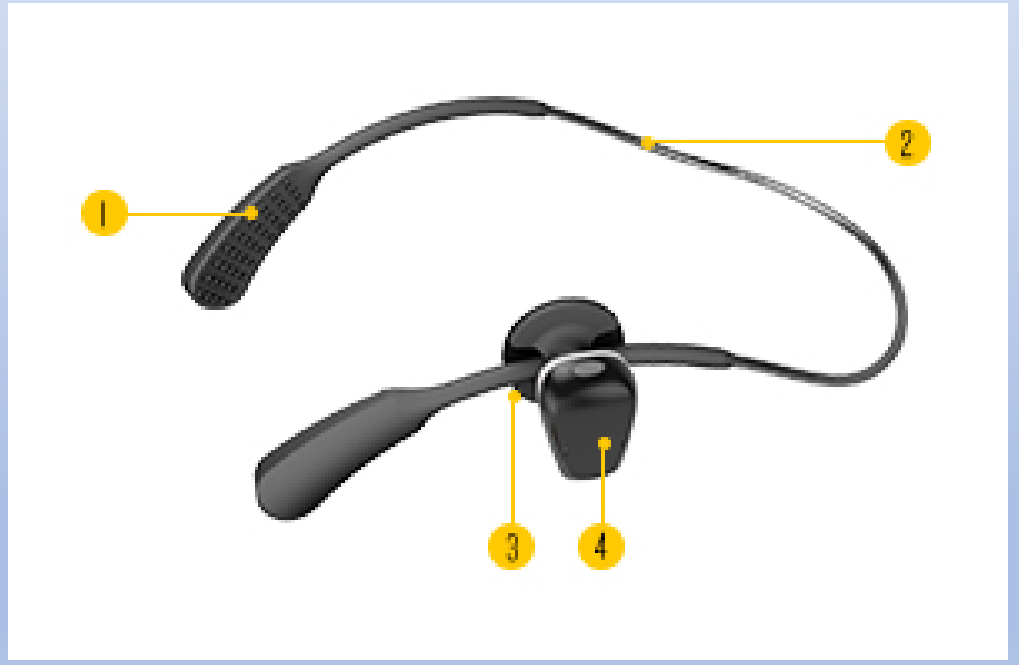
- Hearing vs Listening
- Genetic ?
- Generational ?

Wax

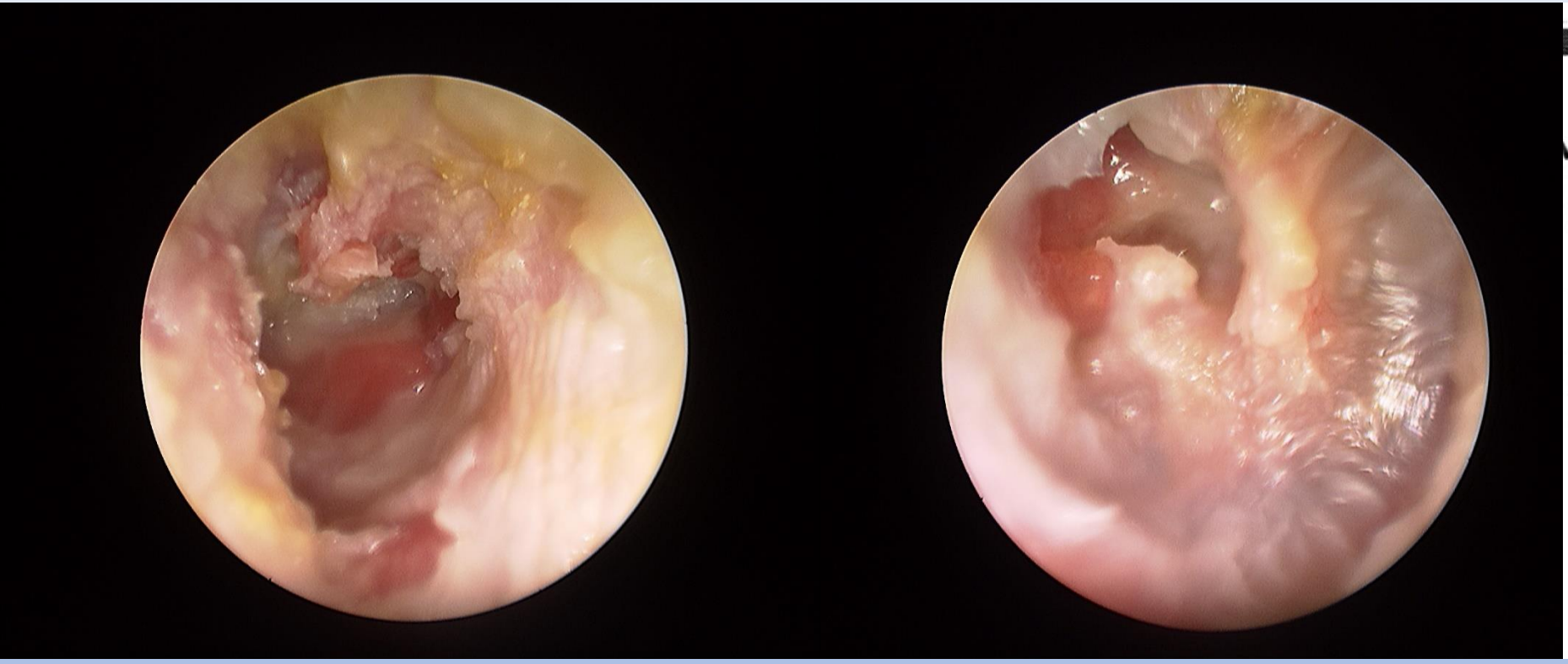
Schwartz, S. R., et al. (2017). "Clinical Practice Guideline (Update) Clinical Practice Guideline: Earwax (Cerumen Impaction)." Otolaryngol Head Neck Surg **156**(1): 14-29.

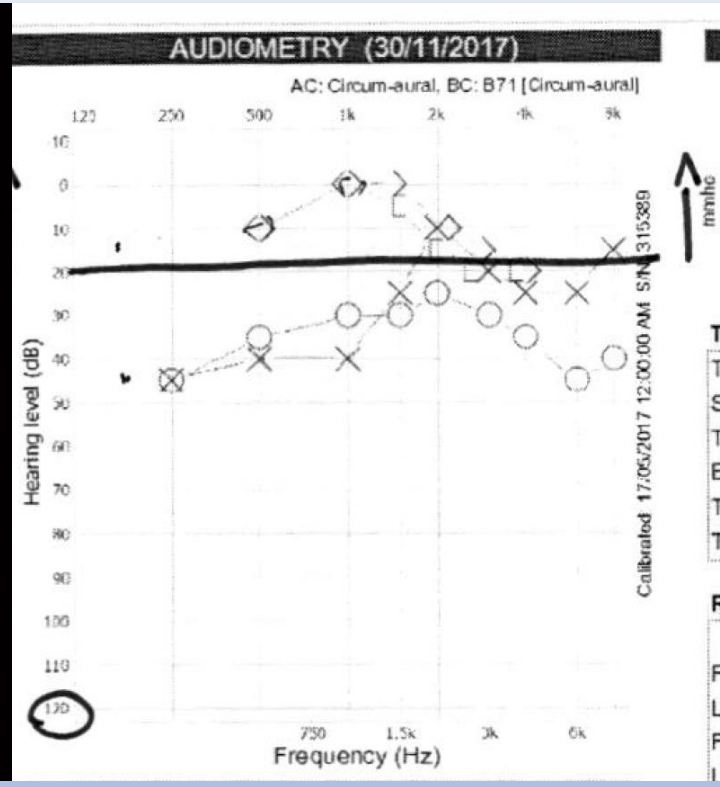
Non-surgical bone conducting aids

BAHA Soft Band and Sound Arc



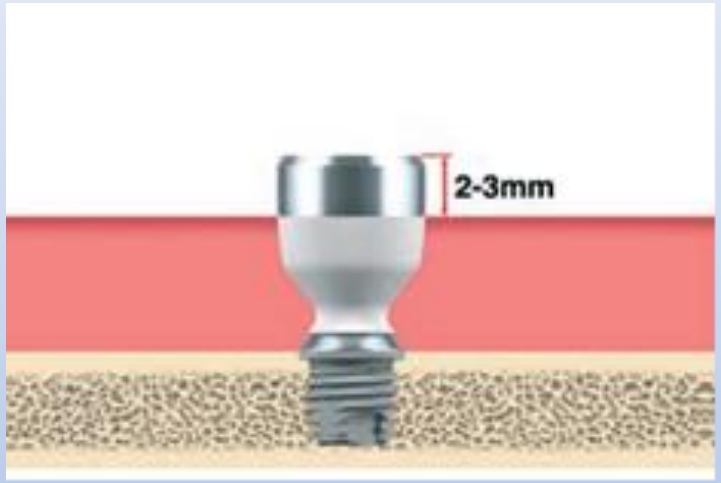
JK 28 yo



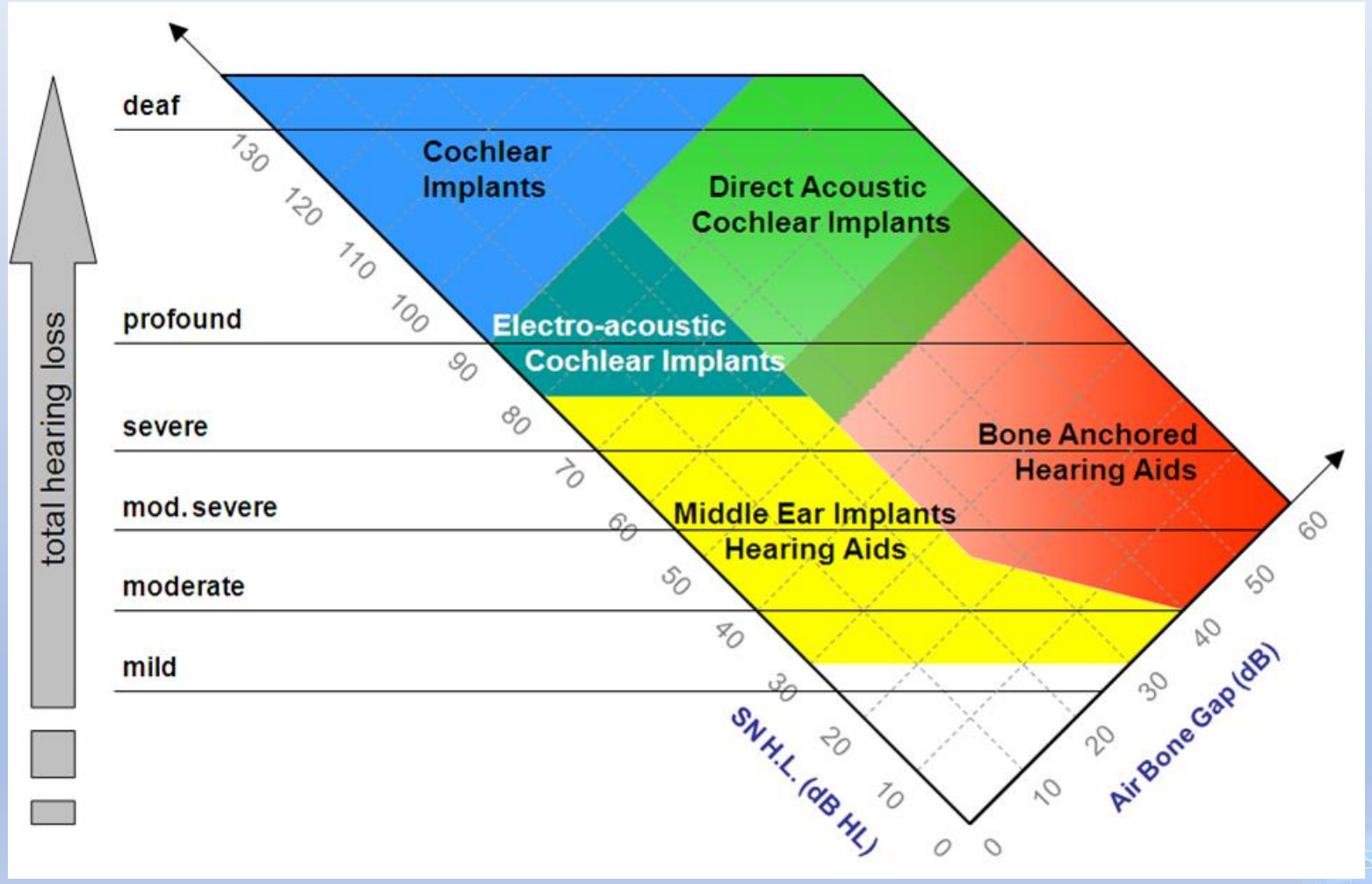


Can be used to manage perioperative hearing in bilateral CSOM

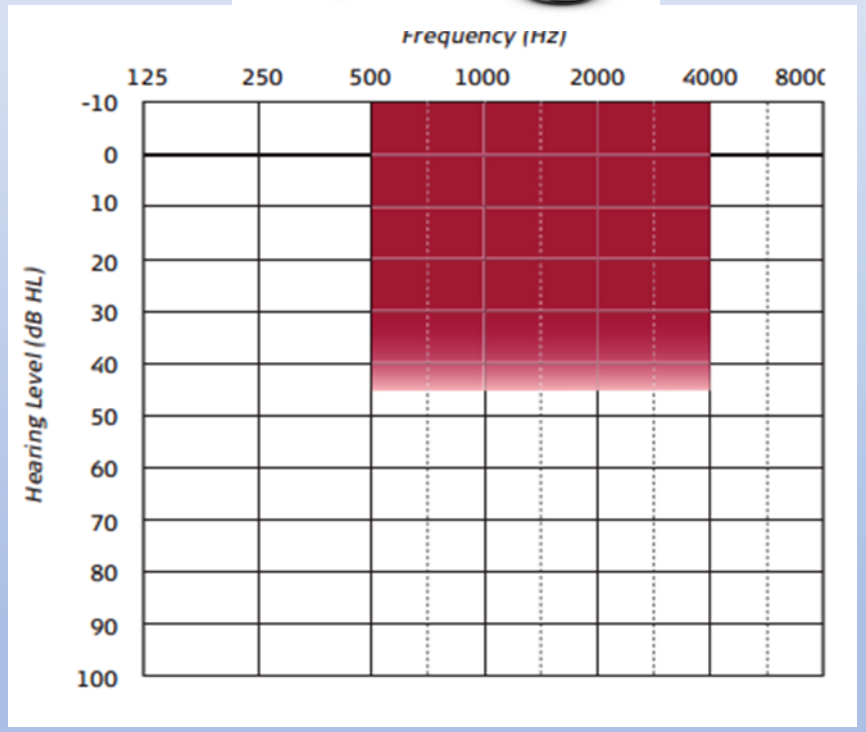
Bone Anchored Hearing Aids: ?Too much choice



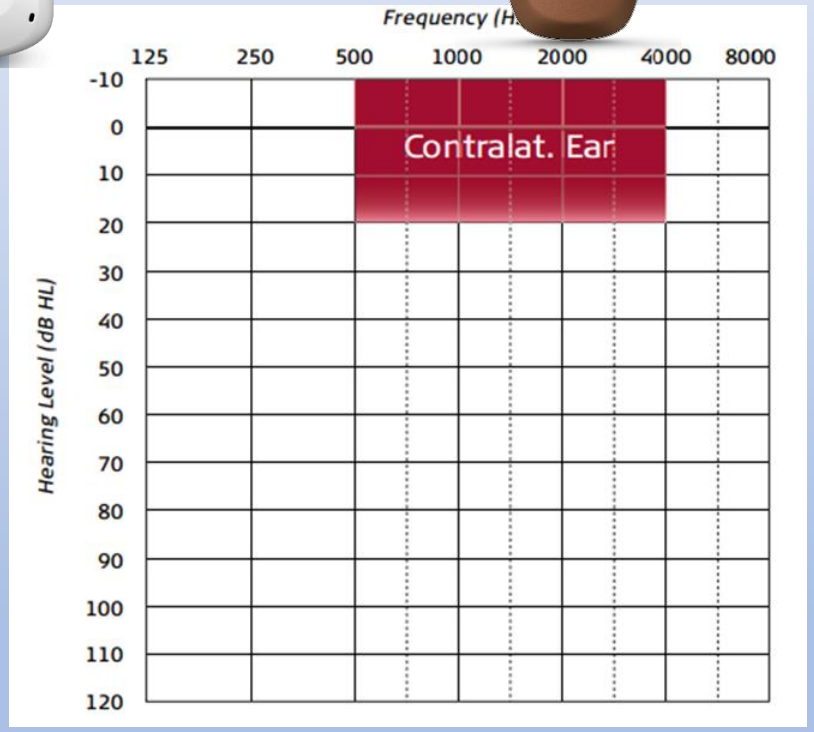
Indications



Indications Bonebridge: Ponto: BAHA 5



Conductive or Mixed Hearing Loss
BC thresholds within shaded area
5 years and older

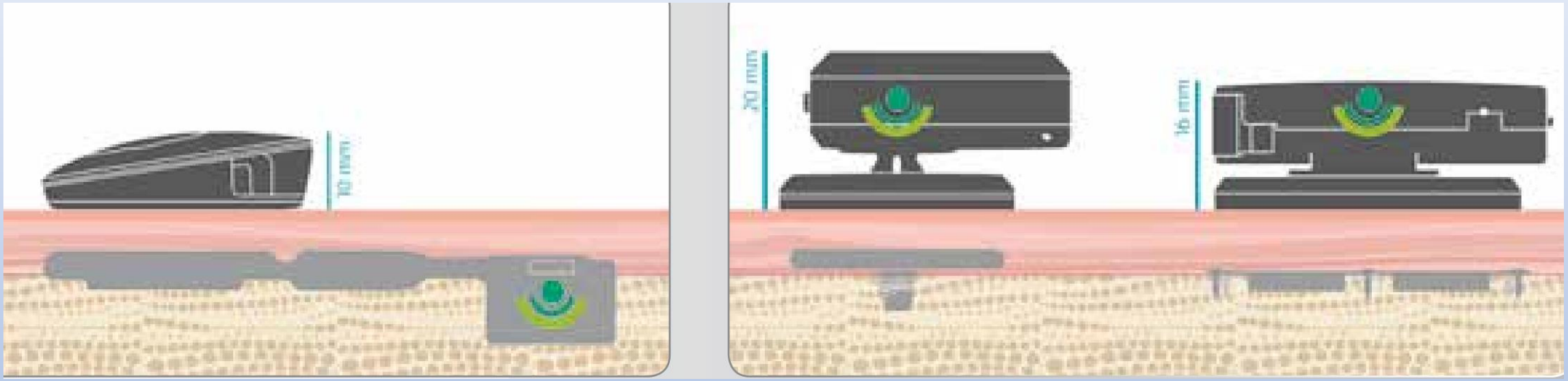


Single-Sided Deafness
AC thresholds within shaded area
5 years and older

Percutaneous

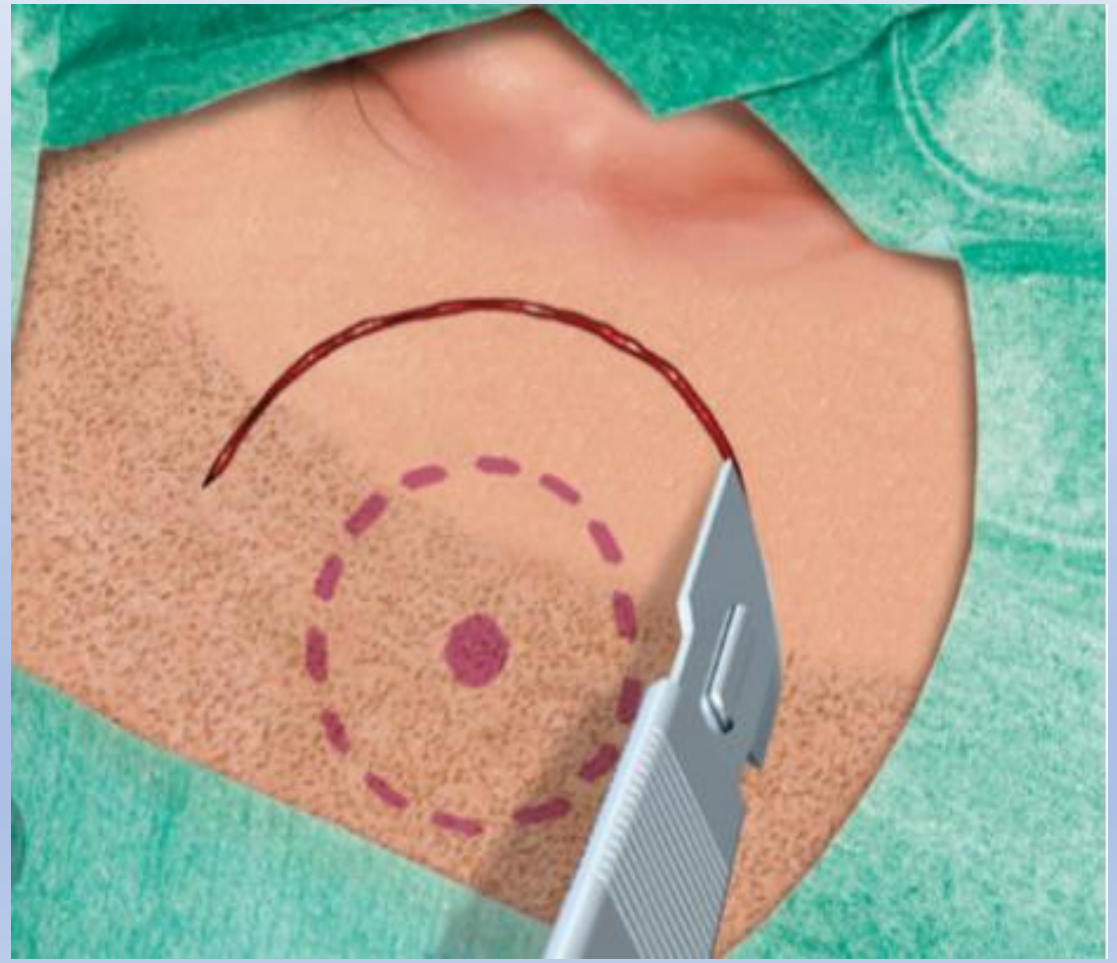
Choice of processor

Transcutaneous Implant profiles

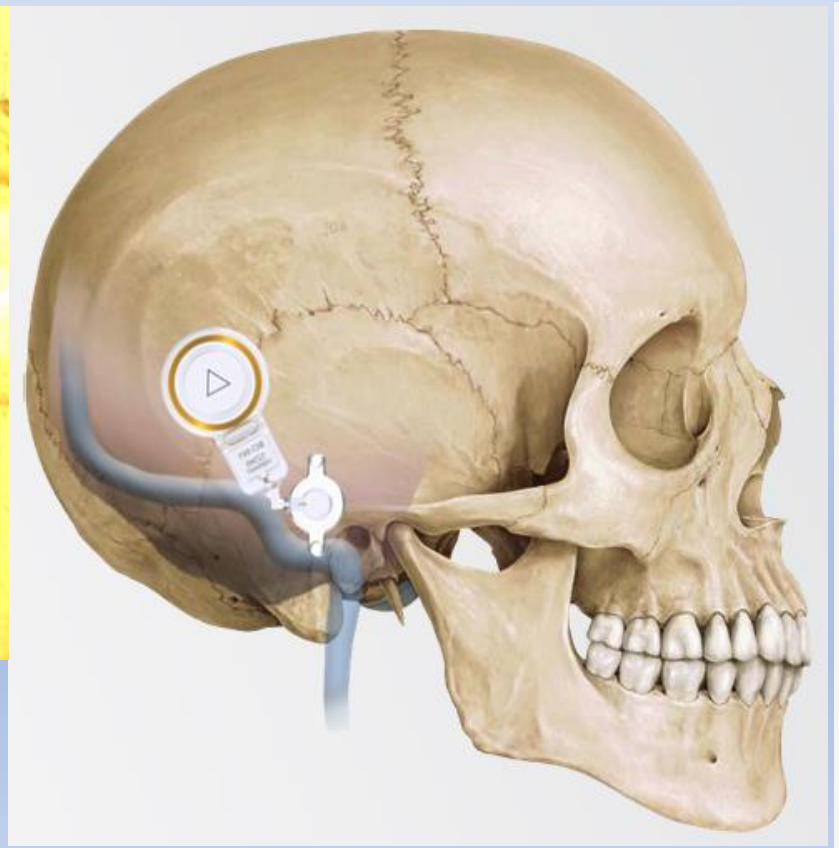


Weight
Security
Feedback

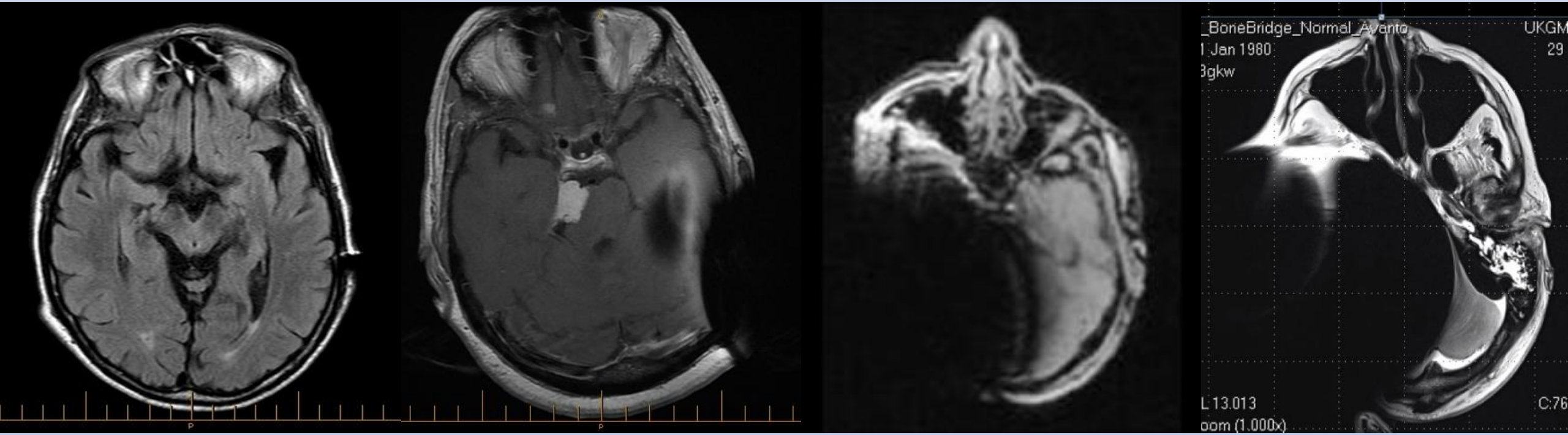
Incision for attract



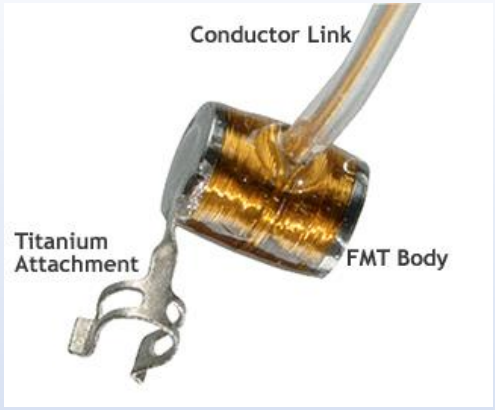
Incision for Bonebridge



MRI with implants in-situ

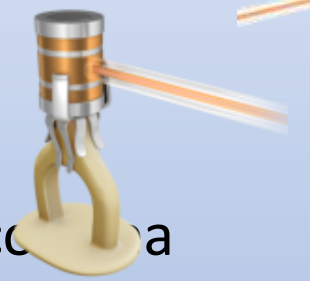


Active middle ear implants



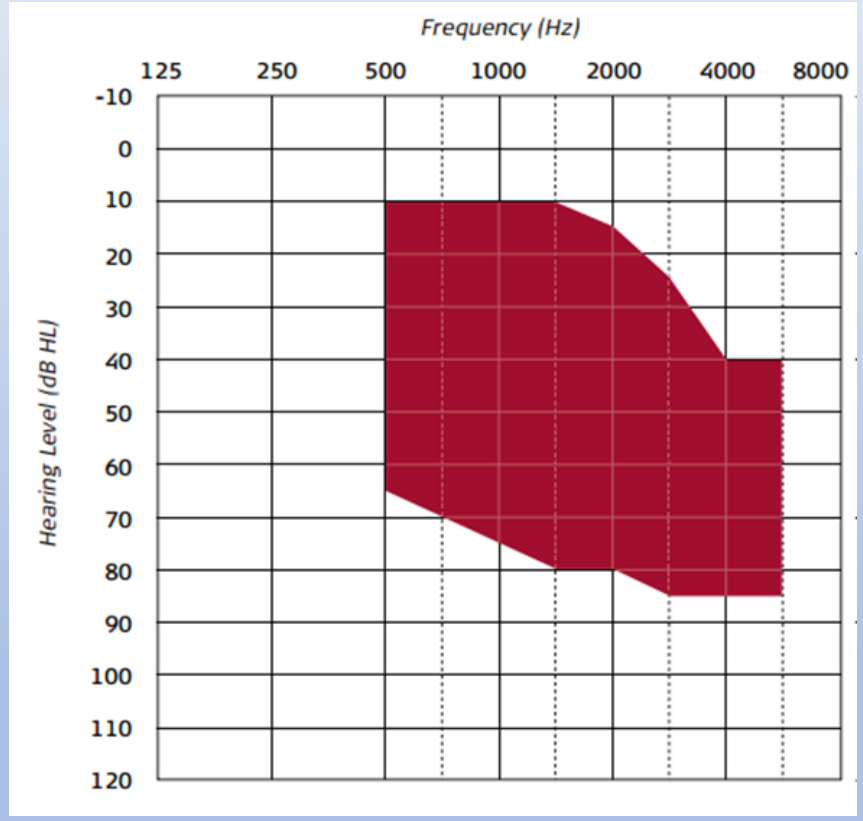
Vibrant Soundbridge

- Semi implantable with external receiver
- More extensive surgery
  - Atticotomy, facial recess
- Multiple coupling options
  - Direct stimulation of ossicles/co a
- External processor less visible
- MRI compatibility for 1.5 tesla
- Recently available for Australian mark



Standard Soundbridge Indications

- Unable to tolerate hearing aid
- Absence of middle ear pathology



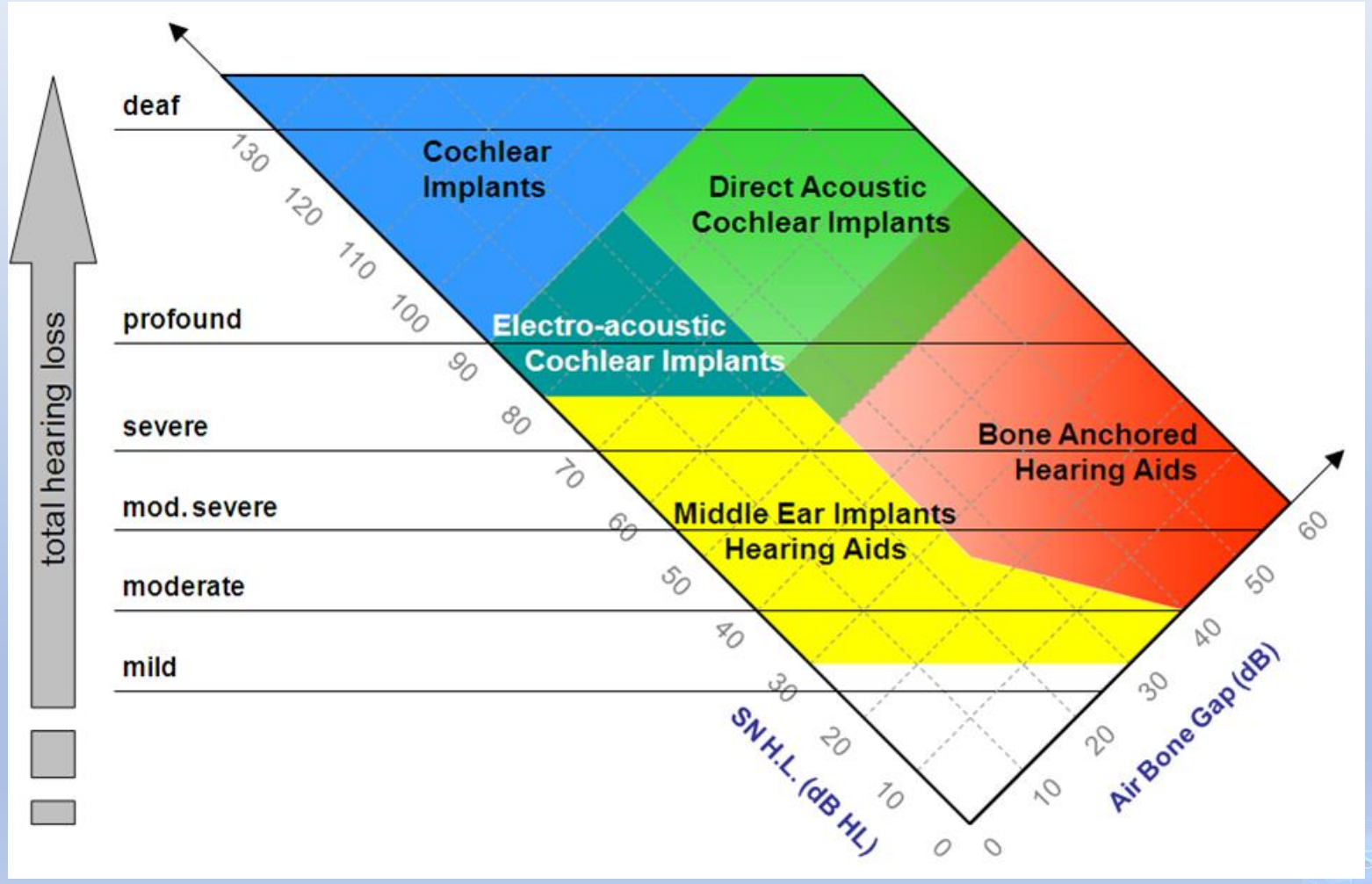
Sensorineural Hearing Loss
AC thresholds within shaded area
5 years and older

Soundbridge: limited true indications

- Maximal conductive hearing loss
- +/- A degree of sensorineural loss
- Allows unilateral stimulation of the cochlear

- Blind sac closure
- Absent stapes
- Favourable atresia

Indications

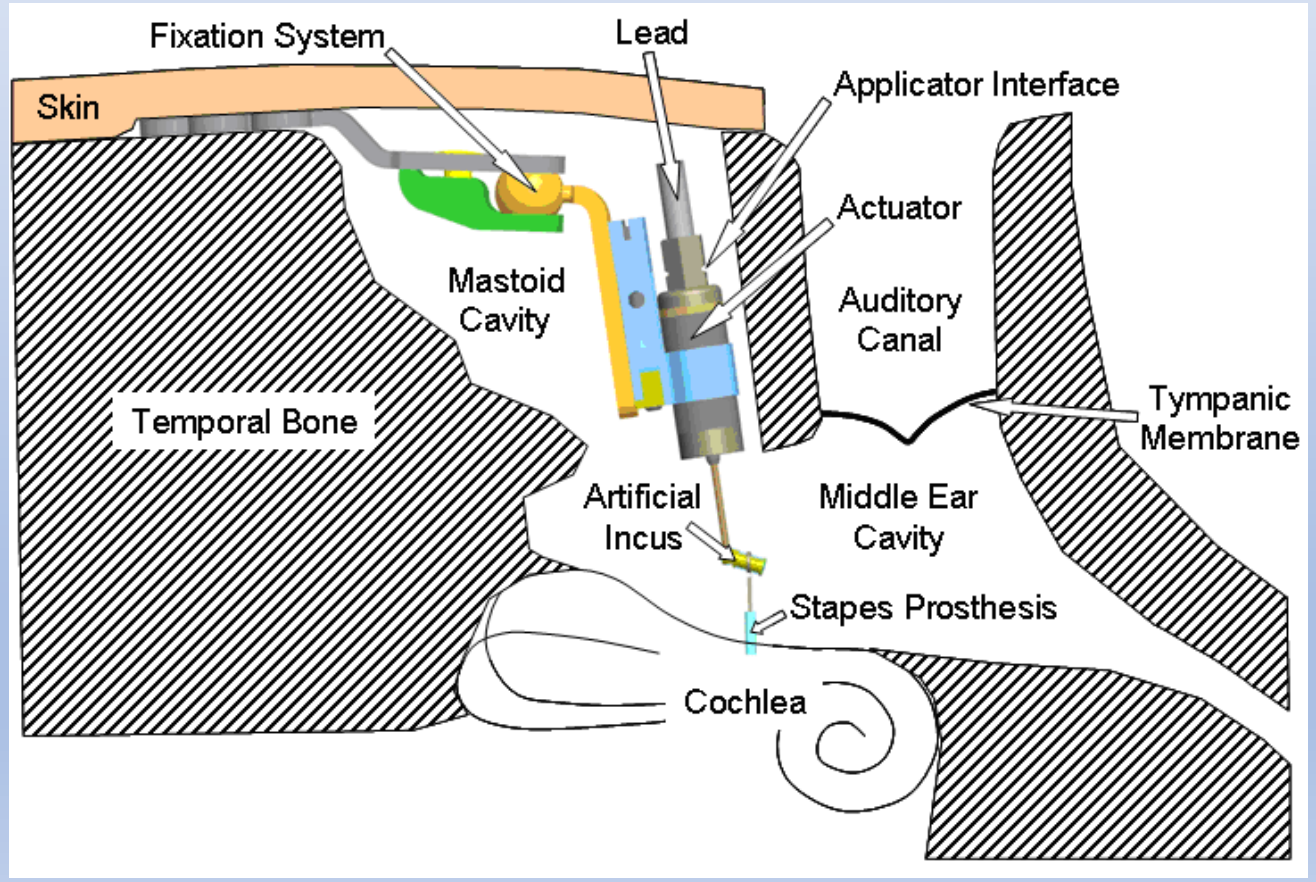


Direct Acoustic Implants

Cochlear MET and Carina systems

- Semi or fully implantable w/o receiver
- More extensive surgery
  - Atticotomy, facial recess
- Multiple coupling options
  - Direct stimulation of ossicles/cochlea
- External processor less visible
- Not MRI compatible
- Stronger audiological output
- Not yet available for Australian market

Codacs system



Cases

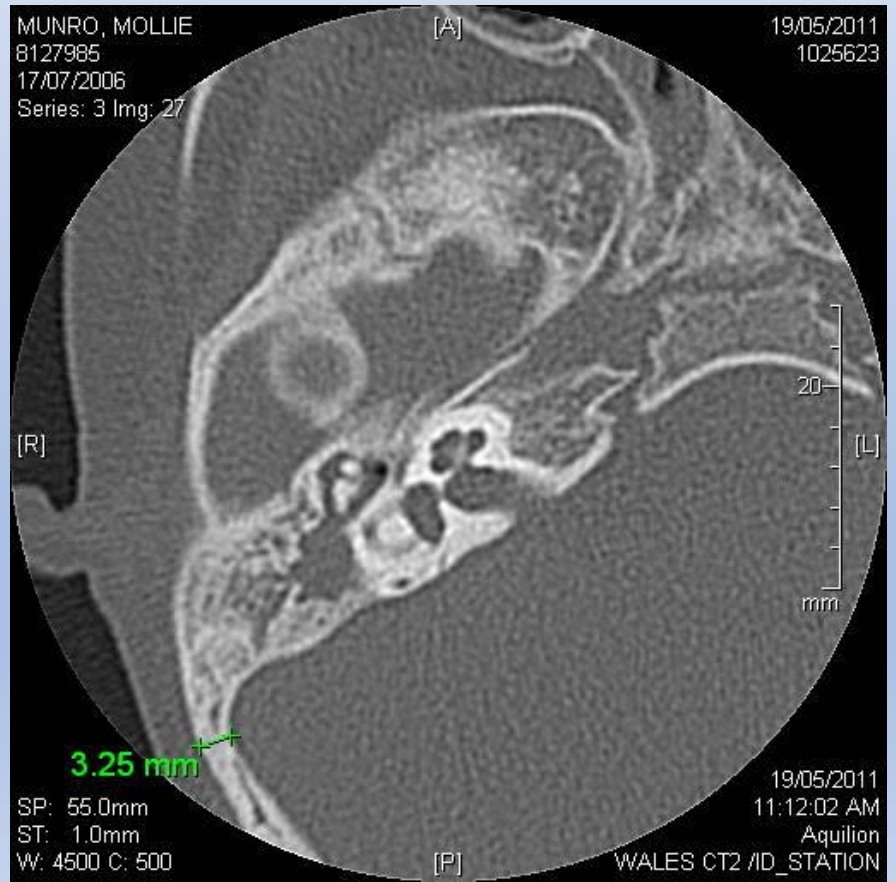
65 year old lady with blind sac for CSF leak

4 year old, starting school next year
Recurrent AOM left ear: 8 documented cases last 12 months

Correcting Unilateral Conductive Hearing Loss

- Stimulation of both cochleas could limit directionality
- Convincing evidence of benefit in learning
- Interestingly sound localisation benefits less predictable in congenital unilateral hearing loss; possibly related to age of correction (aiding)

Liu, C. C., et al. (2017). "The role of bone conduction hearing aids in congenital unilateral hearing loss: A systematic review." Int J Pediatr Otorhinolaryngol **94**: 45-51.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8127985
17/07/2006
Series: 3 Img: 27
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Aquilion
WALES CT2 /ID_STATION


MUNRO, MOLLIE
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Series: 3 Img: 24
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ST: 1.0mm
W: 4500 C: 500
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19/05/2011
11:12:02 AM
Aquilion
WALES CT2 /ID_STATION

Options

- Ventilation tube left ear
- Right ear

  Nothing

  Soft Band or ADHEAR

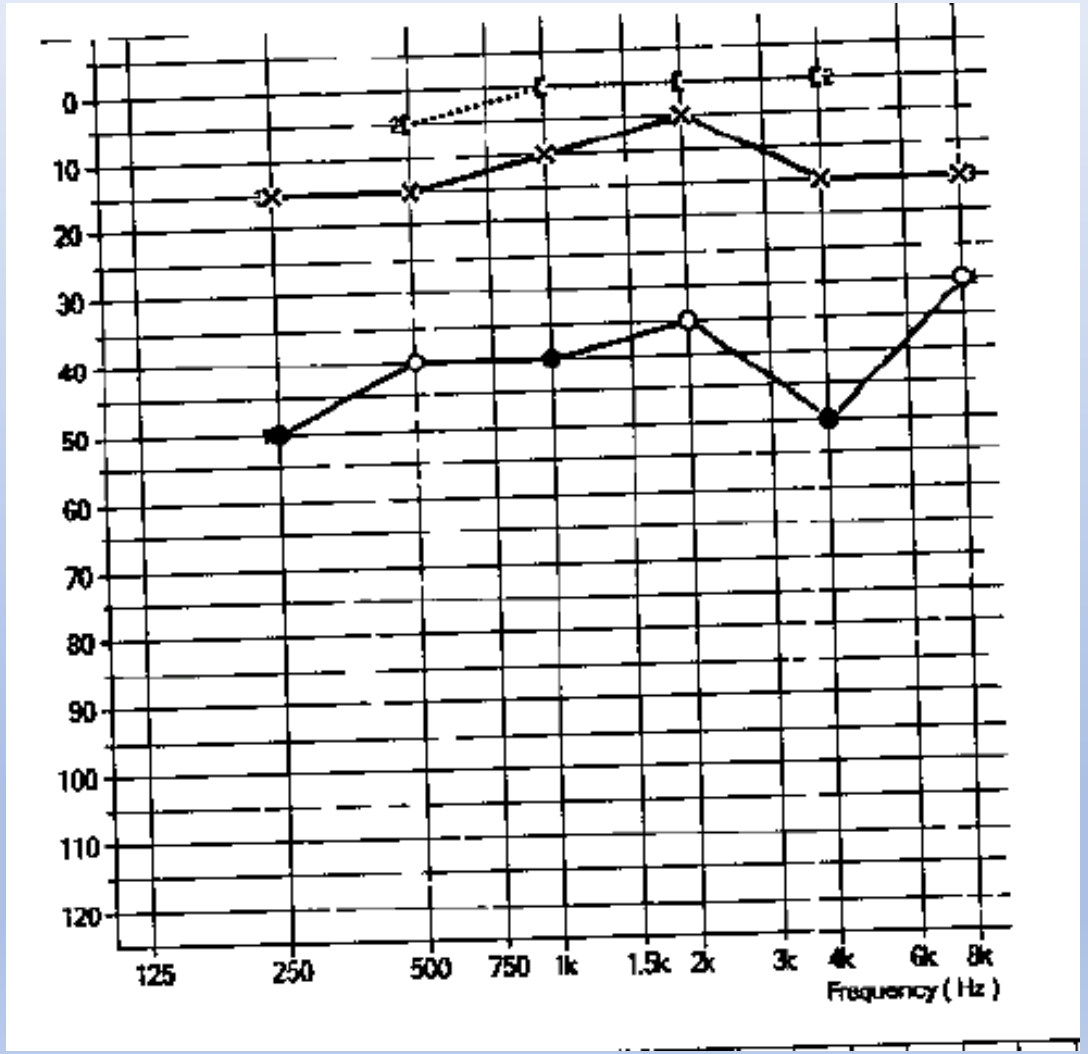
  BAHA connect or attract

  Bonebridge

  Vibrant Sound Bridge

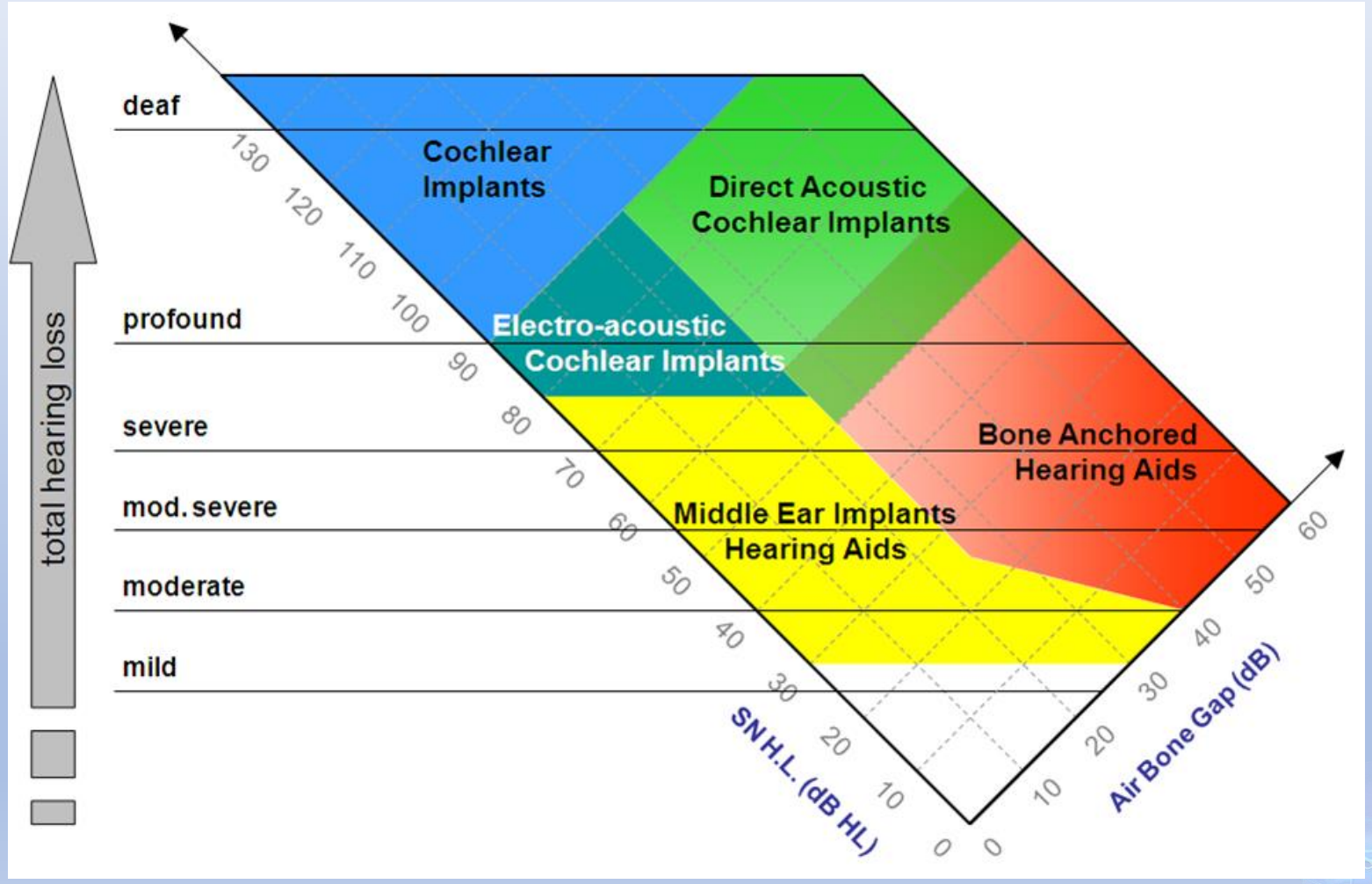
  Reconstruction

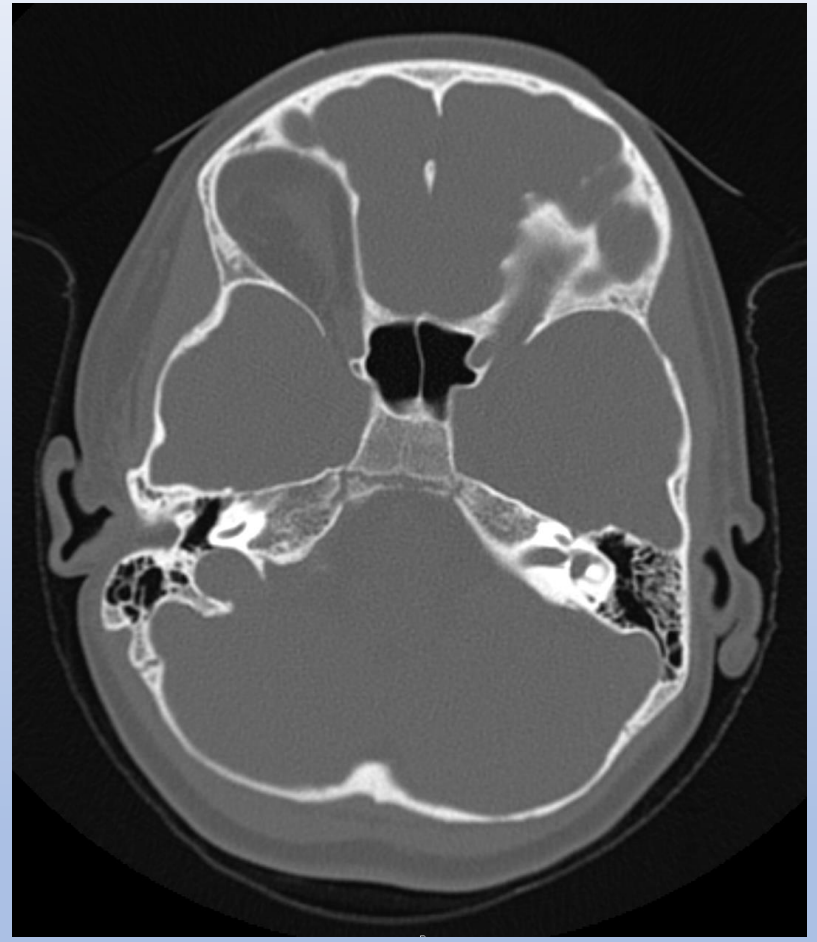
5 year old girl

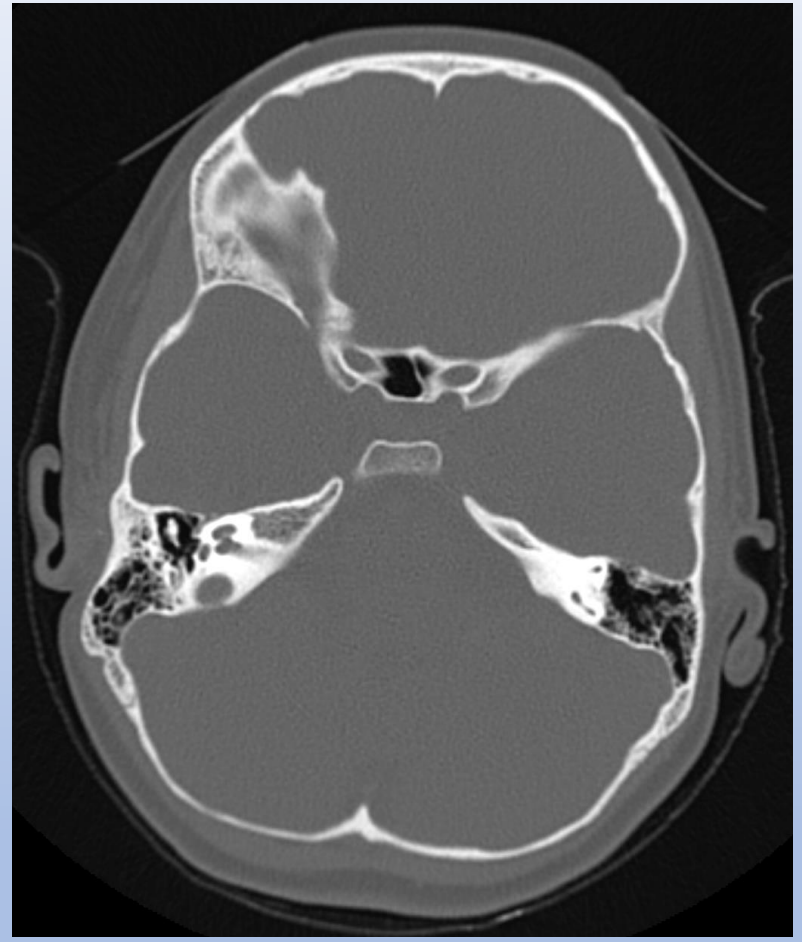


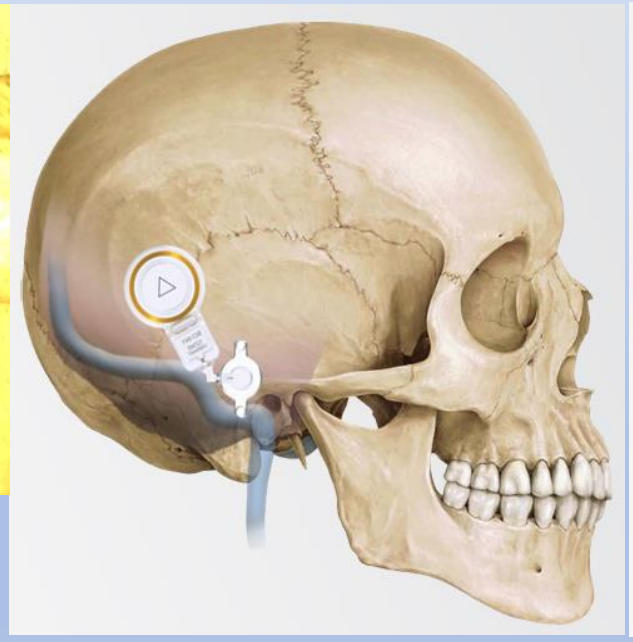
Canal atresia

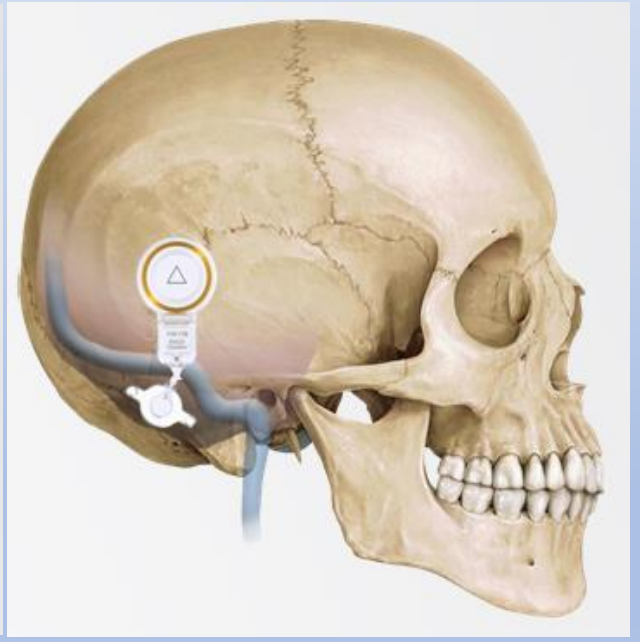
Indications

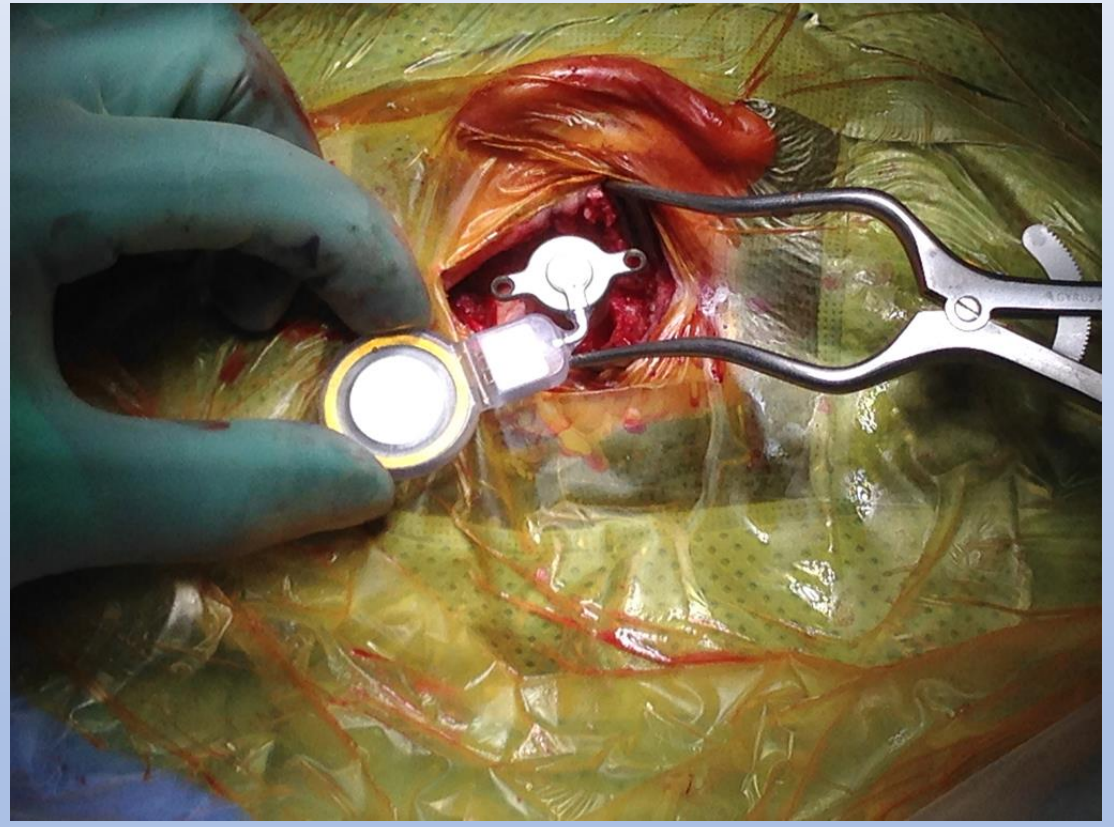




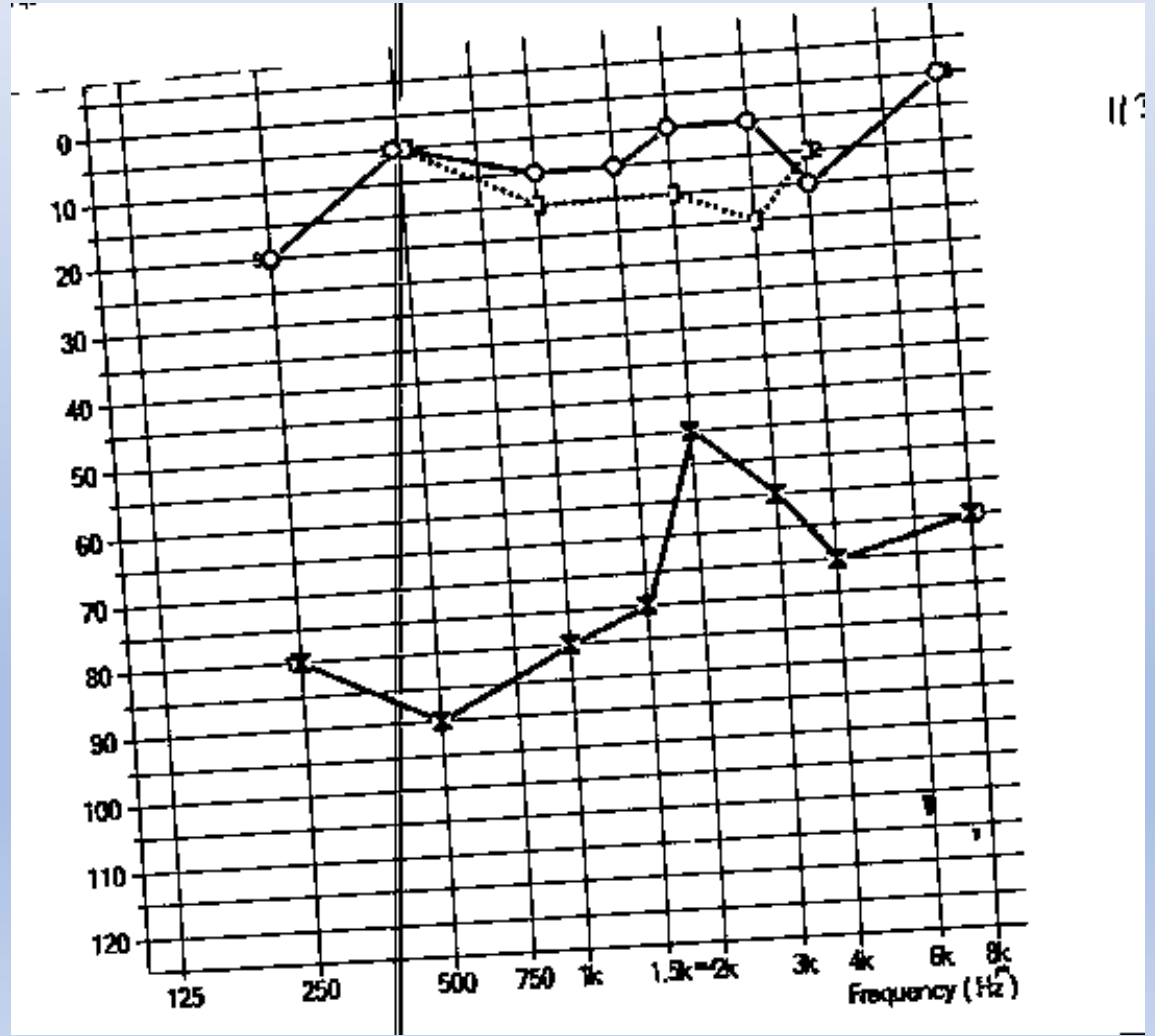


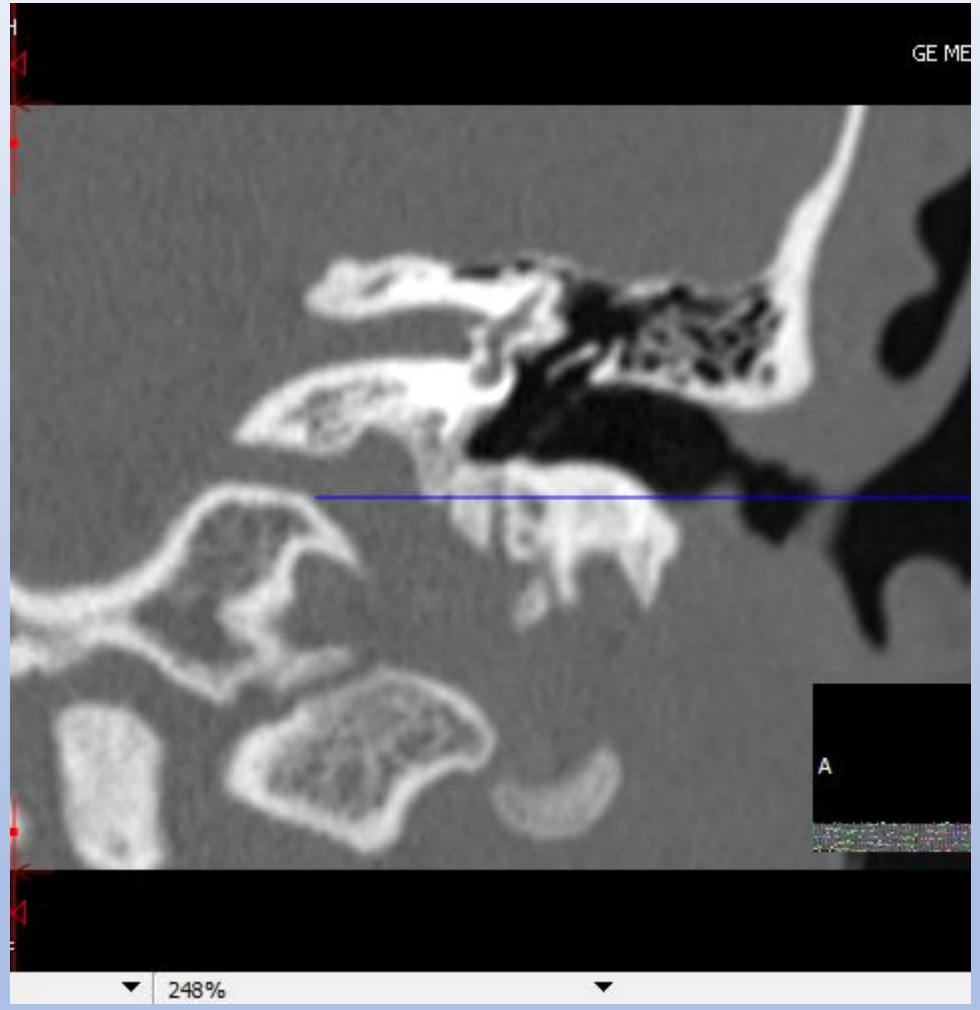






14 year old boy with lifelong left hearing loss

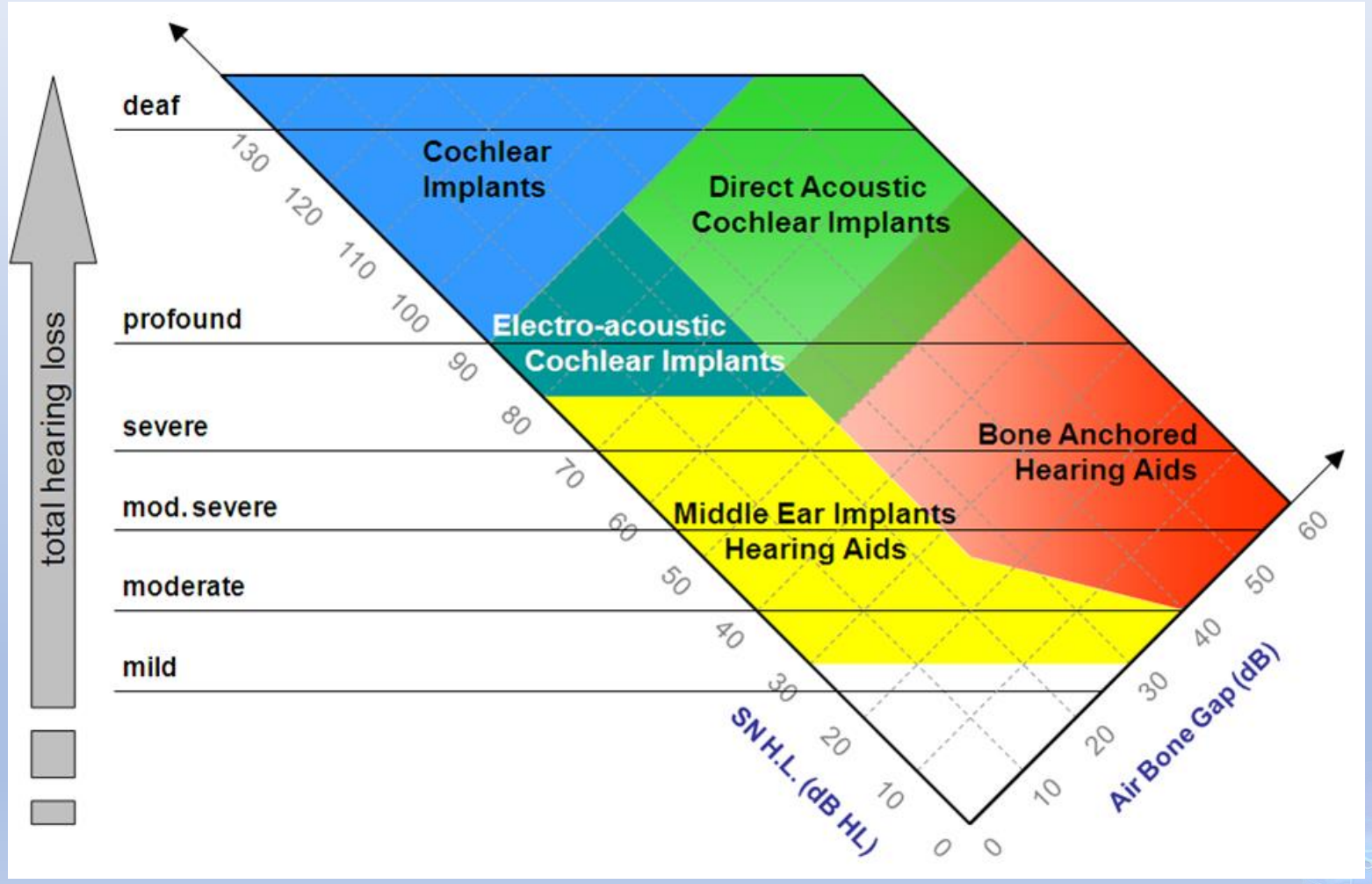




Absent left stapes

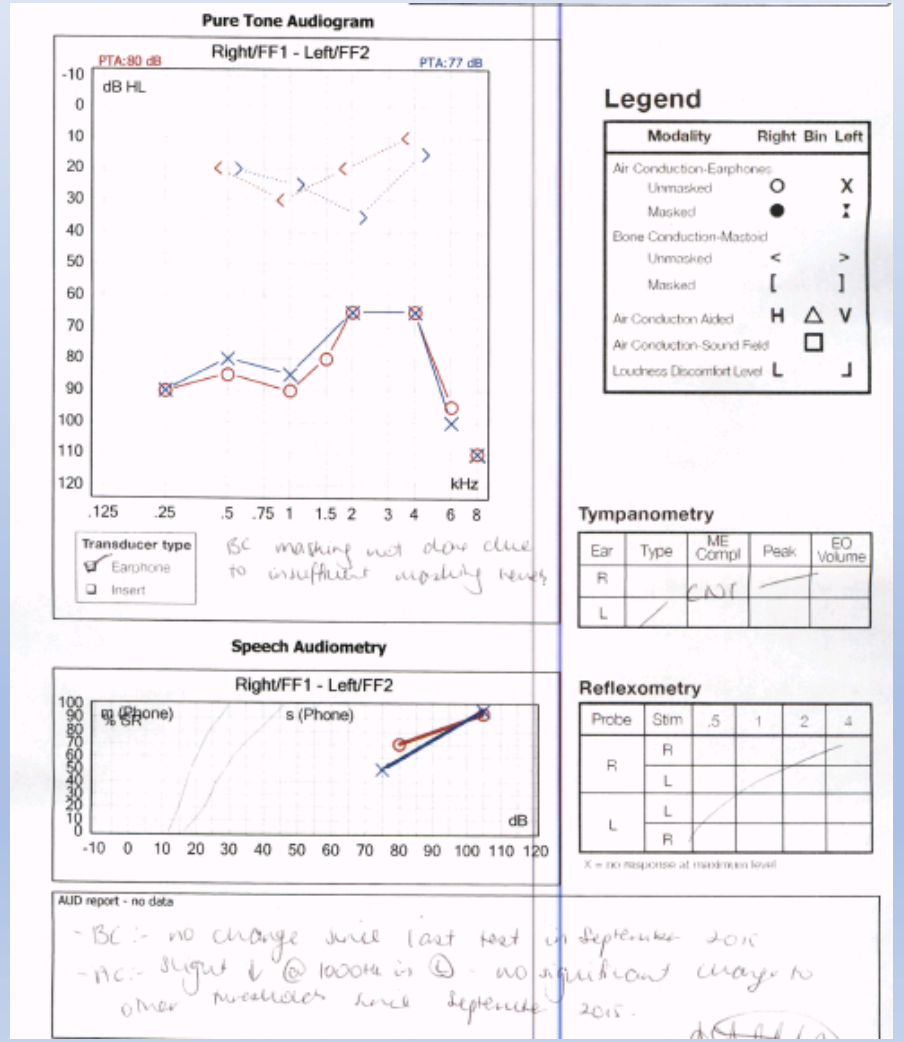
sean@sydneyentclinic.com

Indications

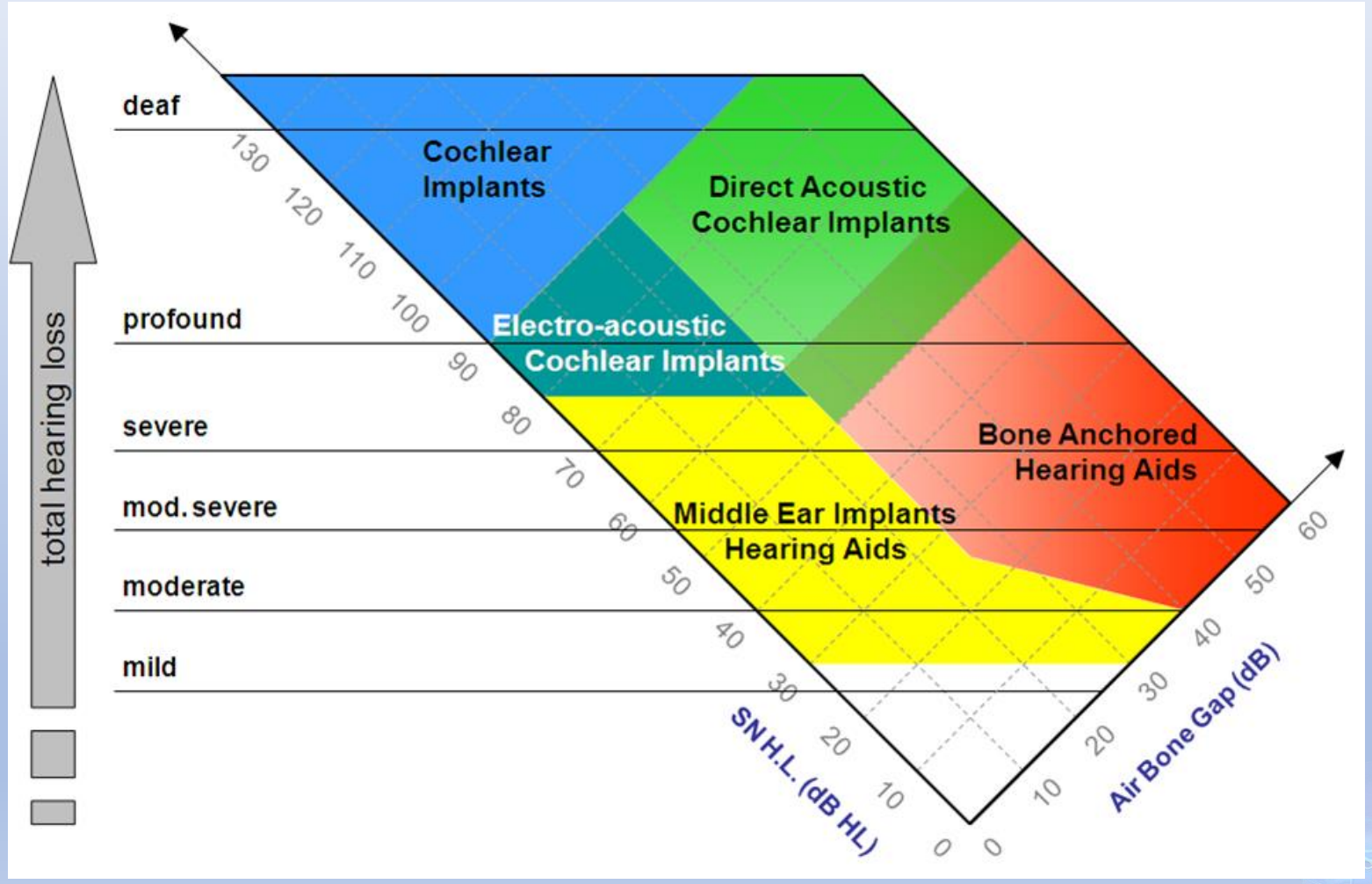


Left BAHA attract

26 year old man with bilateral atresia with auricular reconstruction

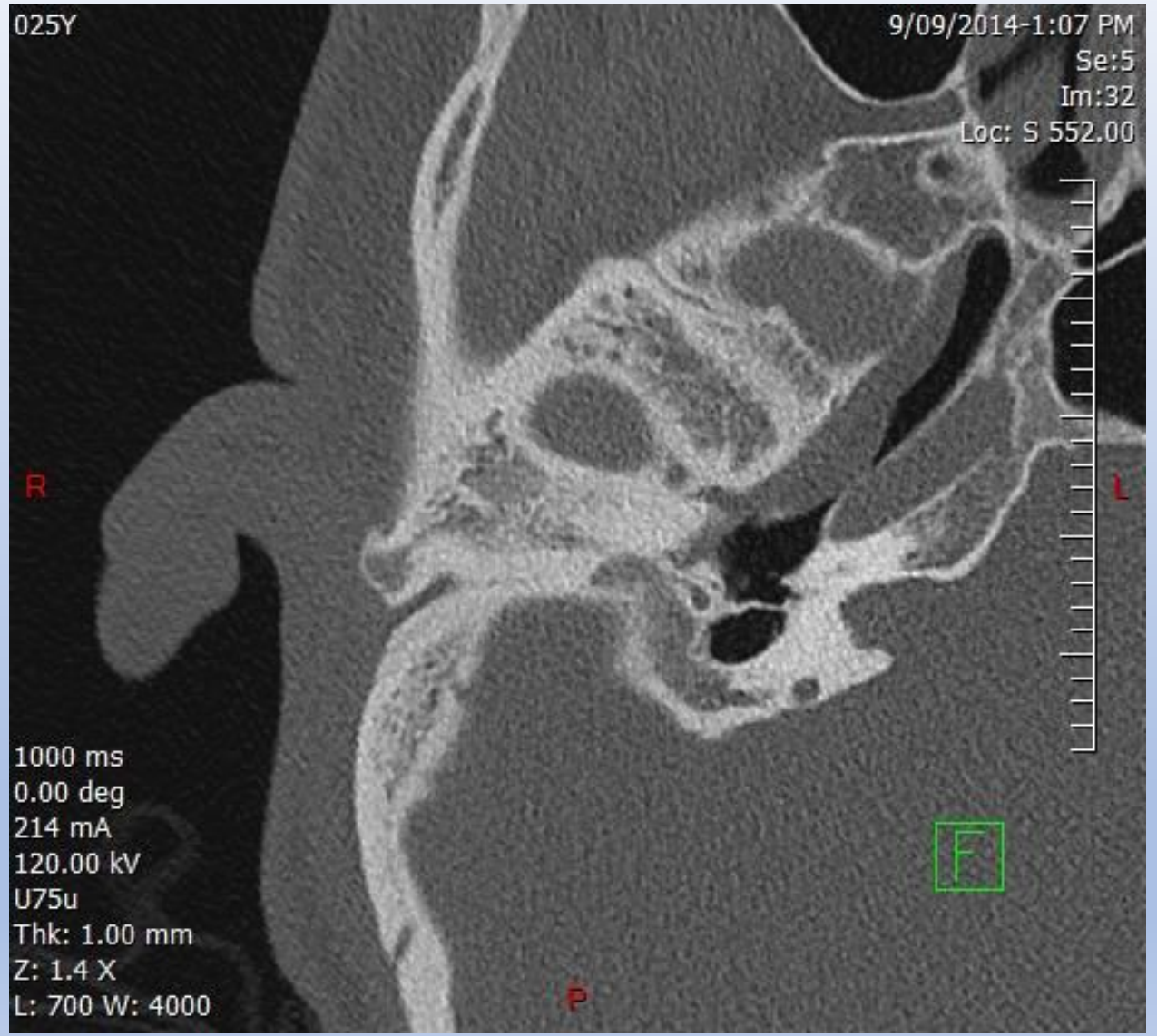


Indications



Which implant (if any)

- Unilateral vs Bilateral
- BAHA: Connect vs Attract
- Ponto
- Sophono
- Bonebridge
- Soundbridge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120.00 kV
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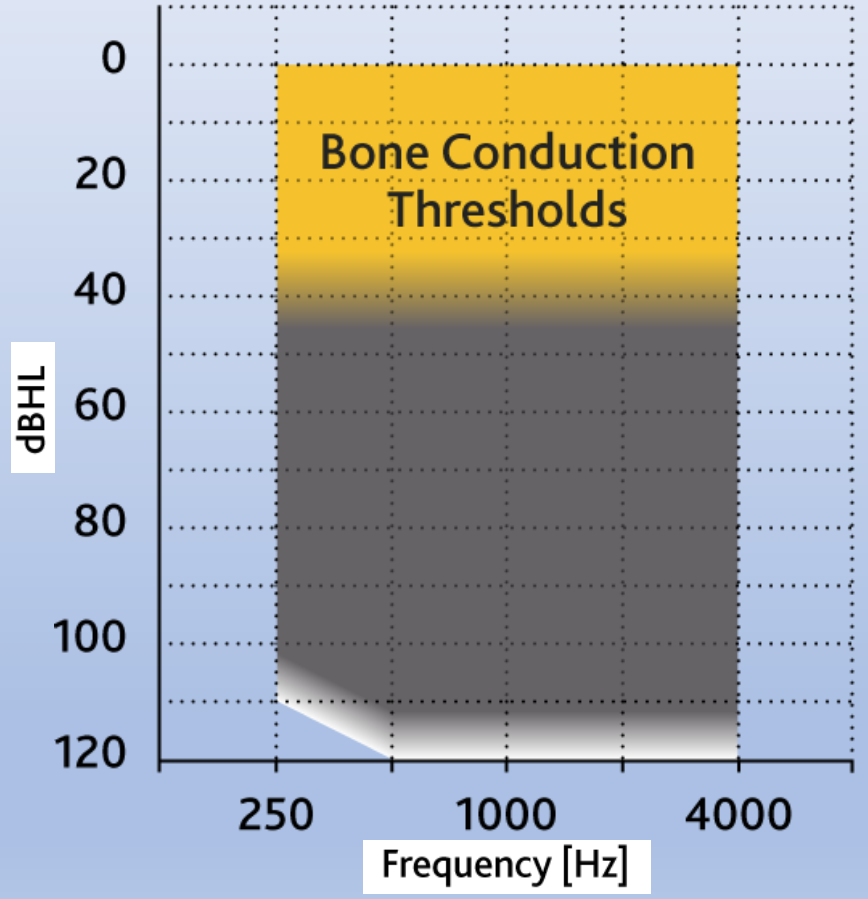
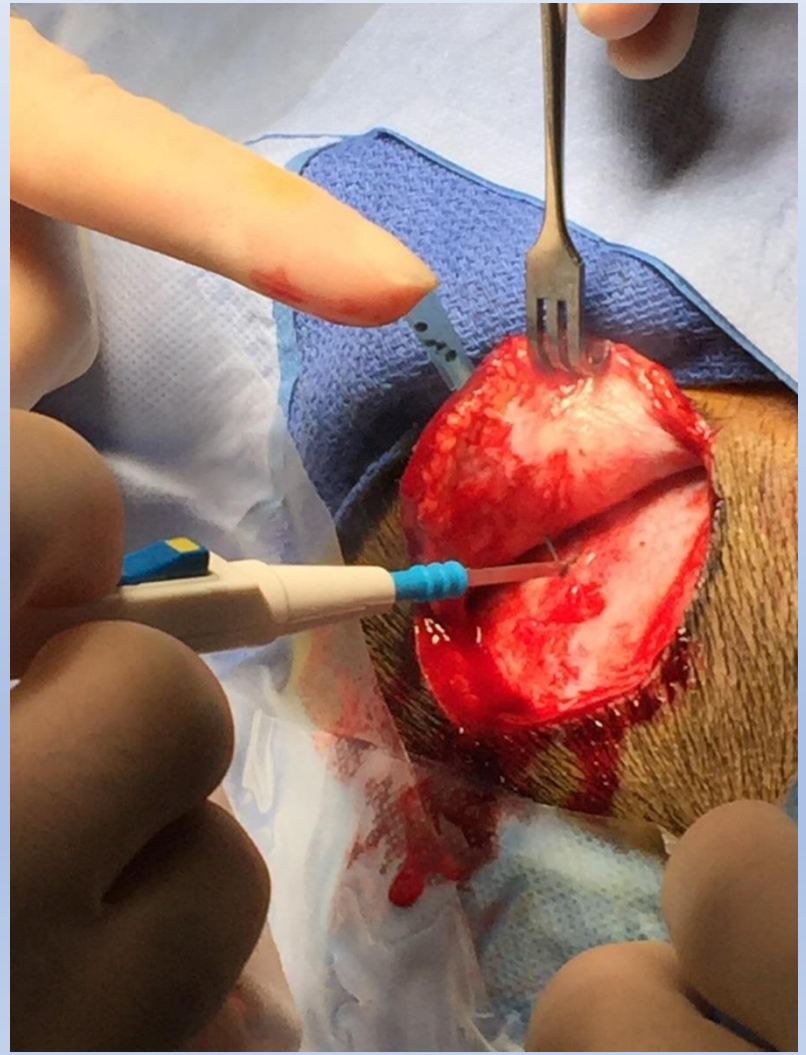
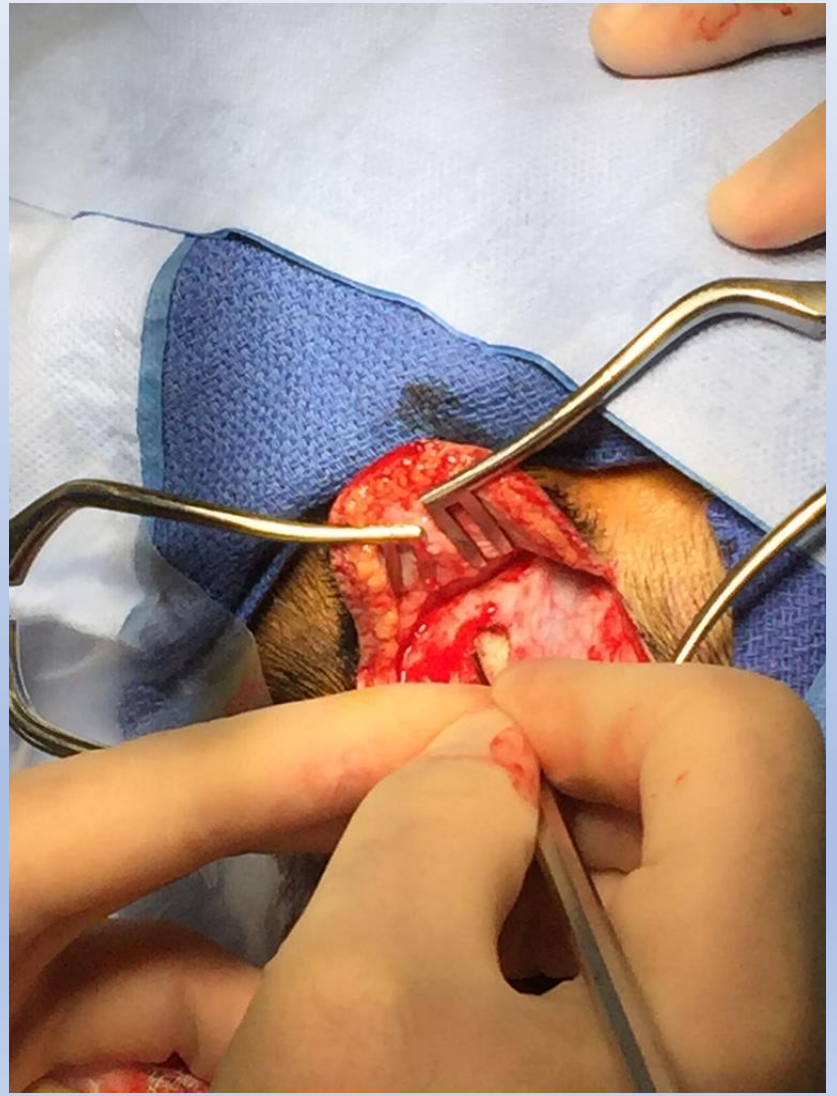
Up to **45 dB** SNHL

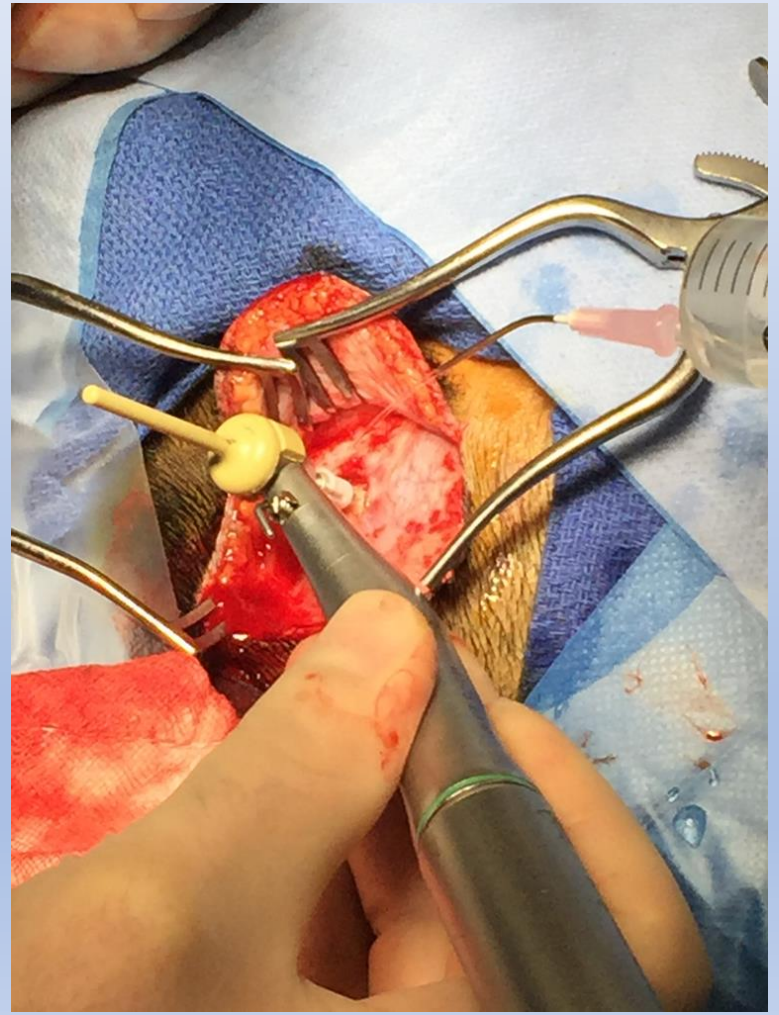


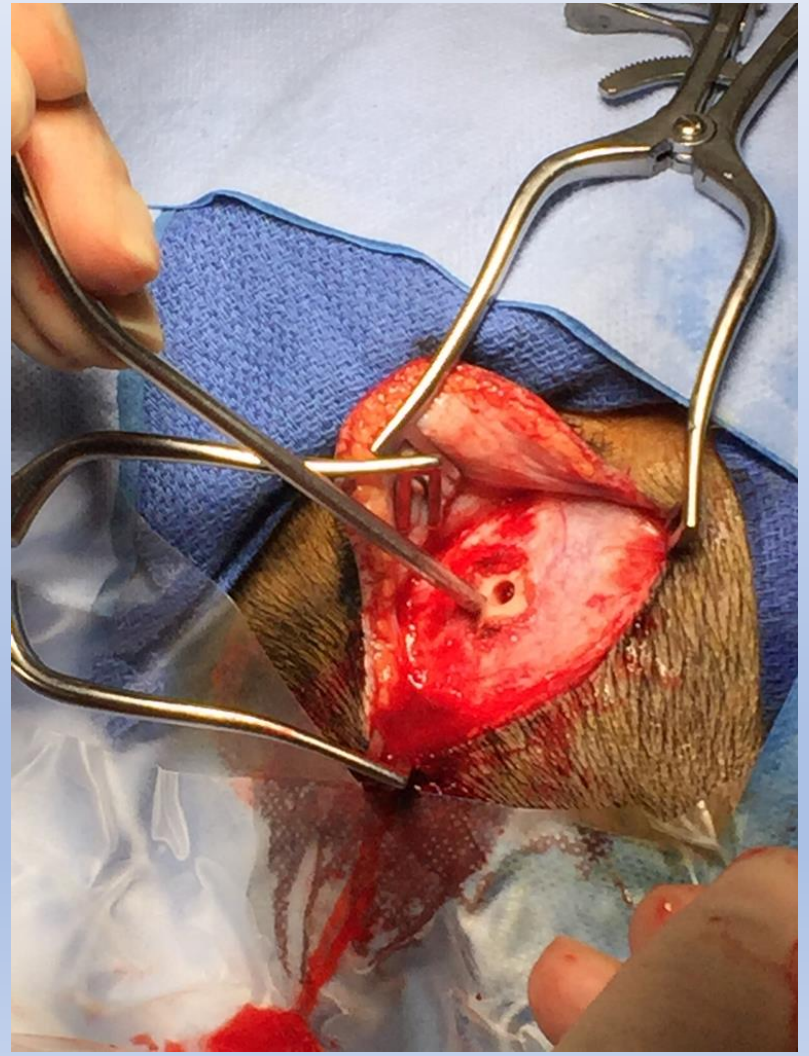
1. Norrman, J, Review of fitting ranges. Cochlear Bone Anchored Solutions AB, D773528, 2015.

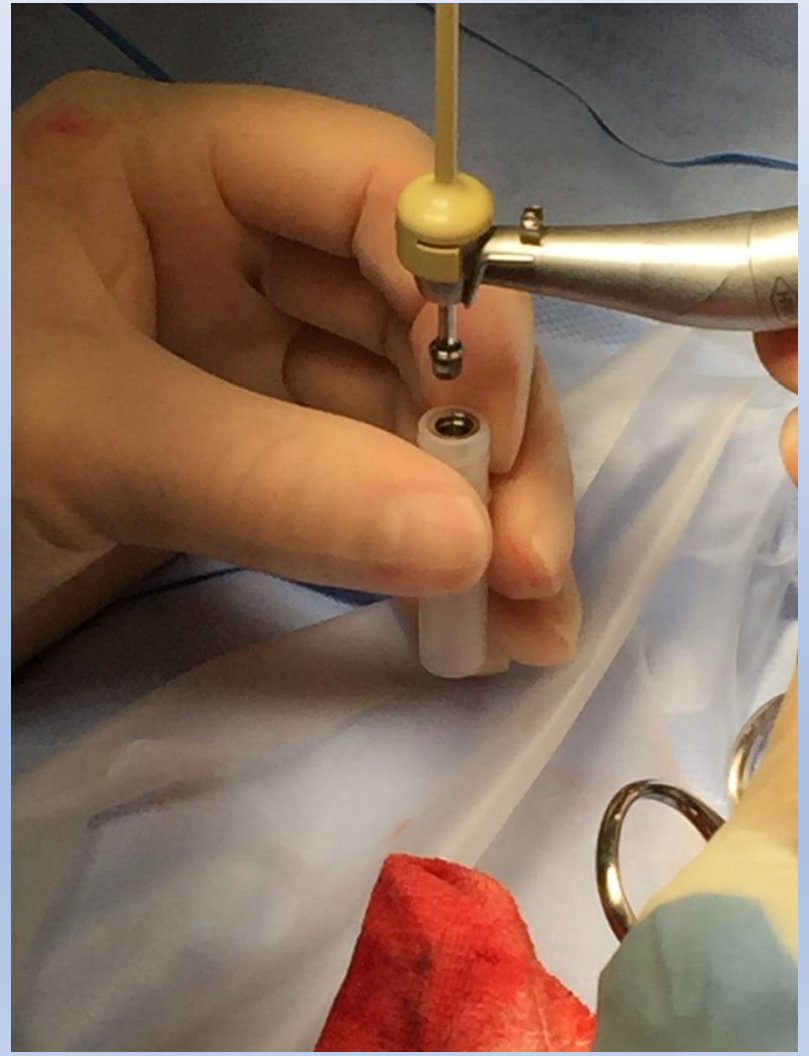
Ant based flap due to previous reconstruction

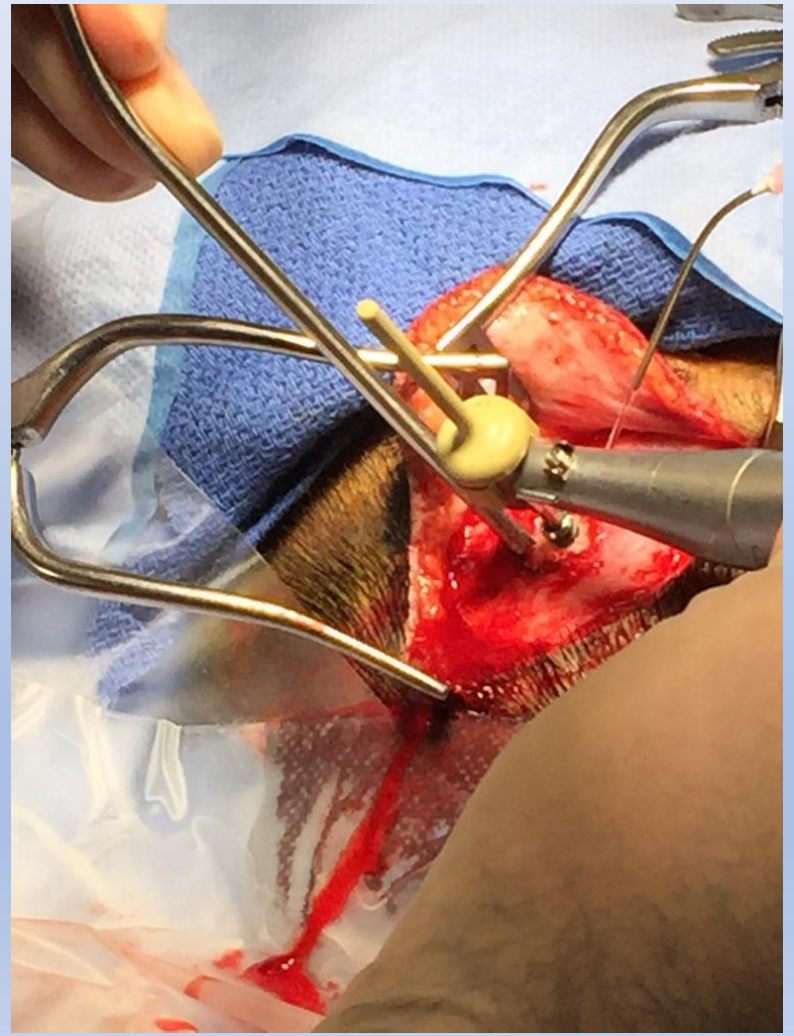


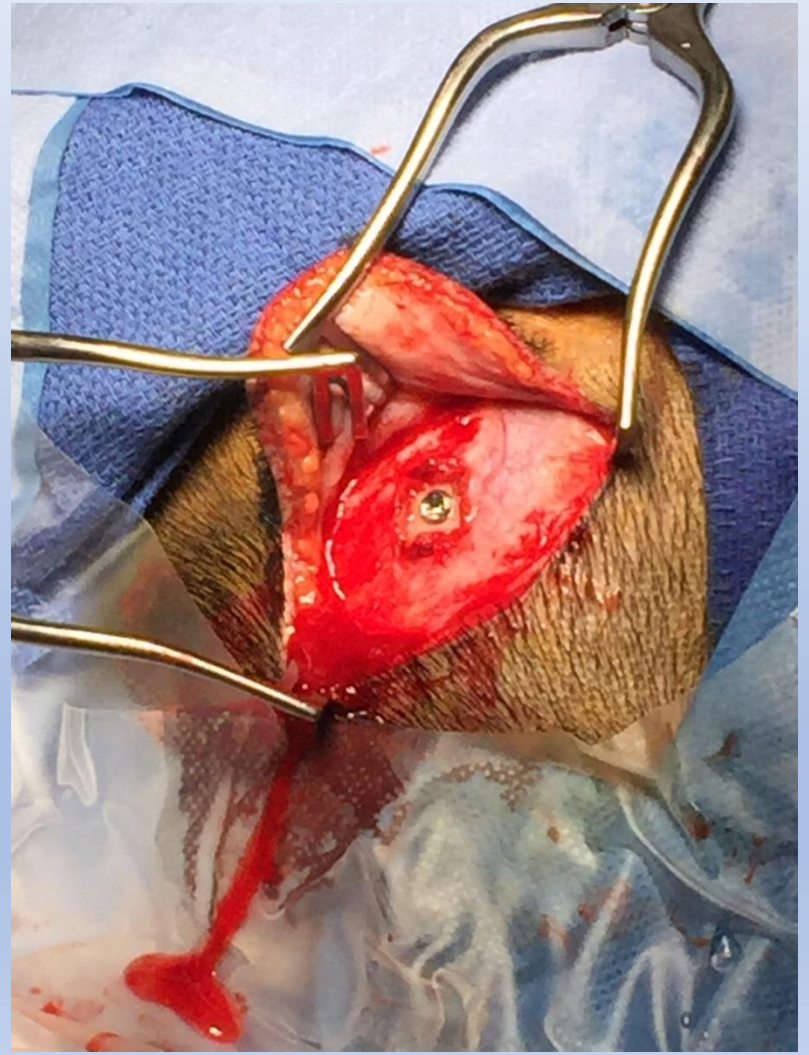


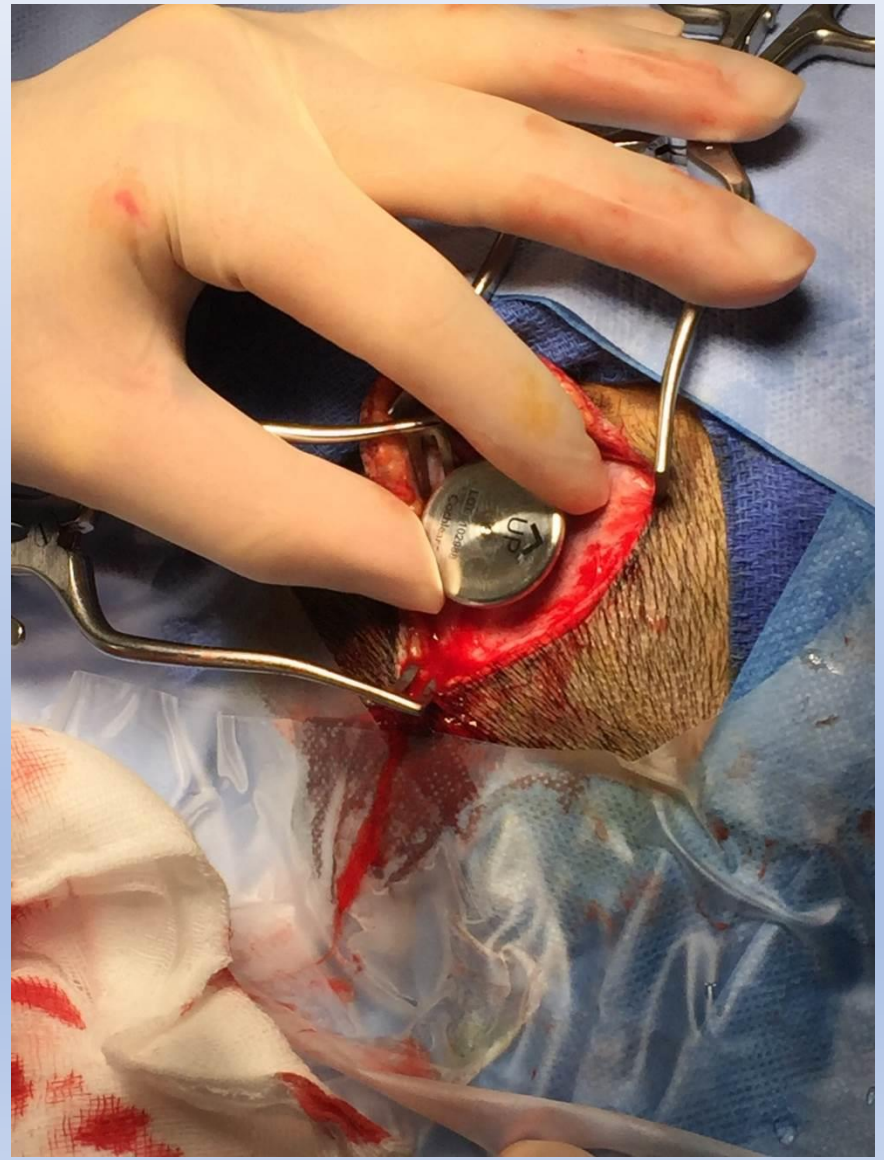


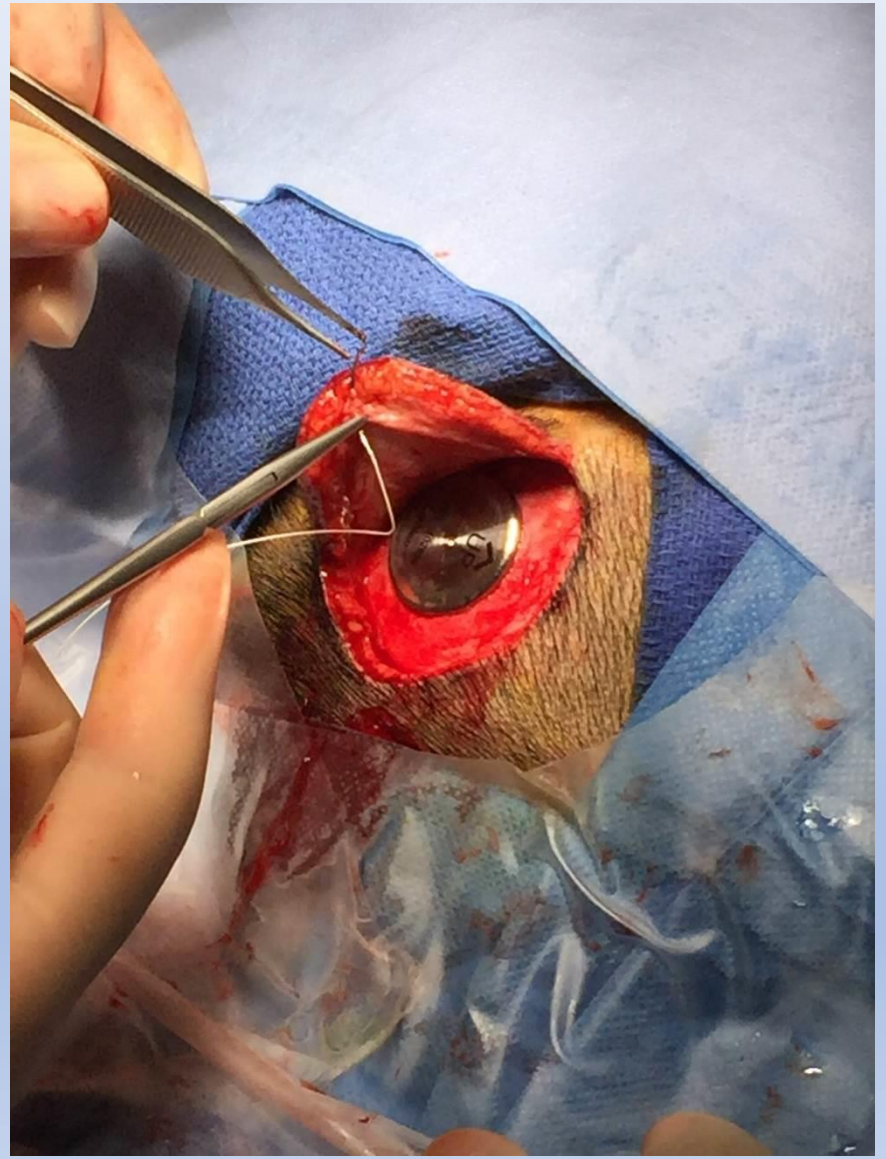




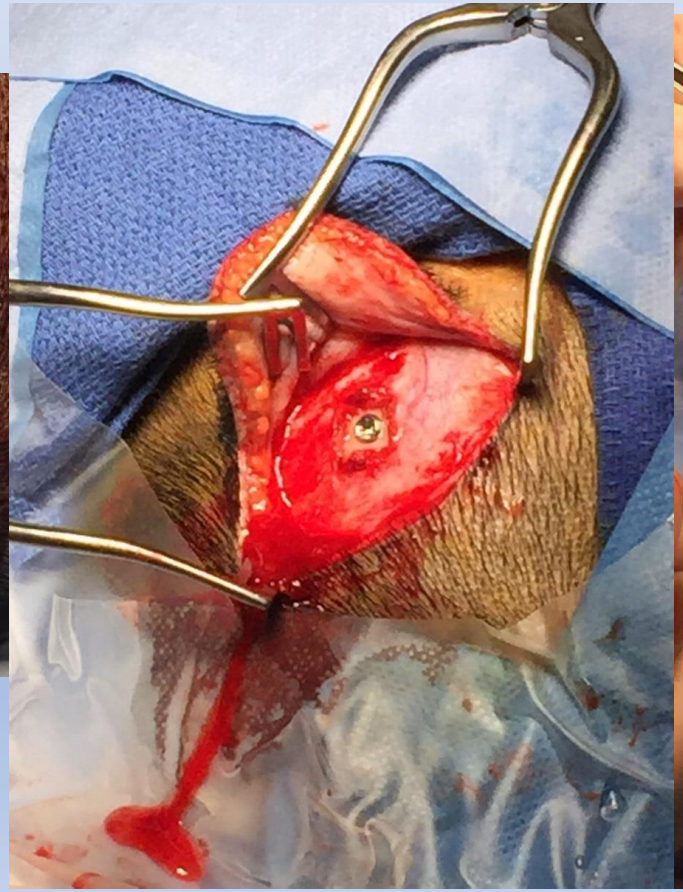


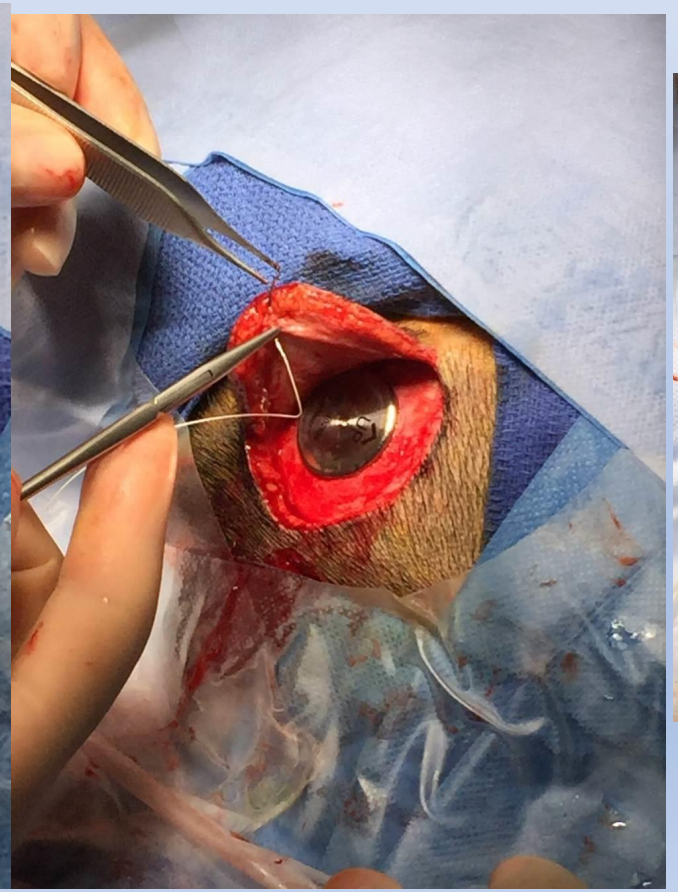






Baha Attract





78 year old man

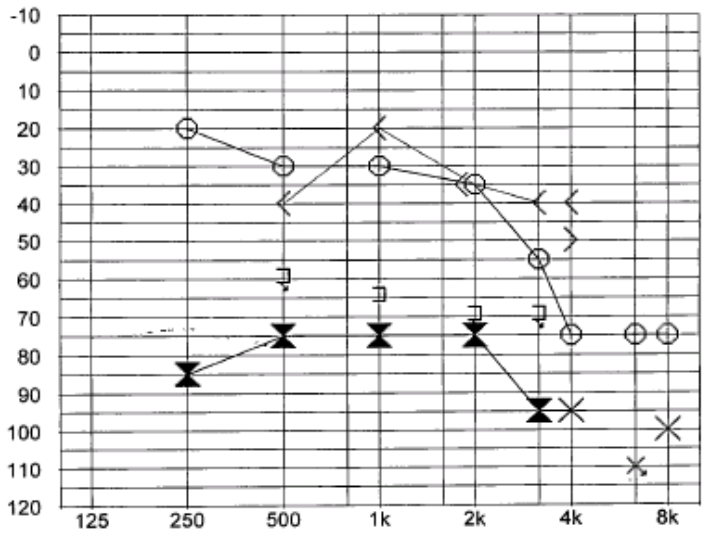
- Left sided vestibular schwannoma

- 8mm in size, no growth for 8 years

Options:

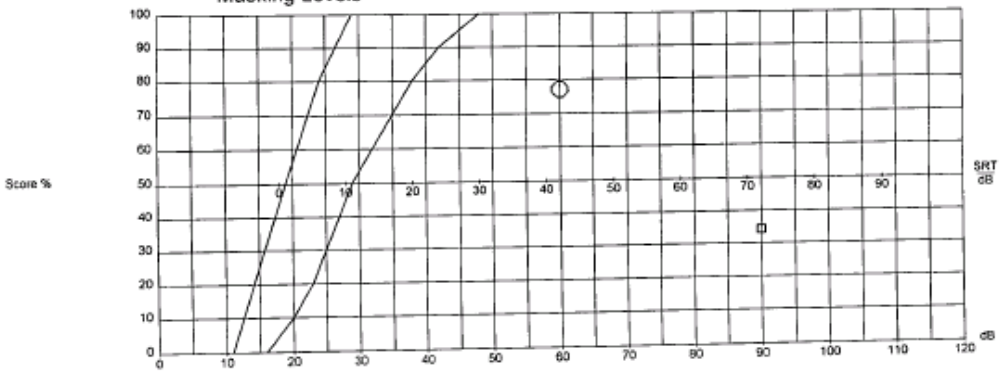
Bicross (the best)

Bone anchored hearing aid for SSD (which one)



		80	70	70	75	85
AC:			70	90	65	85
BC:						
SF:						
SF A:						

Masking Levels

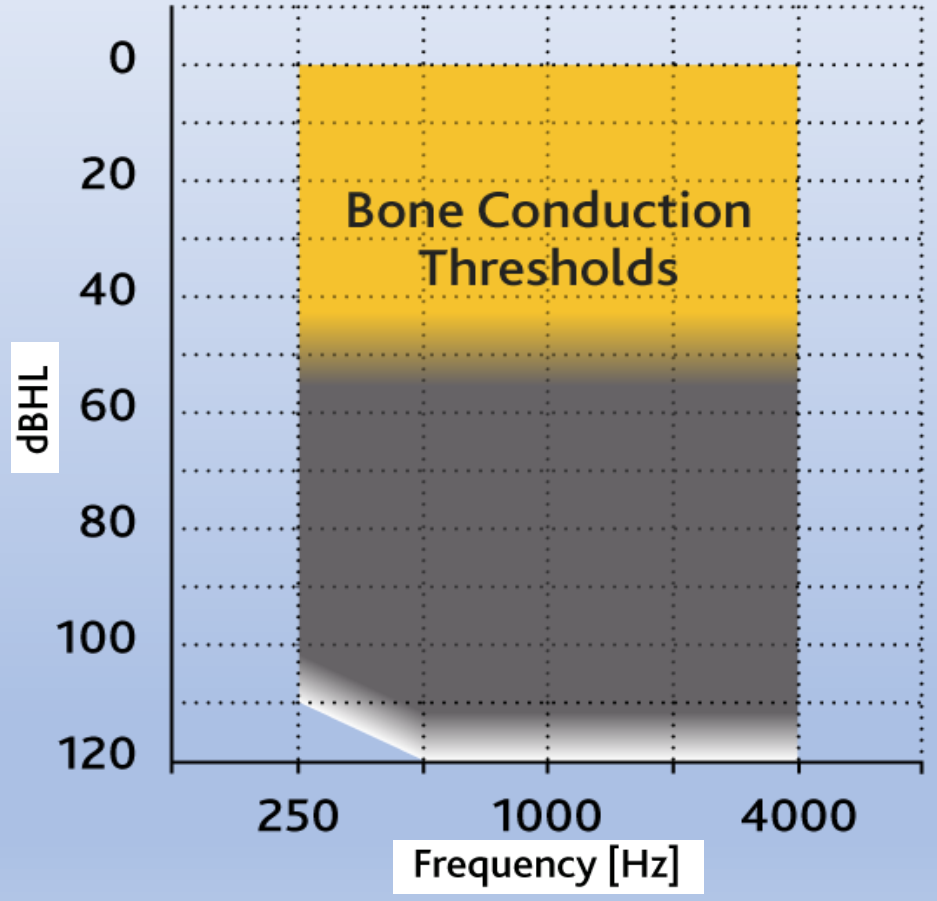


Notes
Could not mask 4kHz bone in the left ear due to degree of AC thresholds.

Speech Discrimination

R @ 60dB HL= 78%
L @ 95dB HL with masking= 35%

Up to **55 dB**
SNHL

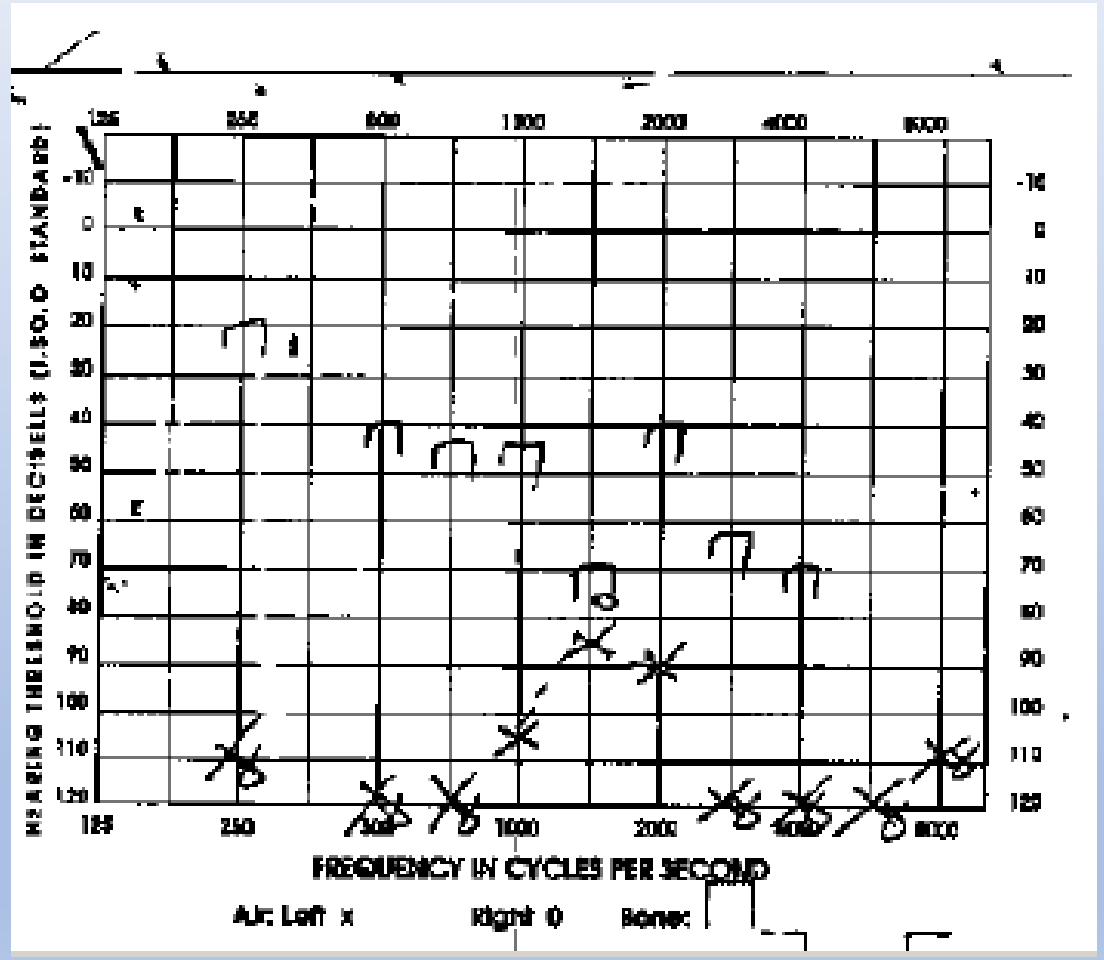


D952195 ISS1 JULY16

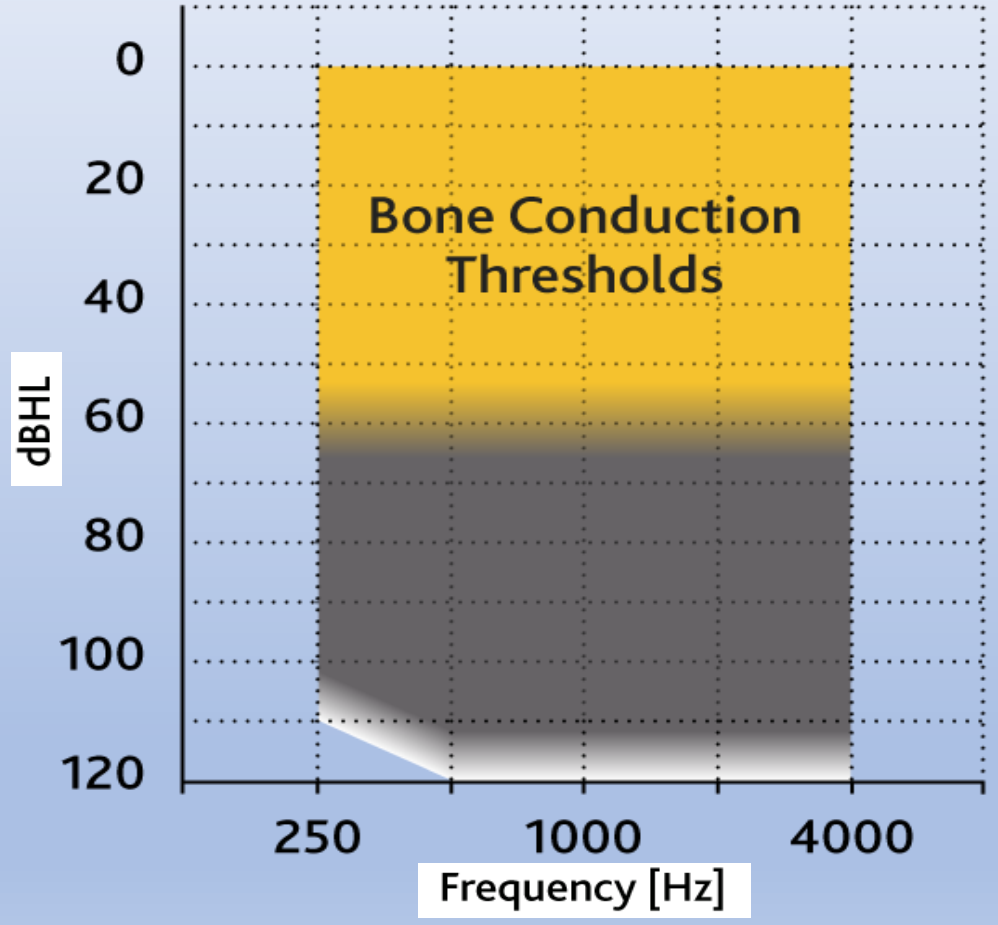
1. Norrman, J, Review of fitting ranges. Cochlear Bone Anchored Solutions AB, D773528, 2015.

74 year old man

- Right fenestration at age 14 years old
- Dead ear within 1 month
- Progressive hearing loss left ear

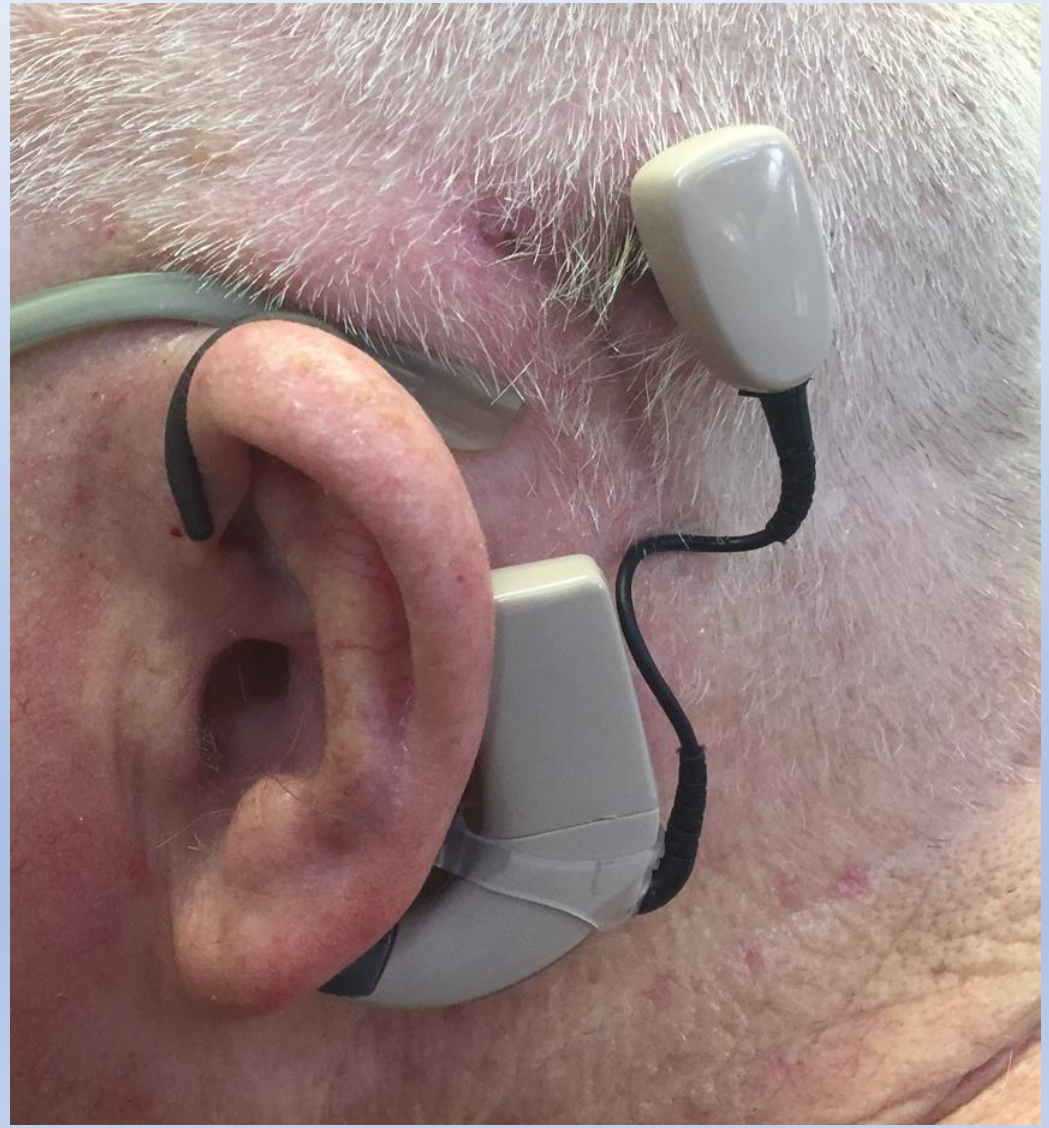


Up to **65 dB**
SNHL



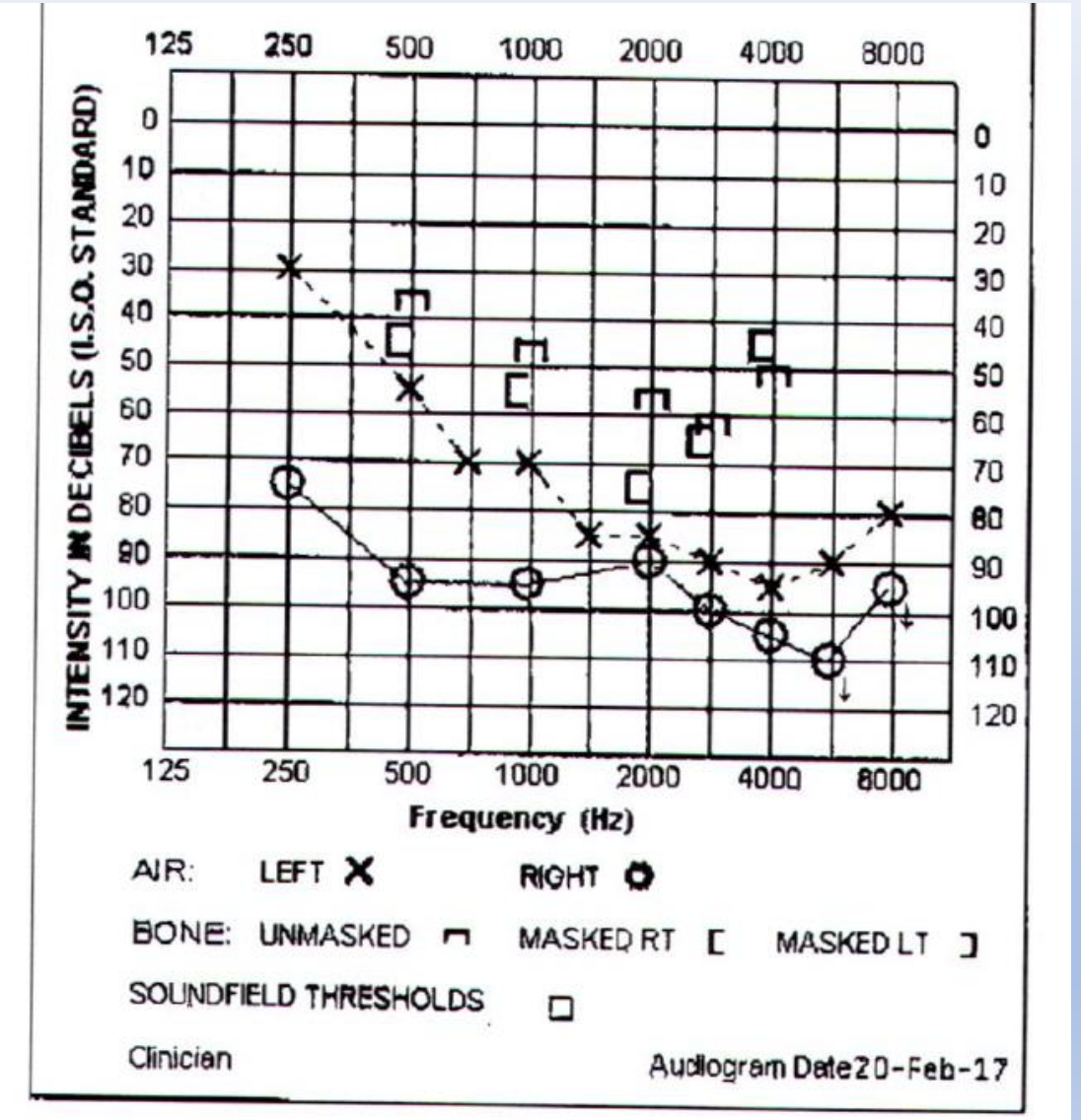
1. Norrman, J, Review of fitting ranges. Cochlear Bone Anchored Solutions AB, D773528, 2015.

BAHA Superpower Connect

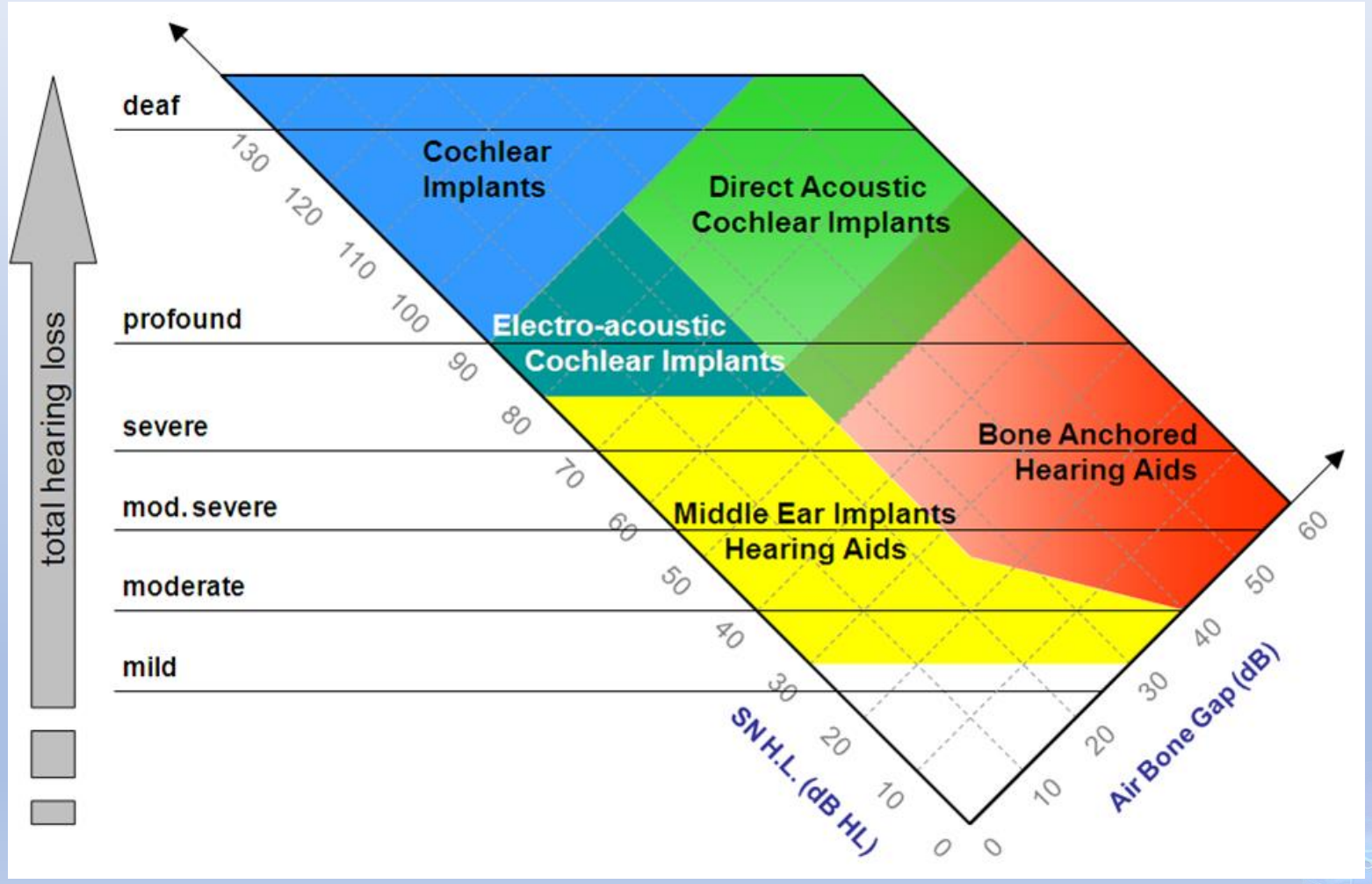


68 year old man

- Multiple surgeries right ear, ongoing suppuration
- Cholesteatoma left ear

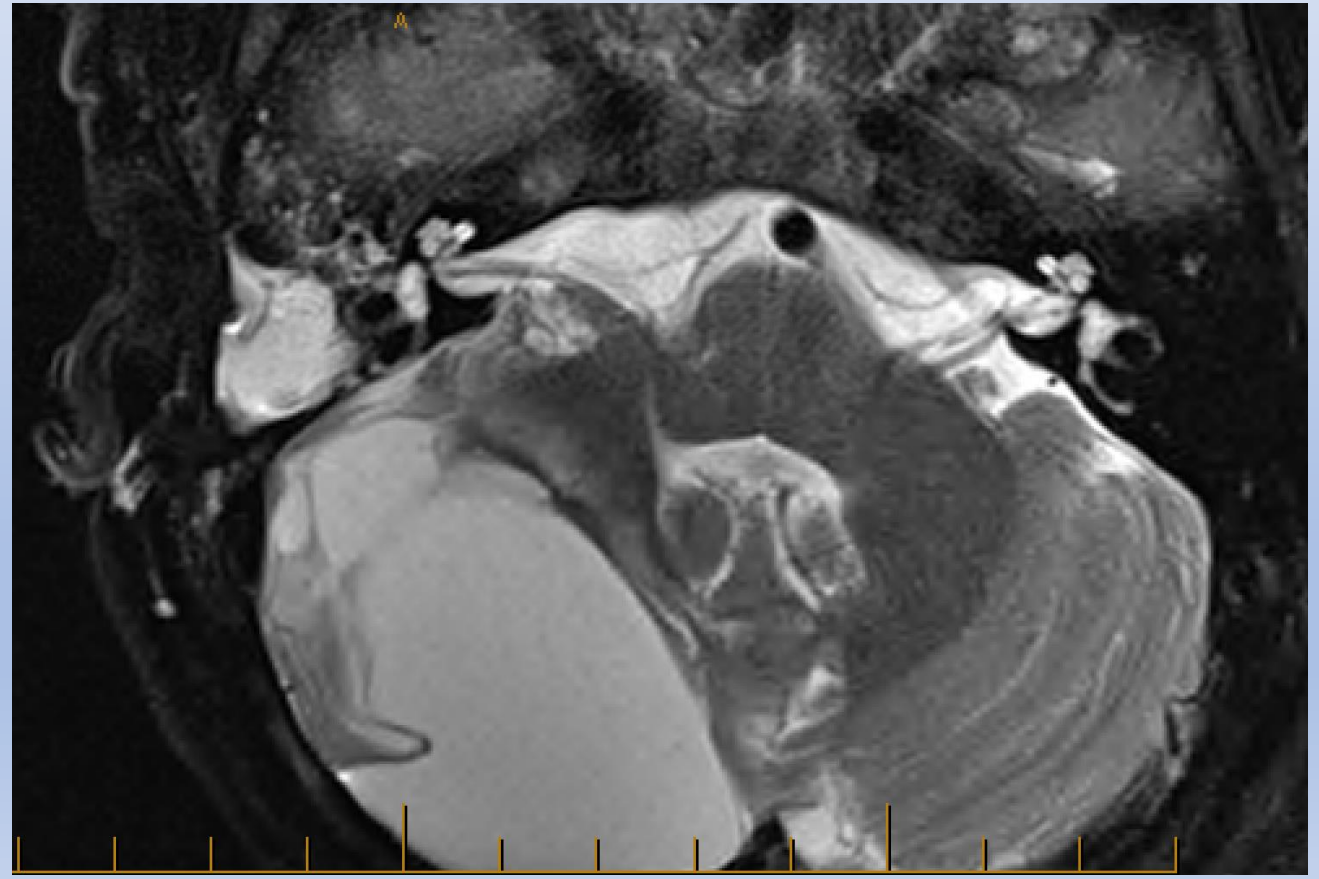


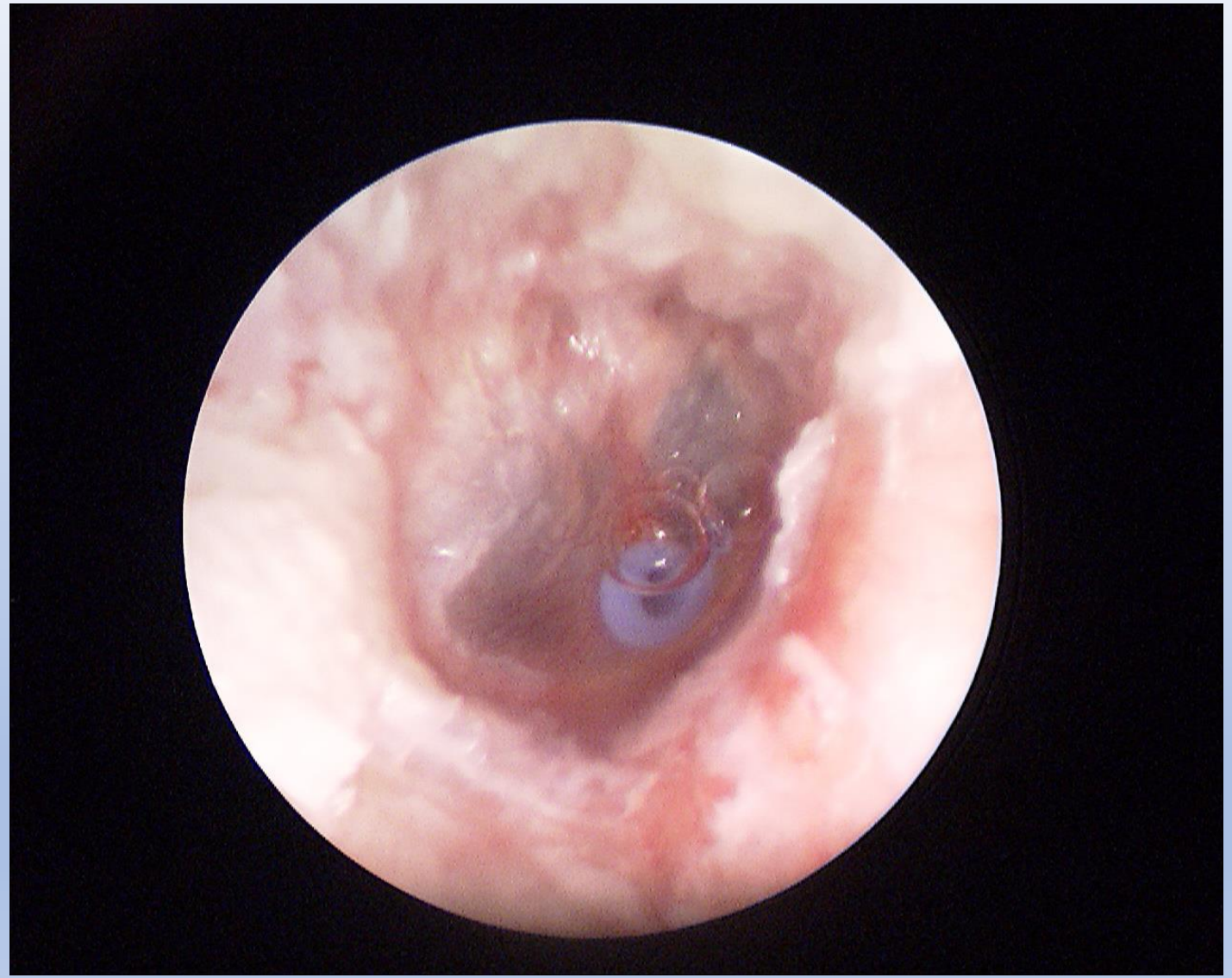
Indications



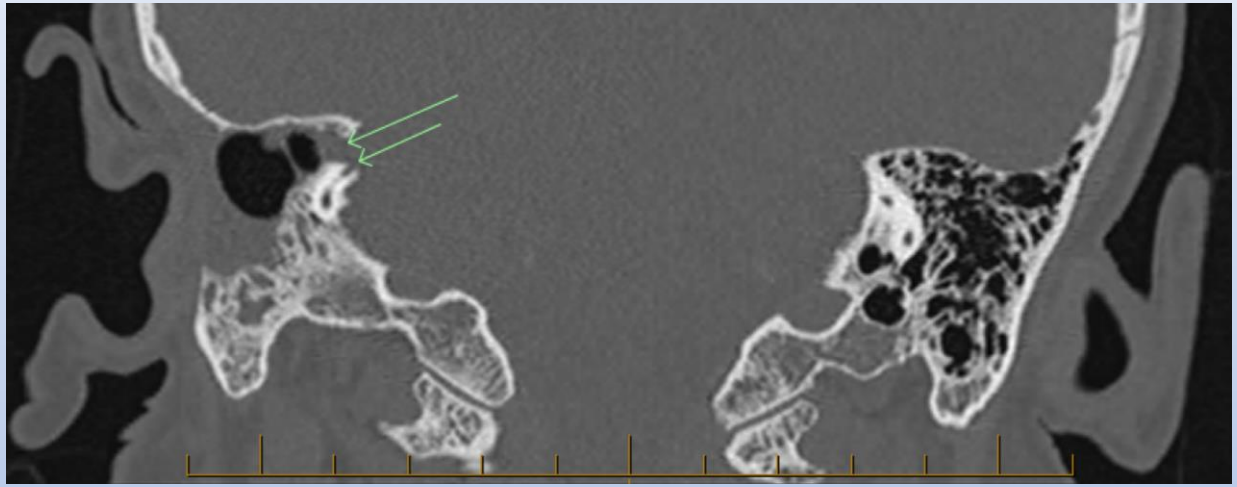
BAHA superpower attract

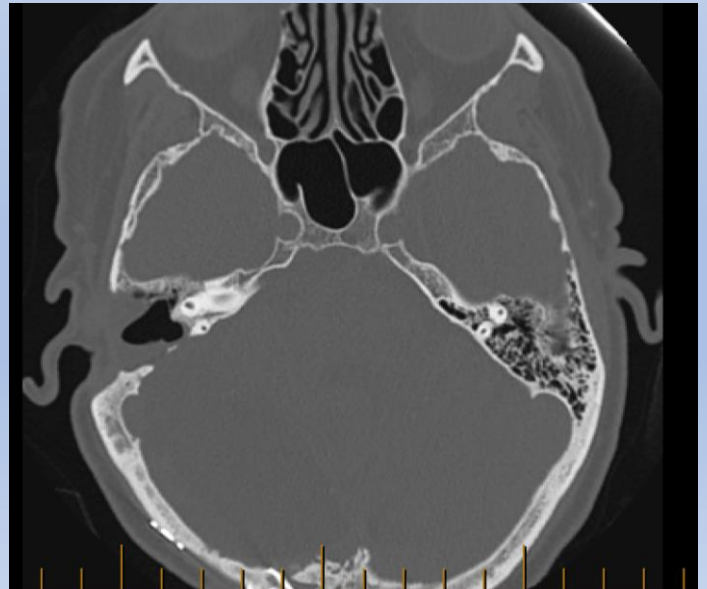
Large meningioma removed post cranial fossa 4 years ago: presents with life threatening meningitis



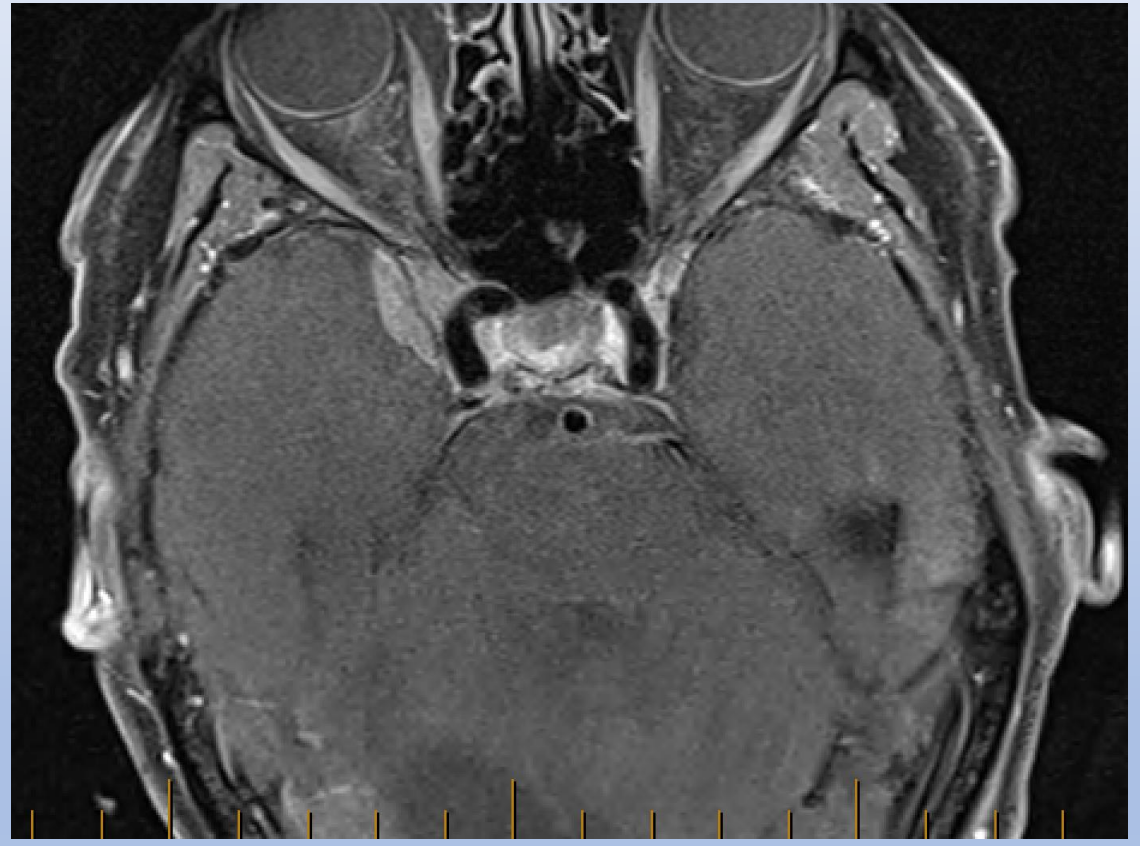


Ongoing CSF leak

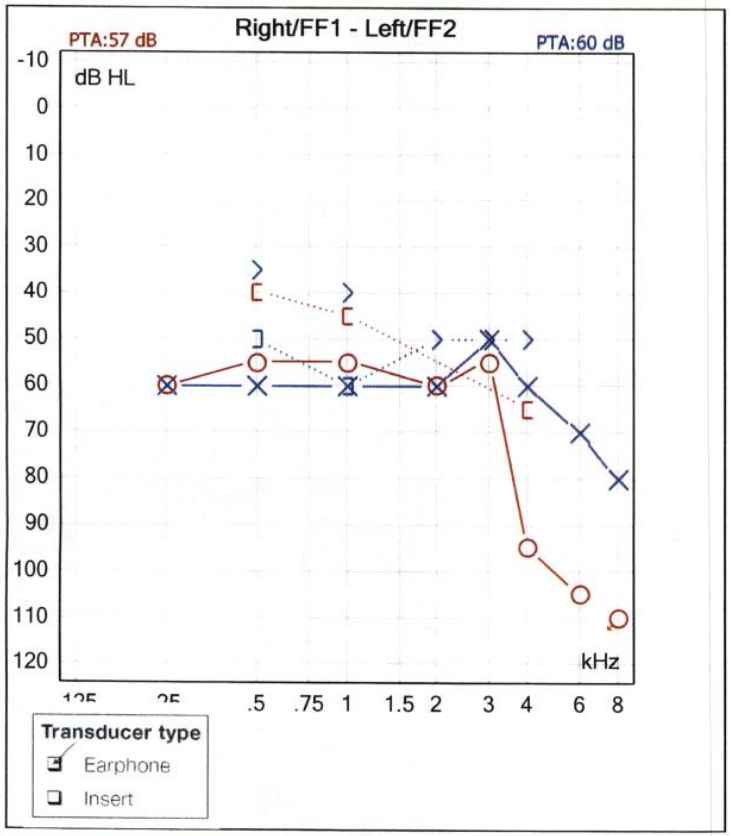




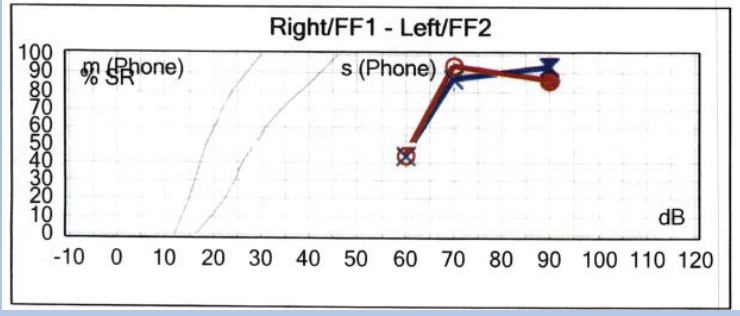
Small meningioma requiring ongoing MRI scans



Pure Tone Audiogram



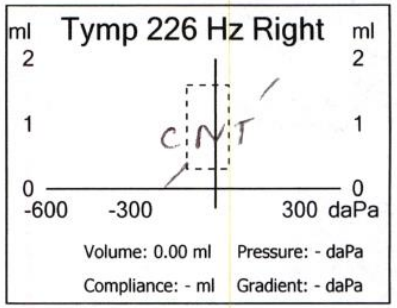
Speech Audiometry



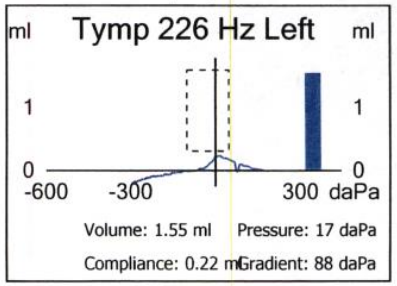
Legend

Modality	Right	Bin	Left
Air Conduction-Earphones			
Unmasked	O		X
Masked	●		⧗
Bone Conduction-Mastoid			
Unmasked	<		>
Masked	[		]
Air Conduction Aided	H	△	V
Air Conduction-Sound Field		□	
Loudness Discomfort Level	L		⅃

Type:



Type: A(s)



Reflexometry

Probe	Stim	.5	1	2	4

Subtotal petrous temporal bone resection and blind sac closure

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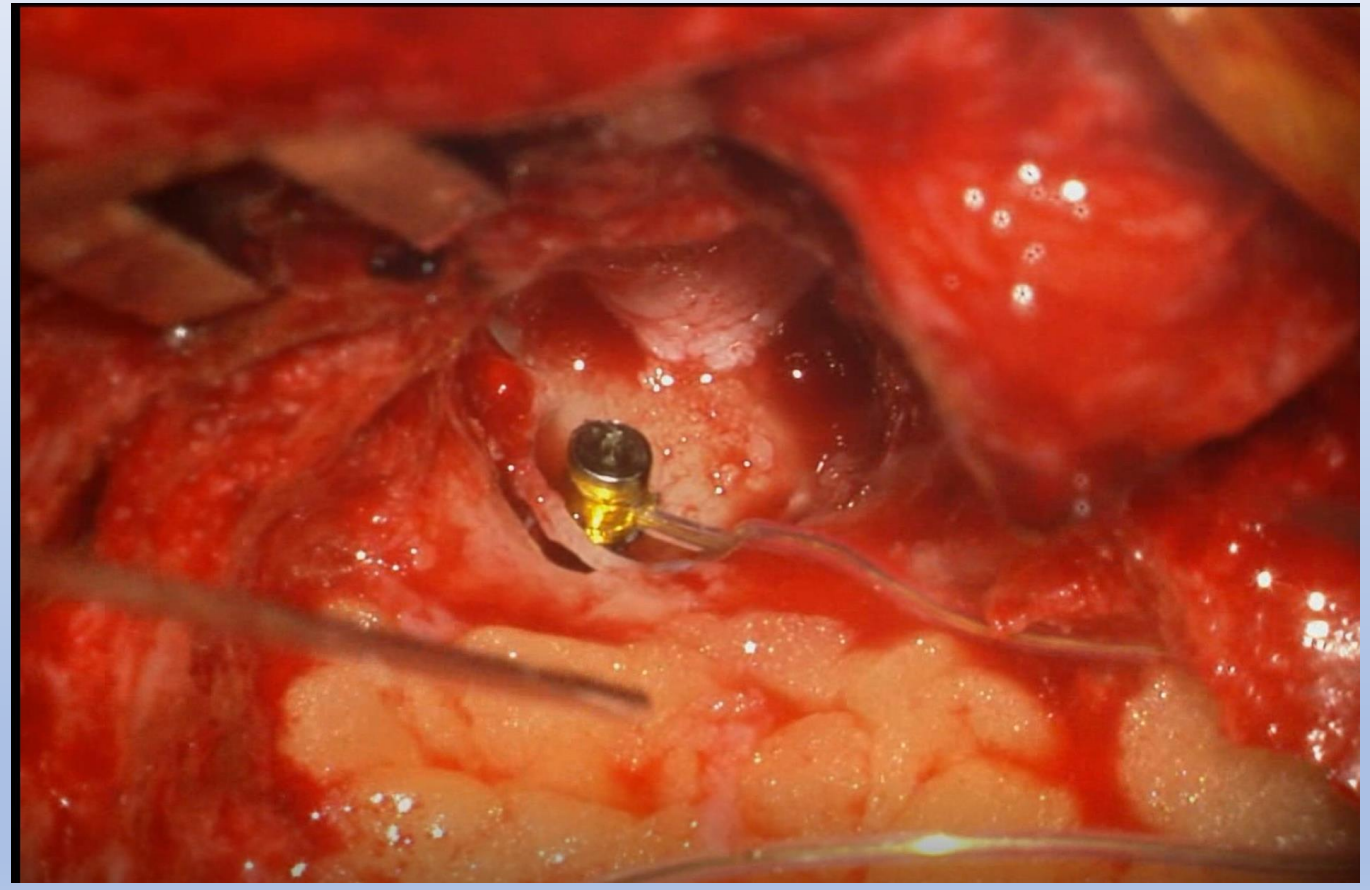
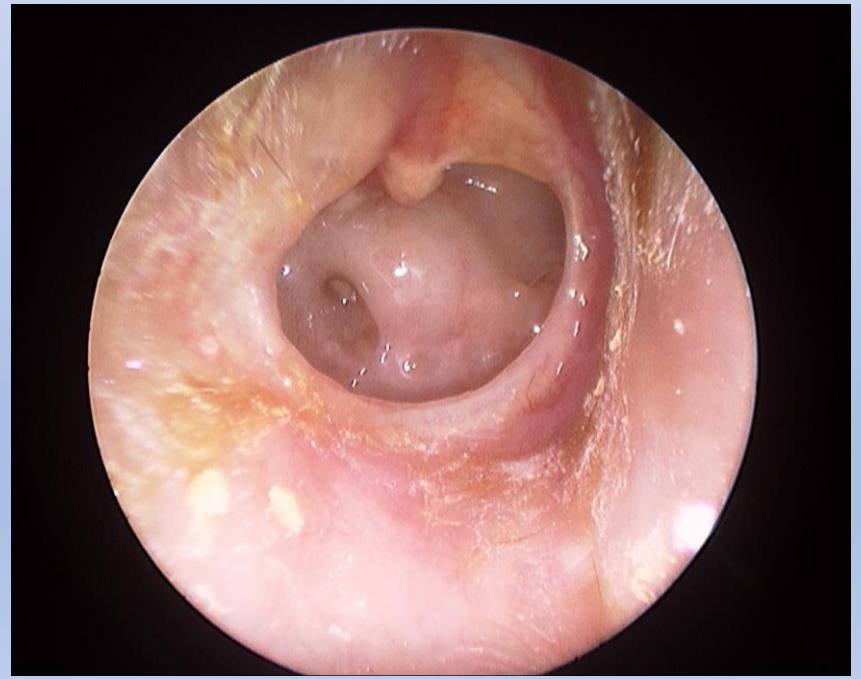
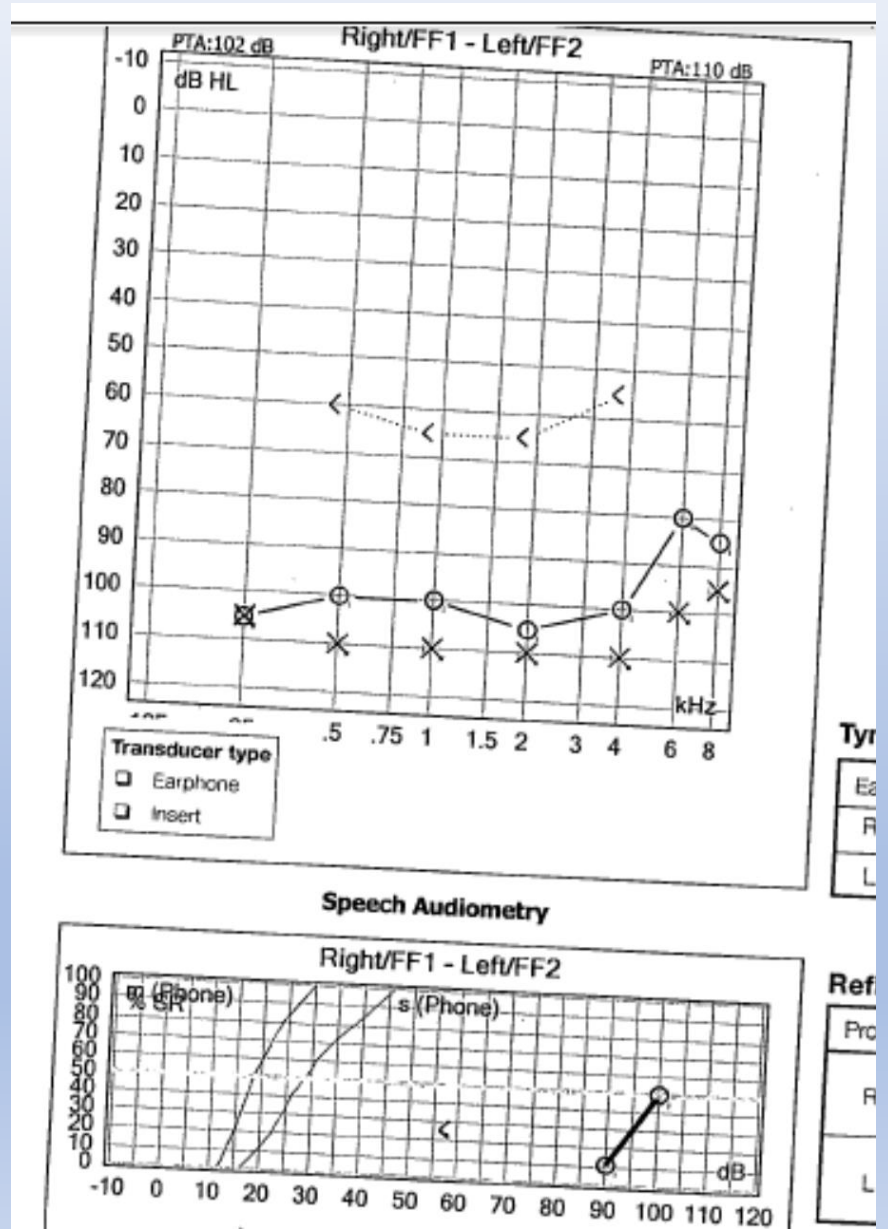
Sound bridge with stapes coupler

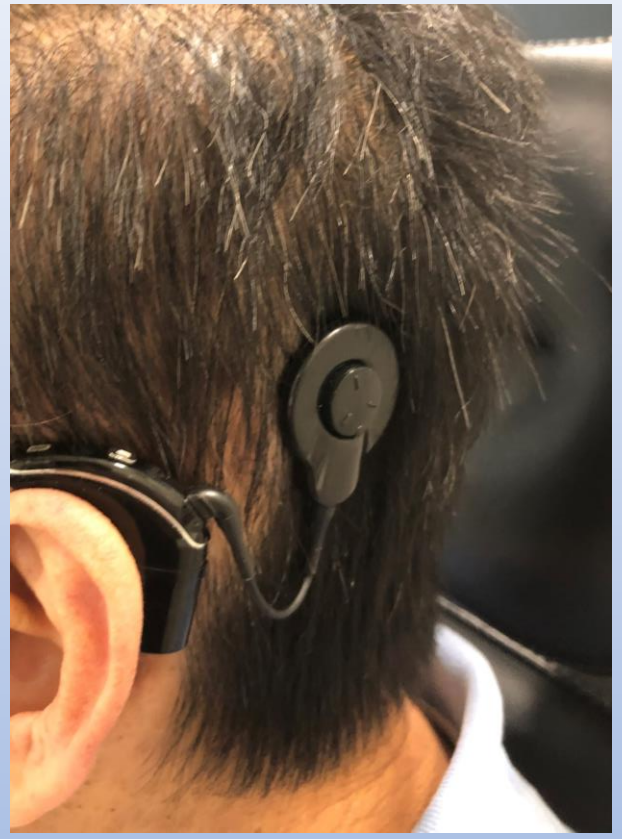


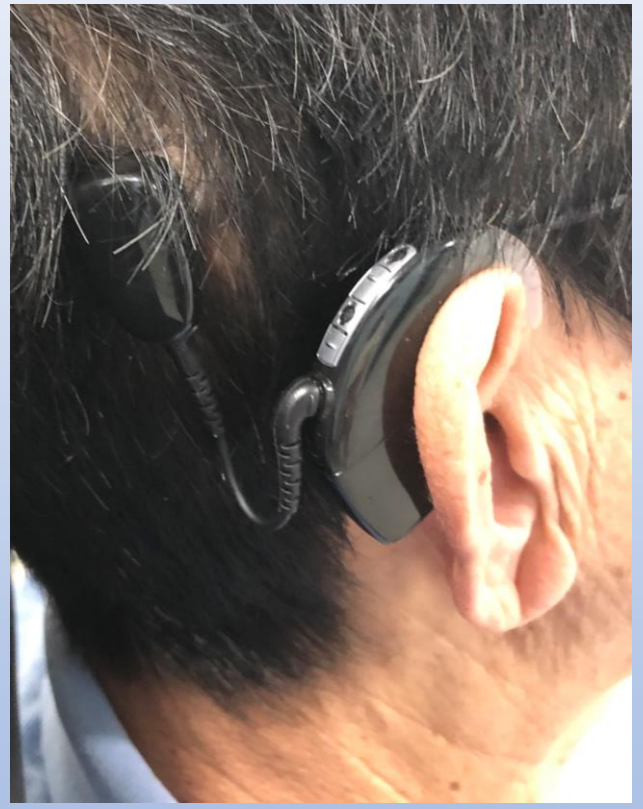
72 yo man

Blind sac left with BAHA connect
HA right: recurrent infections. Subtotal perforation









2 month review post Left CI

The Implant Test results were normal. Mapping indicated a change in his T and C levels compared with his last mapping 3 weeks post switch on.

CI Aided Audiogram:
Cochlear implant aided thresholds fall at the top of the long term average speech spectrum at all frequencies.

CI Aided Speech Perception Testing:

CUNY Open Set Sentences (Live Voice)

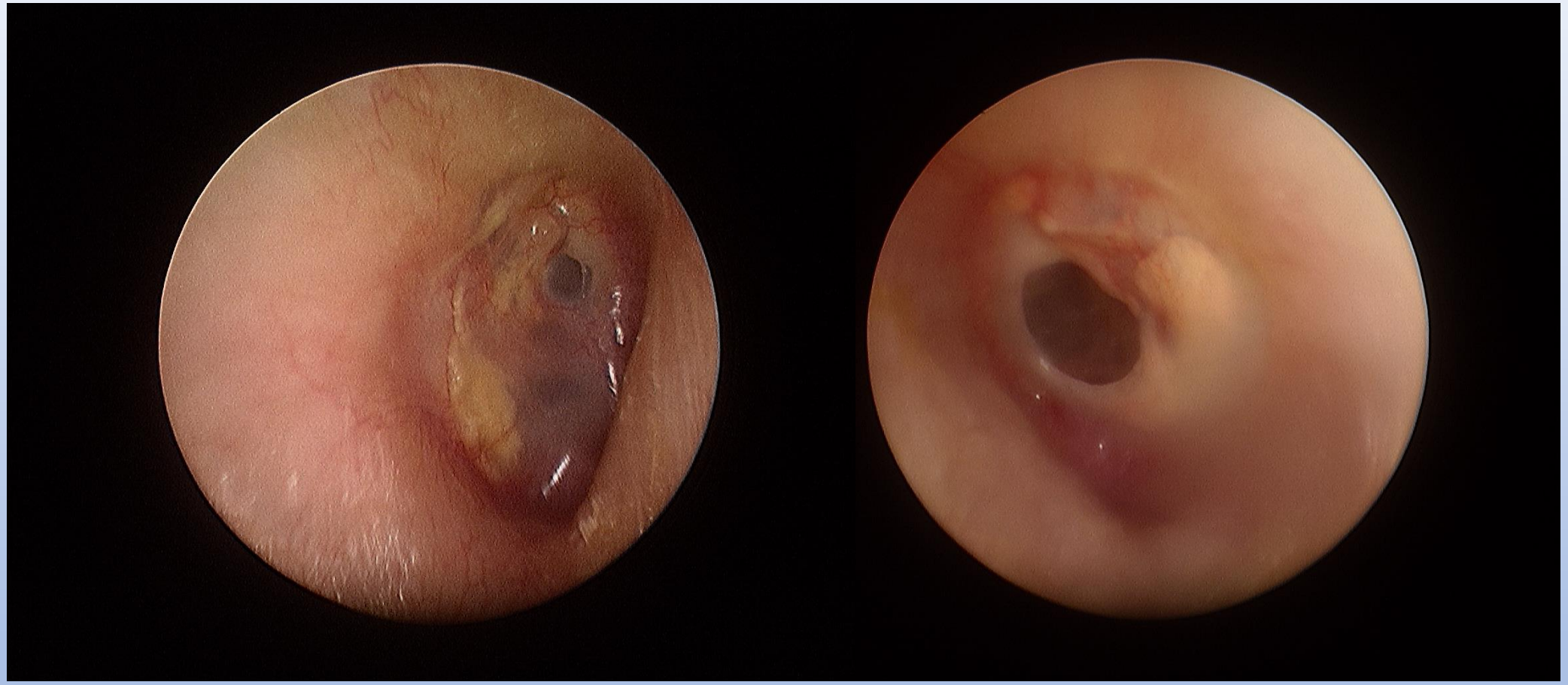
Binaural aided Auditory plus Visual:	100%
Binaural aided Auditory Alone	98%

BKB Open Set Sentences (Pre-recorded) at 65dBHL

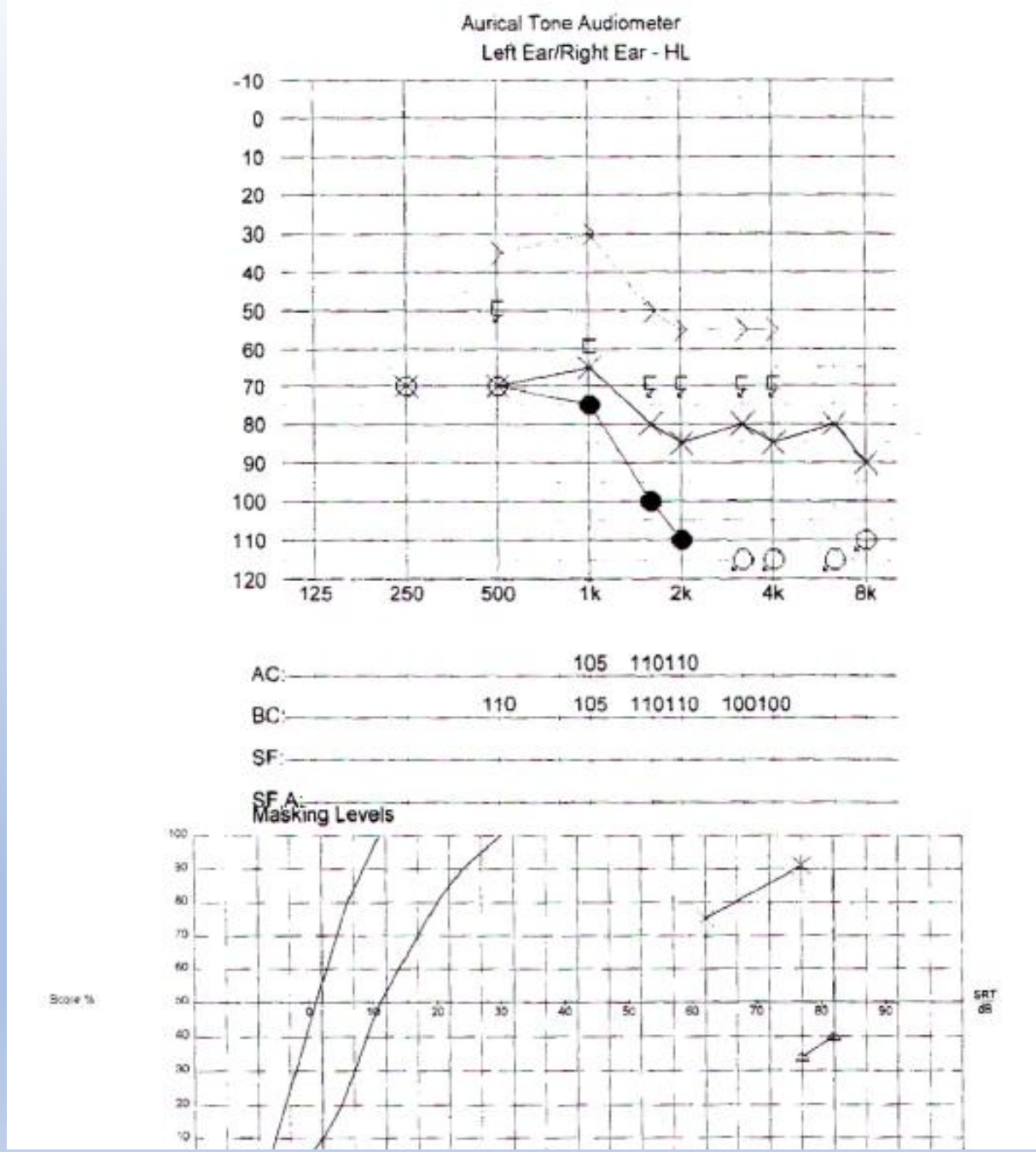
Bimodal aided:	70%
Right Superpower BAHA	Not tested today due to fatigue
Left CI alone	43%

76 year old woman

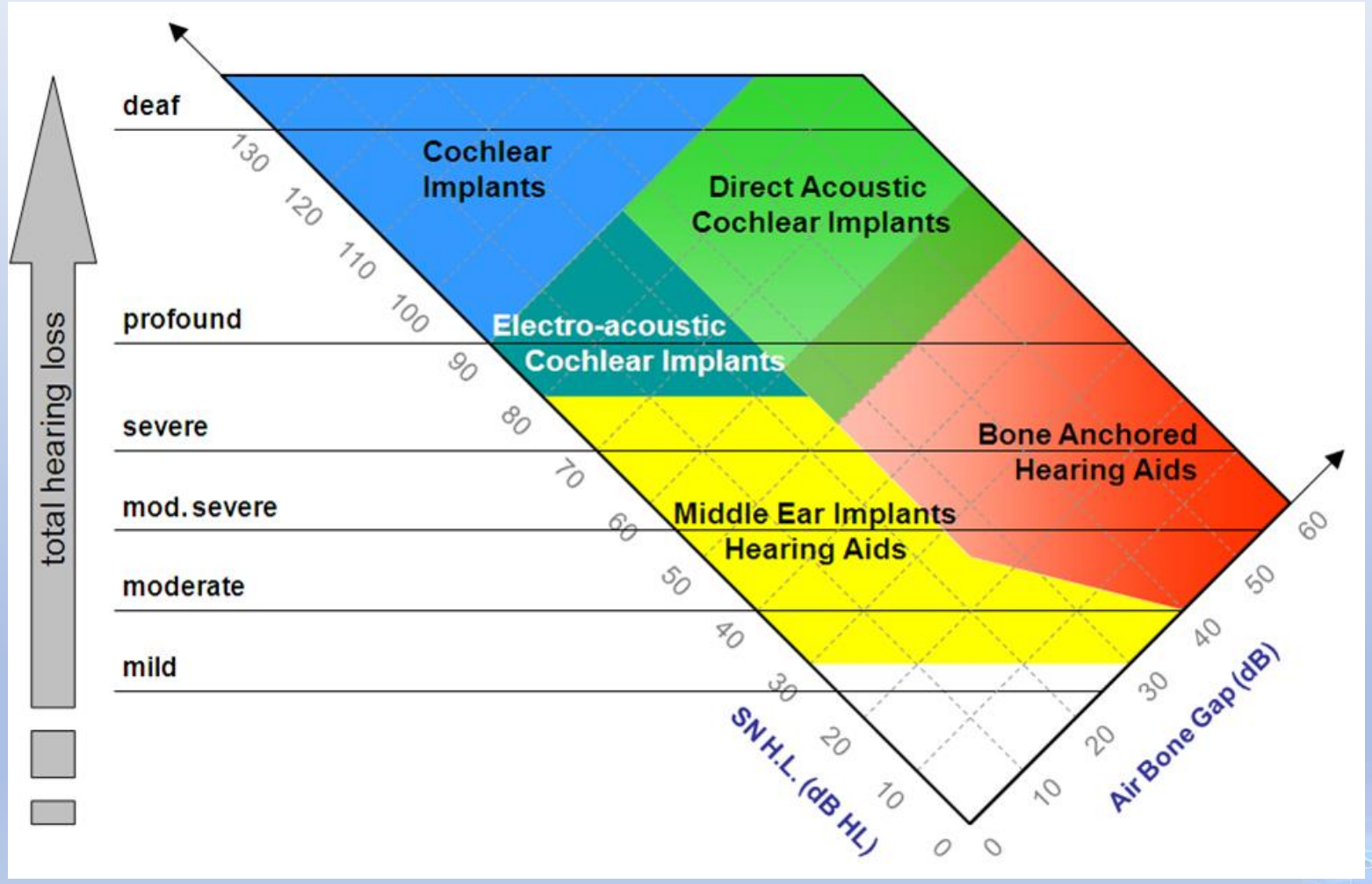
- Surgery on right ear 16 years ago with significant reduction in hearing
- Recurrent suppuration left ear limiting hearing aid use
- Declining sensorineural function left



76 year old woman



Indications



Speech Audiometry Headphones (AB Words)
Left @ 80dB = 75%
Left @ 95dB = 91%
Right @ 95dB = 33%
Right @ 100dB = 40%

Speech Audiometry Freefield (AB Words)
Unaided @ 65dBSPL = 45%
Left aided @ 65dBSPL = 83%
Left aided @ 65dBSPL + 50dB noise = 72%
Left aided @ 65dBSPL + 55dB noise = 58%


P

Part 2

Cost-effectiveness of CI compared with various medical interventions.

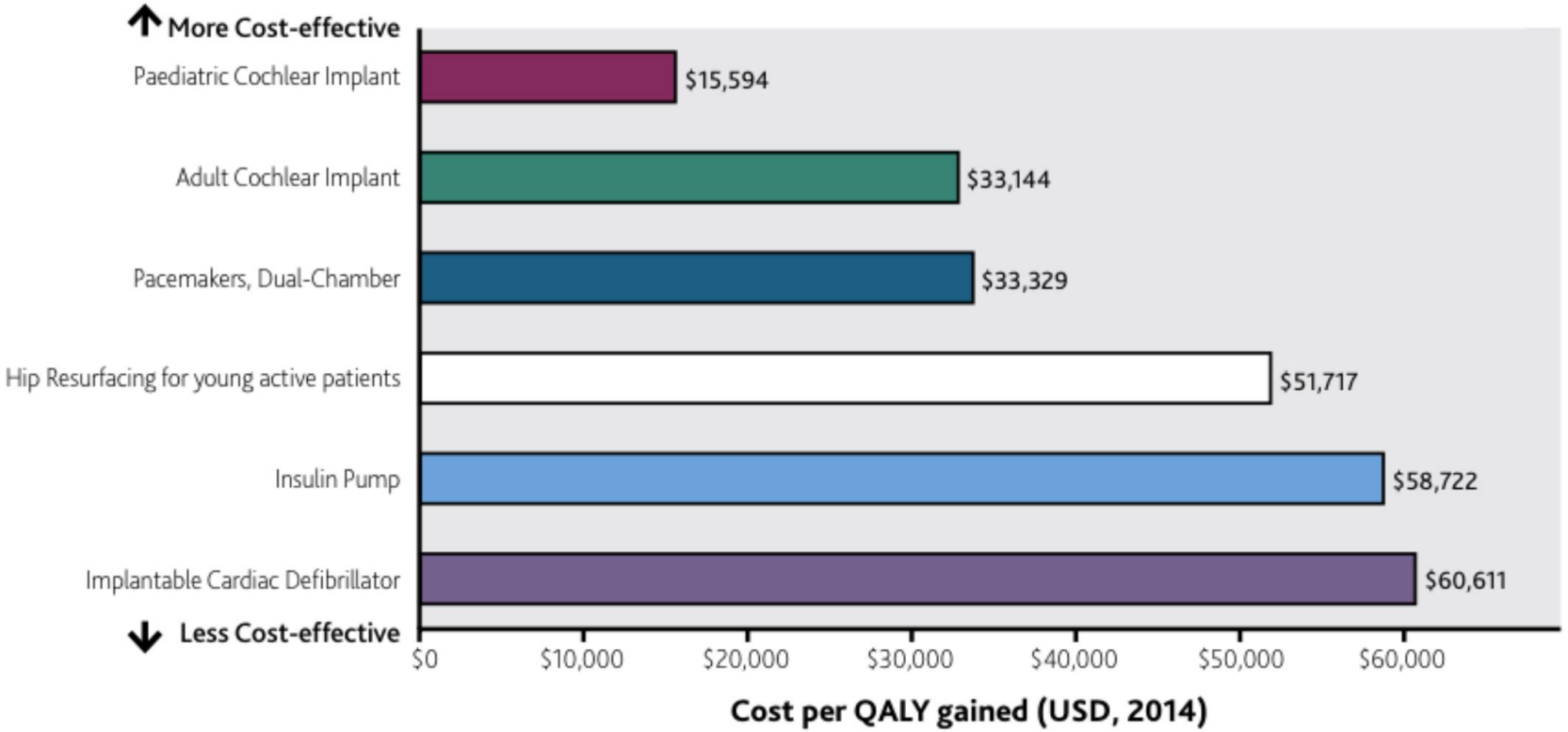


Figure 1: Abbreviations: QALY, Quality Adjusted Life Year; USD, United States Dollars
Sources: Bond et al, 2009; Heintzbergen et al, 2013; Oddershede et al, 2013; Roze et al, 2005; Semenov et al, 2013 and Smith et al, 2012

Paediatric Implantation

- Bilateral profound sensorineural loss
- Must be done before age 6.
- Improved outcomes <2, ideally <1
- In general terms the younger the better.

- Mostly bilateral simultaneous implantation

SWISH Program

Aim for SWISH program → Intervention to be commenced prior to 6 months of age

Automated ABR

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Aims and results

- Significant hearing loss is defined as being greater than 40dB in the better ear.
- 4.2%-9.5% of children fail the initial SWISH test, and are required to undergo a second screening test
- Overall about 4% of children require formal audiologic assessment

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Aims and results

Financial Year	Number diagnosed with >40dB Permanent Bilateral Hearing Loss	Significant Bilateral Hearing loss diagnosed per 1000 live births	Number diagnosed with >40 dB unilateral Hearing Loss	Unilateral hearing loss diagnosed per 1000 live births
2006/07	101	1.06	70	0.74
2007/08	85	0.90	57	0.60
2008/09	97	1.02	37	0.39
2009/10	86	0.89	43	0.44

These figures almost double at the age of 10
4 in 1000 reported figures in India

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Access and Expanding criteria

- Socio-economic status shouldn’t matter

Sharma S, Bhatia K, Singh S, Lahiri AK, Aggarwal A**. Impact of socioeconomic factors on paediatric cochlear implant outcomes**. Int J Pediatr Otorhinolaryngol 2017;102:90-7

- Age at Implantation biggest factor

Leigh JR, Dettman SJ, Dowell RC. **Evidence-based guidelines for recommending cochlear implantation for young children: Audiological criteria and optimizing age at implantation**. Int J Audiol 2016;55 Suppl (PTA >60 dB HL ,75% chance of benefit over traditional amplification. PTA >82 dB HL have a 95% chance of benefit. Children implanted under 2.5 years with no significant cognitive deficits made normal language progress but retained a delay approximately equal to their age at implantation.)

- Residual hearing

Leigh J, Dettman S, Dowell R, Sarant J. **Evidence-based approach for making cochlear implant recommendations for infants with residual hearing**. Ear Hear 2011;32:313-22.(>75dB PTA should be implanted)

Manjaly JG, Nash R, Ellis W, et al. **Hearing Preservation With Standard Length Electrodes in Pediatric Cochlear Implantation**. Otol Neurotol 2018;39:1109-14.

- Single sided deafness in children

Friedmann DR, Ahmed OH, McMenomey SO, Shapiro WH, Waltzman SB, Roland JT, Jr. **Single-sided Deafness Cochlear Implantation: Candidacy, Evaluation, and Outcomes in Children and Adults**. Otol Neurotol 2016;37:e154-60.

Considerations

- Neural development inner ear around 6-7 weeks.
- Infections in first trimester can cause SNHL. TORCH
- CMV infection is very important (progression)
- Bacterial meningitis commonest cause of acquired SNHL: very close monitoring required. Urgent cochlear implantation if cochlear ossification

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Adult and adolescent implantation

Audiologic Indications

- Less than 55% word perception in best aided condition
- Less than 61% sentence perception best aided condition
- PTA >65dB

McRackan TR, Fabie JE, Burton JA, Munawar S, Holcomb MA, Dubno JR. **Earphone and Aided Word Recognition Differences in Cochlear Implant Candidates**. Otol Neurotol 2018;39:e543-e9.

Aided speech vs headphone speech

- Poor correlation between headphone SD and aided SD

Earphone and Aided Word Recognition Differences in Cochlear Implant Candidates

Theodore R. McRackan, Joshua E. Fabie, Jane A. Burton, Suqrat Munawar, Meredith A. Holcomb, and Judy R. Dubno

Department of Otolaryngology—Head and Neck Surgery, Medical University of South Carolina, Charleston, South Carolina

Bilateral Implantation

- Simultaneous
    - Bilateral profound loss either postlingual, or <36 months prelingual
- Sequential
    - Worst hearing ear if bilateral severe loss
    - 2nd ear if it meets CI candidacy and no binaural advantage in binaural mode (CI + contralateral HA)

Single sided deafness

- Failed BiCROS and BAHA
- Especially if significant tinnitus
- Only option for true cochlear stimulation and directional hearing
- Longer rehabilitation
- Generally first option for younger, motivated patients

Prejban DA, Hamzavi JS, Arnoldner C, et al. **Single Sided Deaf Cochlear Implant Users in the Difficult Listening Situation: Speech Perception and Subjective Benefit**. Otol Neurotol 2018

Sladen DP, Carlson ML, Dowling BP, et al. **Cochlear Implantation in Adults With Asymmetric Hearing Loss: Speech Recognition in Quiet and in Noise, and Health Related Quality of Life**. Otol Neurotol 2018;39:576-81

Stimulation

- EAS: electric acoustic stimulation

Pillsbury HC, 3rd, Dillon MT, Buchman CA, et al. **Multicenter US Clinical Trial With an Electric-Acoustic Stimulation (EAS) System in Adults: Final Outcomes**. Otol Neurotol 2018;39:299-305.

Single Unit Processors

The expanding criteria….

- ? A different way of thinking about surgery

- Association of severe hearing loss with dementia

Claes AJ, Van de Heyning P, Gilles A, Van Rompaey V, Mertens G. **Cognitive Performance of Severely Hearing-impaired Older Adults Before and After Cochlear Implantation: Preliminary Results of a Prospective, Longitudinal Cohort Study Using the RBANS-H**. Otol Neurotol 2018

Hearing preservation and structure

- Variations in cochlear length
- Place-pitch match
- Does preservation of residual hearing matter ?
- Electric Acoustic Stimulation vs electric stimulation only
- VESTIBULAR CONSIDERATIONS

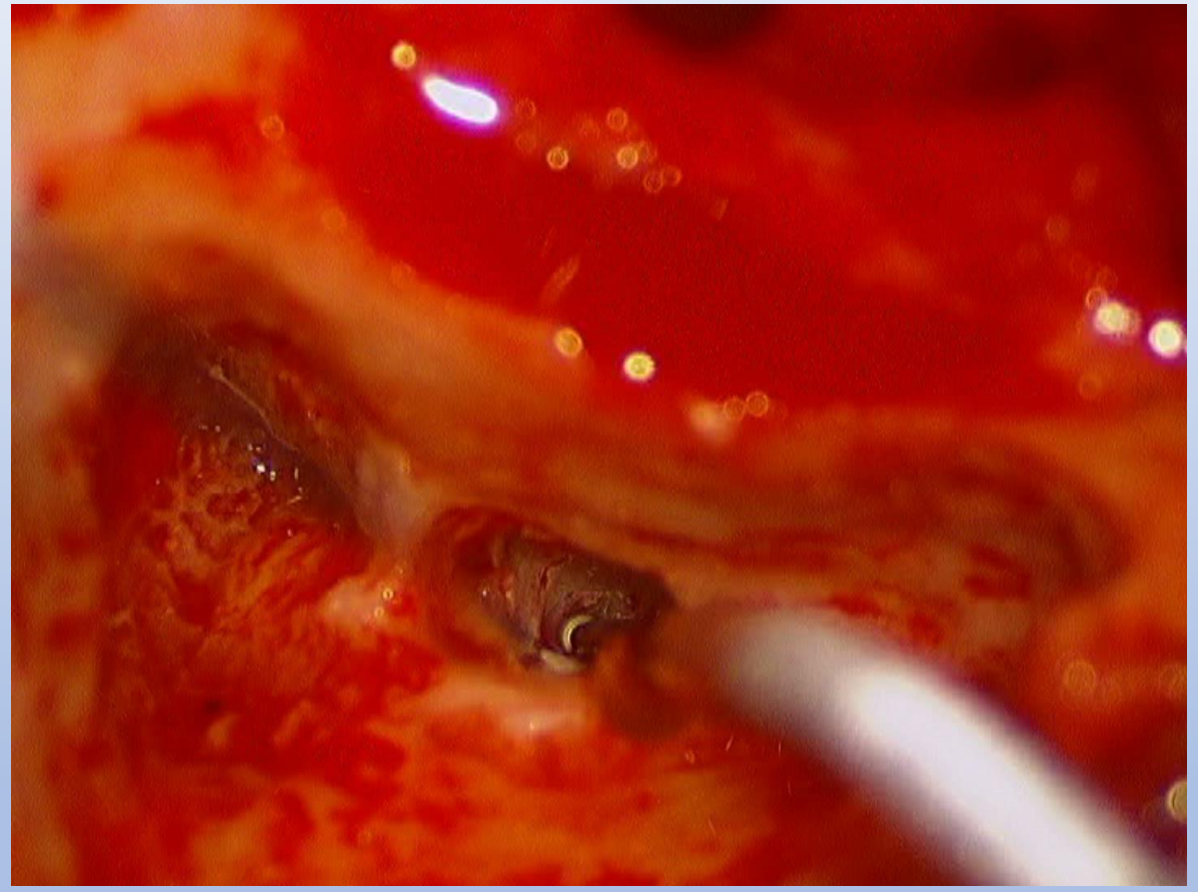
Preservation of hearing and structure

- Scala tympani maximises SP and HP
- Perimodiolar and mid-scala electrodes higher rates SV translocation (await 532 data) Hearing Preservation with the Slim Modiolar Electrode Nucleus CI532(R) Cochlear Implant: A Preliminary Experience. Audiol Neurootol 2018;22:317-25 (70% <15dB loss)
- RW insertion 70% lower rates SV translocation
- Lateral wall electrodes 8X more likely to preserve long term functional hearing

Hearing preservation and structure

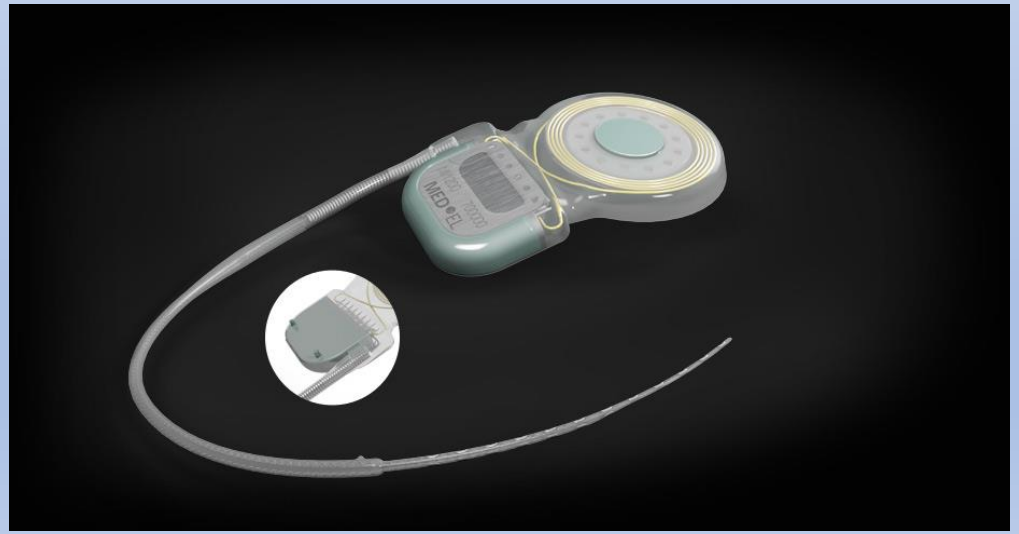
- Every 10 degree increase in angular insertion depth CNC scores increase 0.6% BUT PTA shift higher for deeper insertions.

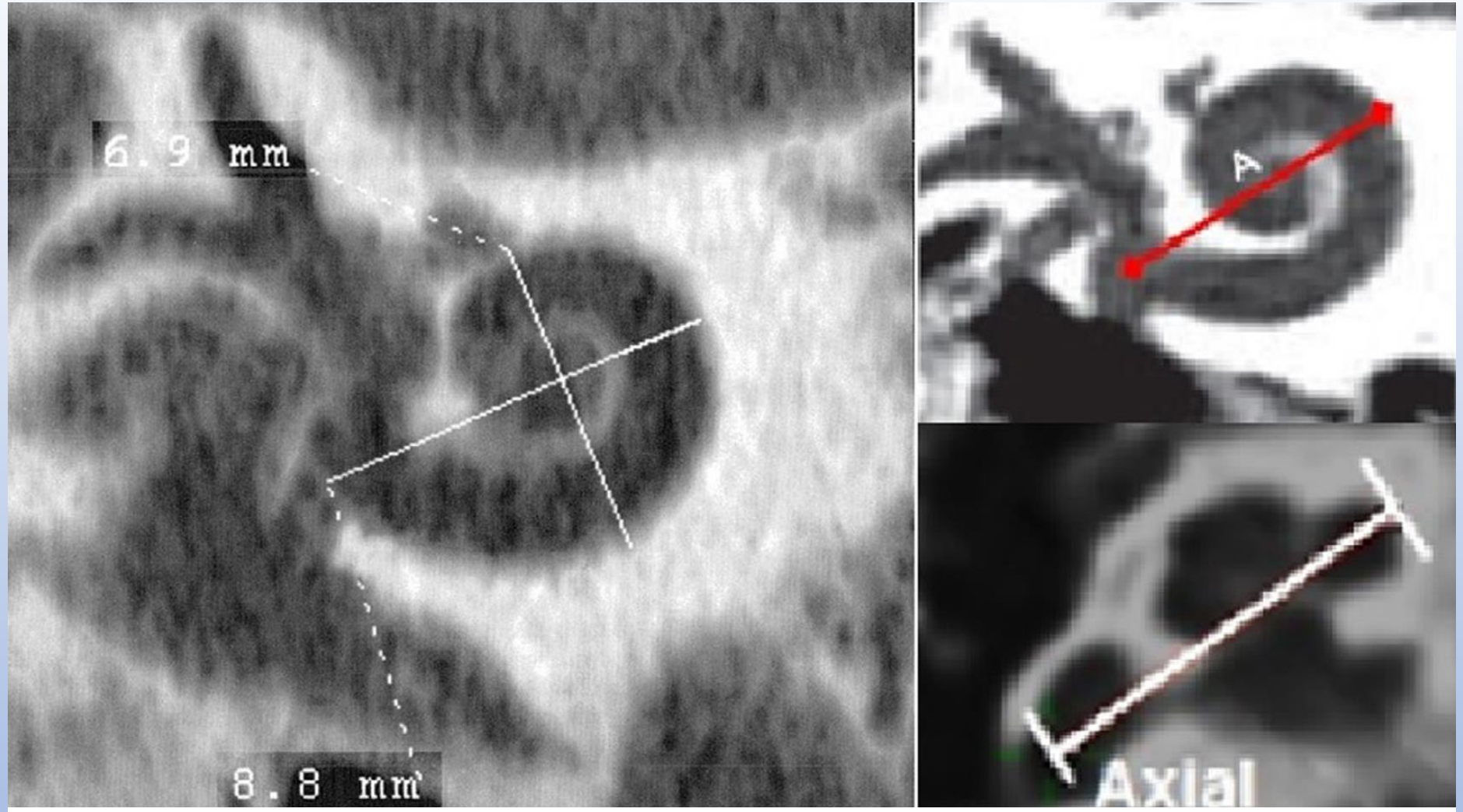
- Shorter electrode to increase HP vs longer electrode to maximise CCC if functional hearing lost.



Which electrode ?
Which receiver stimulator ?

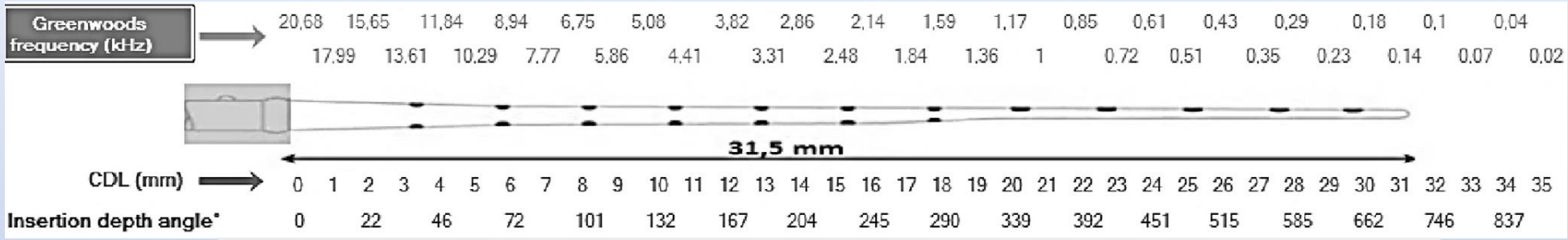
MRI consideration

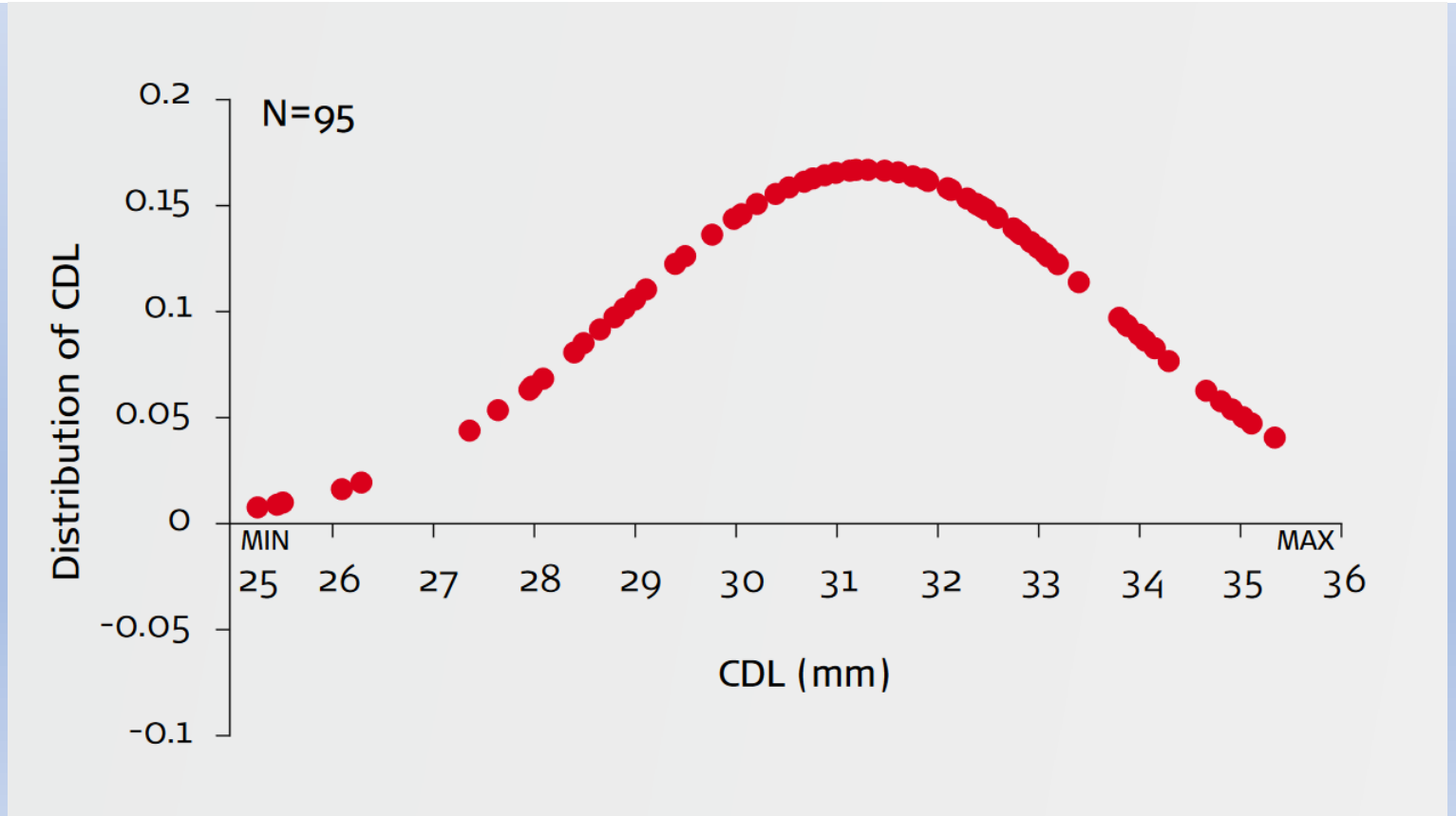




Insertion angle	Cochlear coverage	Equation
900°	Full	$CDL^{900} = 4.16*A–3.98$
720°	2 turns	$CDL^{720} = 3.65*A–3.63$
540°	1.5 turns	$CDL^{540} = 3*A–3.02$
360°	1 turn	$CDL^{360} = 2.43*A–2.43$

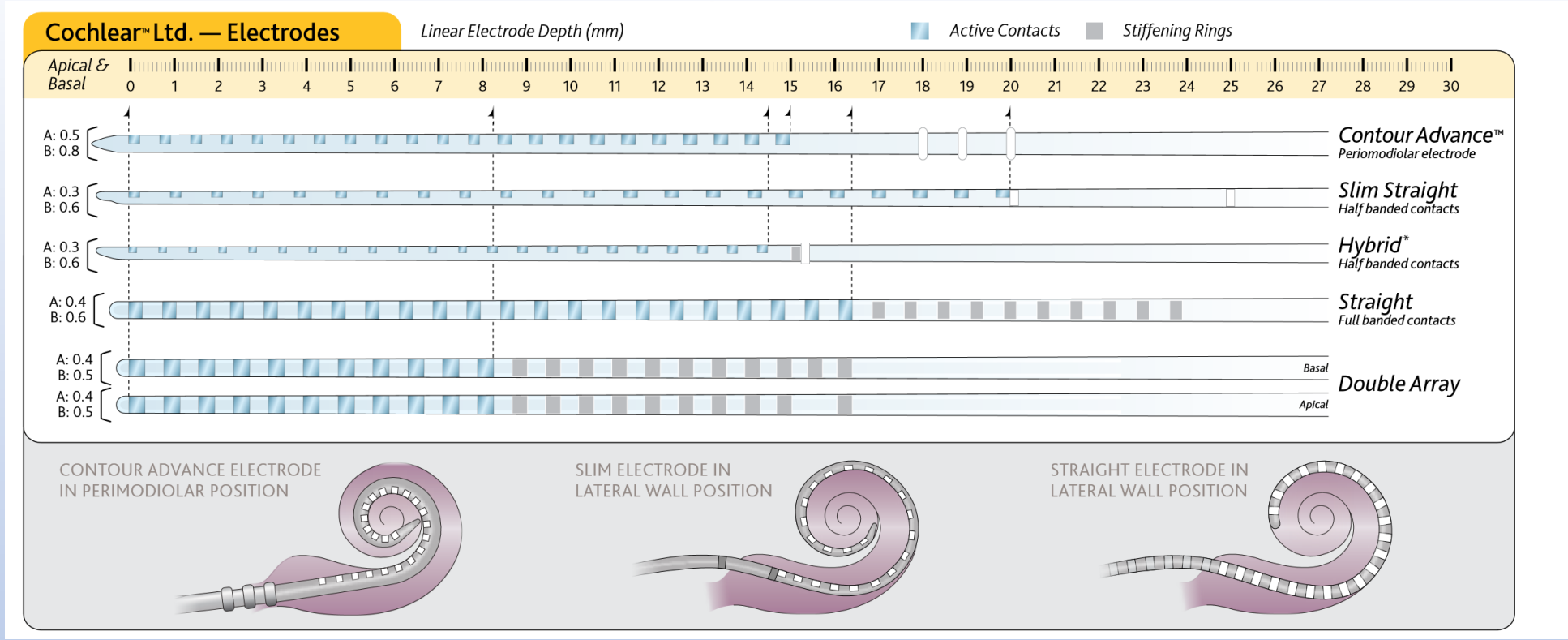
Greenwood's function

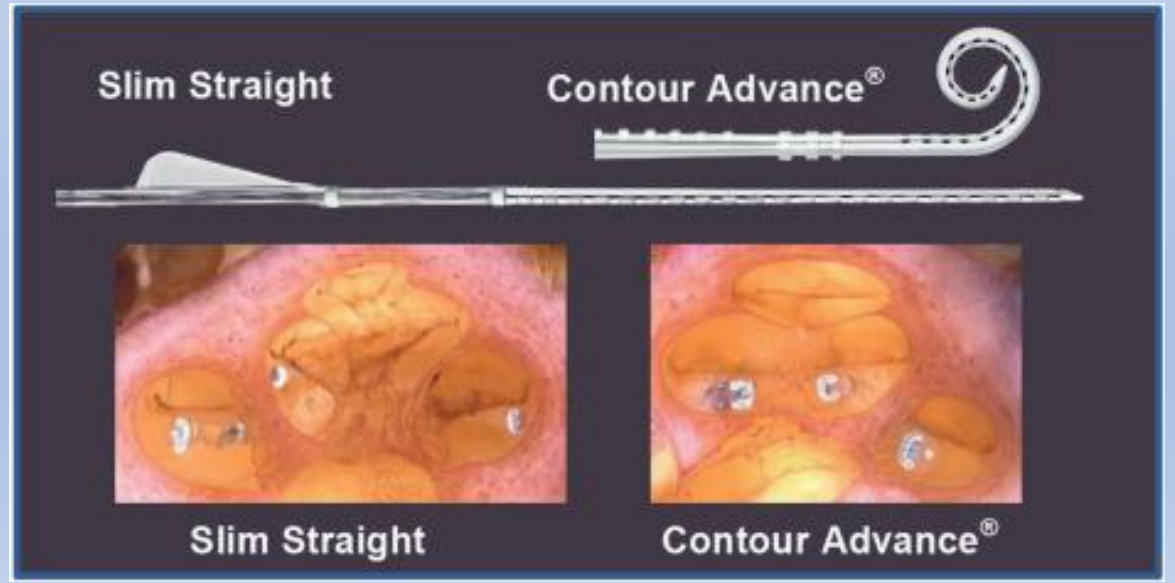


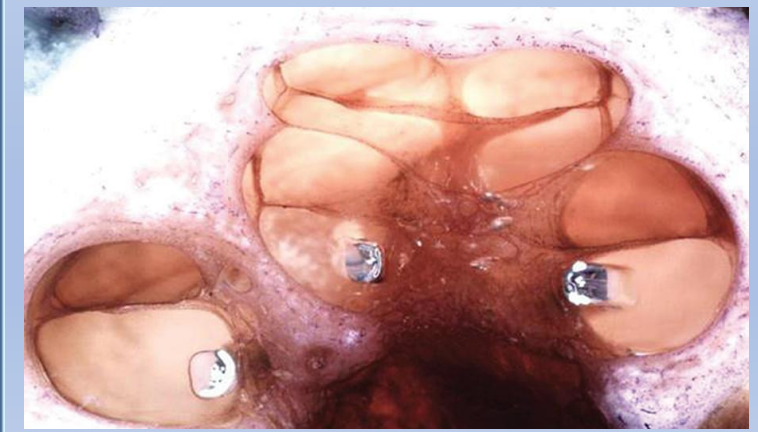


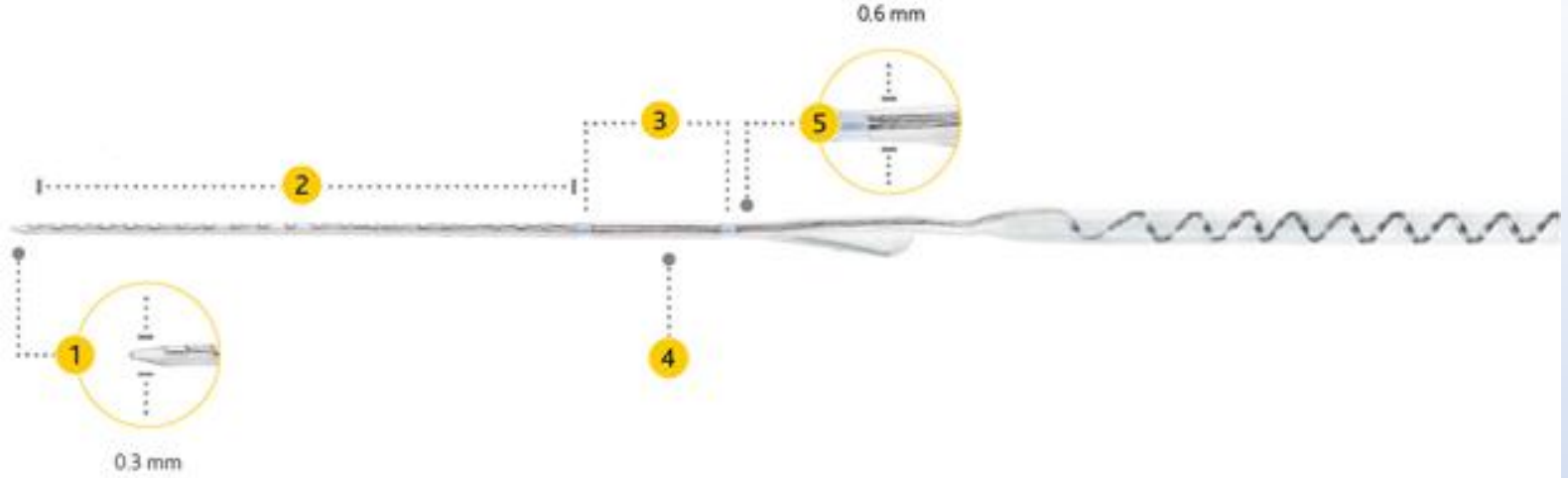
Considerations

- Insertion depth and cochlear coverage
- Matching neuro-tonotopicity
- Atraumatic electrode array insertion and insertion forces against the intra-cochlear structures
- Choosing an electrode array that matches the recipient's individual cochlear: length/malformation


Cochlear™ Ltd. — Electrodes
Linear Electrode Depth (mm)
Active Contacts
Stiffening Rings
Apical & Basal
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
A: 0.5 B: 0.8
Contour Advance™
Periomodiolar electrode
A: 0.3 B: 0.6
Slim Straight
Half banded contacts
A: 0.3 B: 0.6
Hybrid*
Half banded contacts
A: 0.4 B: 0.6
Straight
Full banded contacts
A: 0.4 B: 0.5
Basal
A: 0.4 B: 0.5
Apical
Double Array
CONTOUR ADVANCE ELECTRODE IN PERIMODIOLAR POSITION
SLIM ELECTRODE IN LATERAL WALL POSITION
STRAIGHT ELECTRODE IN LATERAL WALL POSITION

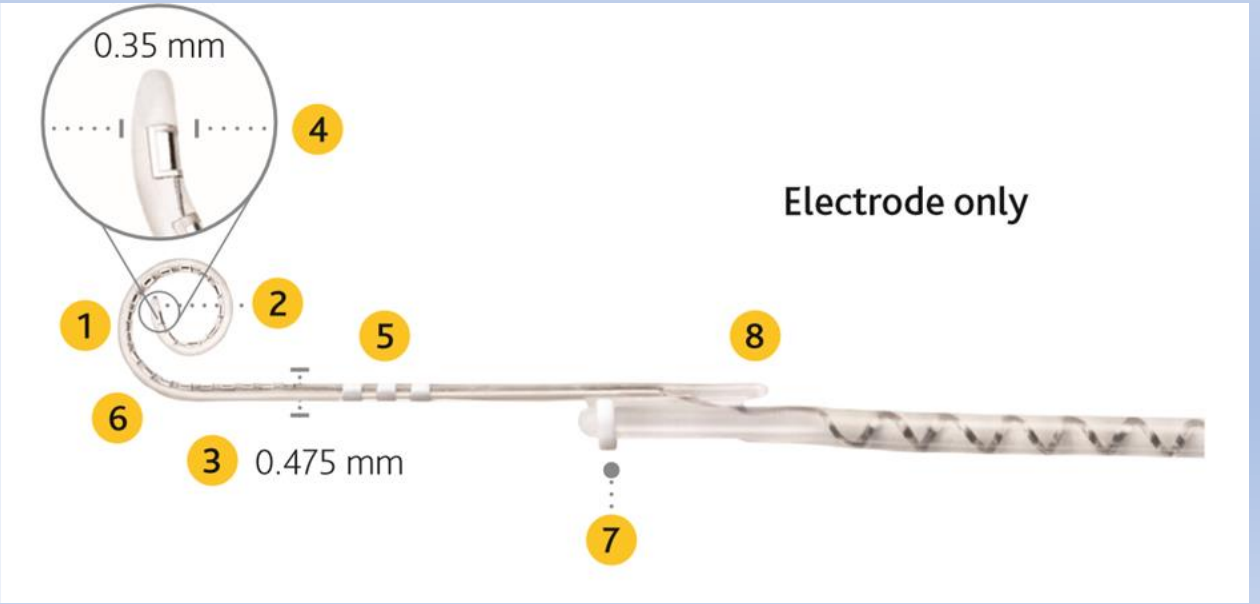

Slim Straight
Contour Advance®
Slim Straight
Contour Advance®





1. **Softip™** measuring 0.3 mm diameter at apical end, proven to minimise insertion trauma
2. **Smooth surface** to minimise lateral wall friction during electrode insertion
3. **White markers** providing variable insertion depth between 20 and 25 mm
4. **Basal stiffener** providing more control and accurate tactile feedback for an atraumatic insertion, while minimising buckling
5. **Basal diameter at 0.6 mm** making it particularly suitable for round window insertion

- Intracochlear electrode with 22 platinum electrode contacts spread over 14 mm active length.
- Distance from electrode tip to most proximal electrode contact - 14.4 mm.
- Dimensions at basal end **0.475 x 0.5 mm**.
- Dimensions at apical end **0.35 x 0.4 mm**.
- Three white insertion depth markers, visible only after sheath is removed. Distance between white markers - 1 mm.
- Distance from electrode tip to most proximal white marker - 18.4 mm.



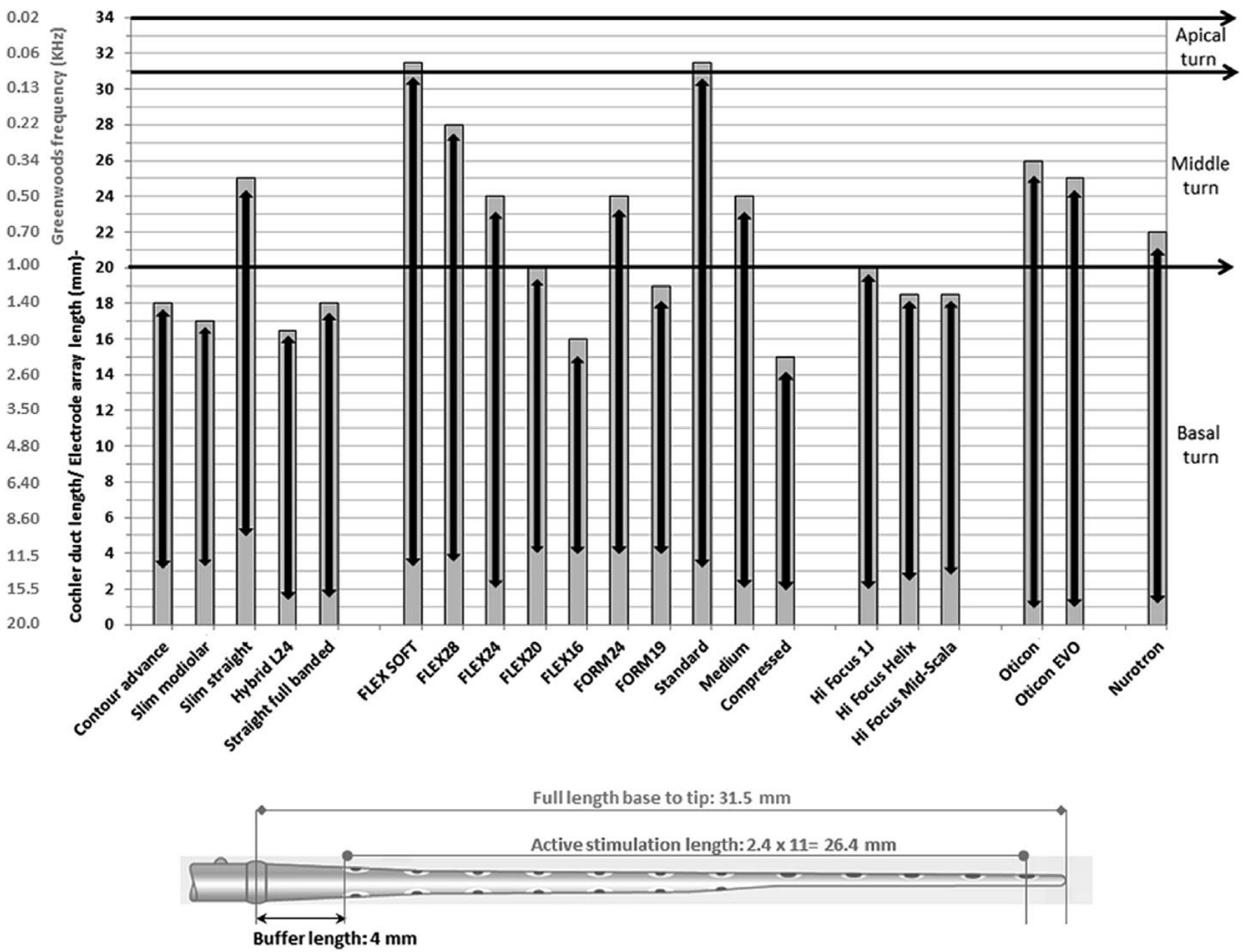


Fig. 1. Bar diagram showing the full array length and the active stimulation length of commercially available CI electrodes. On the Y-axis is the cochlear length at the organ of corti (OoC) of 34 mm and the corresponding Greenwood frequency map. The electrode picture under the bar diagram is from MED-EL (Austria) showing the buffer distance between the stopper marker and the basal most stimulating contacts, the active stimulation length covering all the stimulating contacts.

Lateral wall electrodes: matching neuro-tonotopicity

- Healthy normal-functioning human cochlea can hear sound signals in the frequency range of 20 kHz, in the basal region, to 20 Hz in the apical region
- Positioned just under the organ of Corti.
- **Complete cochlear coverage vs preservation of residual hearing**
- Correct frequency mapping is in this case dictated by the Greenwood's function describing the tonotopic map of the organ of Corti.

Perimodiolar electrodes

- **Contacts closer to the modiolus wall**
- Extended battery life
- Narrower spread of excitation,
- Reduced behavioural and electrically-evoked compound action potential (ECAP) thresholds
- Wider dynamic range
- Significant improvements in listening performance have also been reported with perimodiolar placement
- Reduced electrode array extrusion
- Allows passage into partially fibrosed scala tympani
- Lower rates of hearing preservation

Surgical Technique

- Round window insertion
- Minimal force
- Slow insertion (how slow)
- Peri-operative steroids
- Topical steroids

Summary

- Place for both lateral wall and perimodiolar
- Hearing preservation: lateral wall (how long)
- Open cavity, fibrosis: perimodiolar

Basics

- Appropriate work-up radiologically
- Vaccination in paediatric cases
- Perioperative antibiotics
- Meticulous haemostasis
- Double layer soft tissue closure

Theunisse HJ, Pennings RJE, Kunst HPM, Mulder JJ, Mylanus EAM. **Risk factors for complications in cochlear implant surgery**. Eur Arch Otorhinolaryngol 2018;275:895-903.

Next day switch on and remote mapping

- Most adult patients switched on the following day

Gunther S, Baumann U, Stover T. Early Fitting in Cochlear Implantation: Benefits and Limits. Otol Neurotol 2018;39:e250-e

- We are currently running a pilot study evaluating remote mapping using iPads

The future

- Totally implantable CI
- Integrated drug delivery systems
  - Anti-inflammatories
  - Neurotropic agents
- Customised electrodes depending on anatomy
- Customised frequency to electrode matching
- Minimally invasive and robotic approaches
- Genetic evaluation (and treatment)

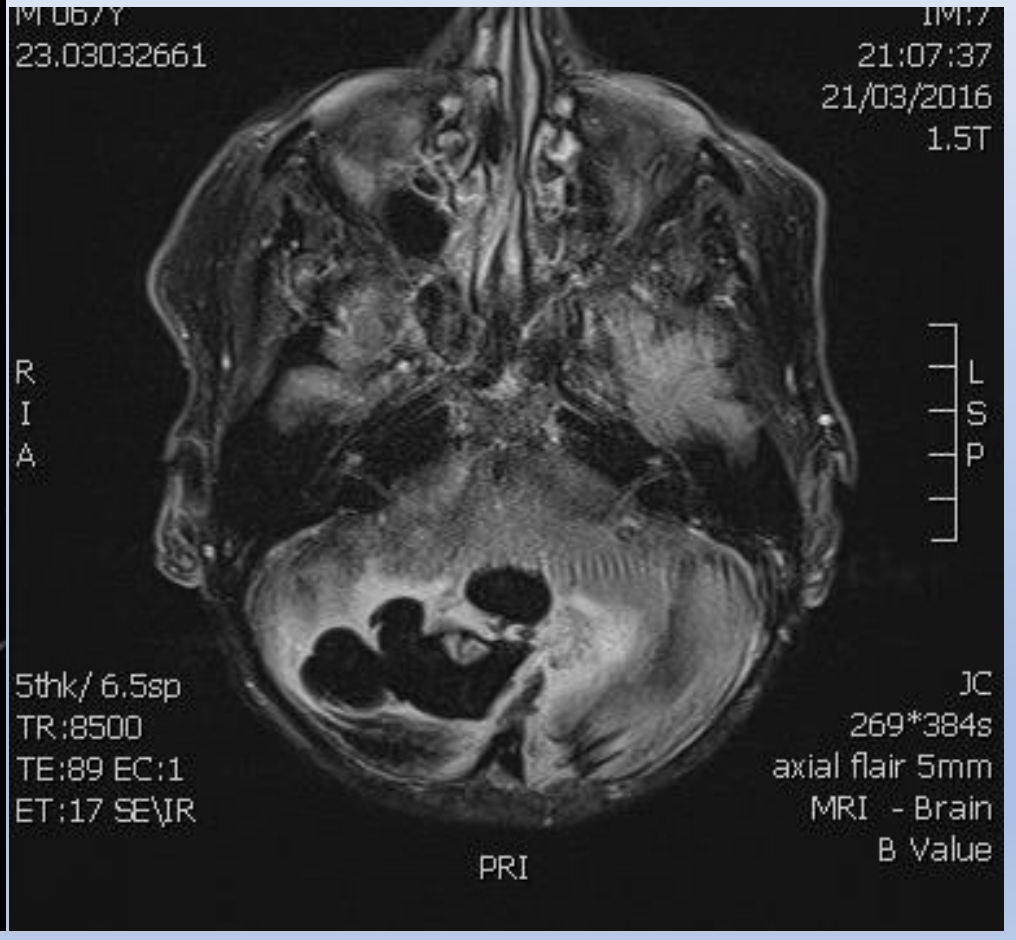
Boudewyns A, van den Ende J, Sommen M, et al. **Role of Targeted Next Generation Sequencing in the Etiological Work-Up of Congenitally Deaf Children**. Otol Neurotol 2018;39:732-8

Most important

- Audiologic support
- Patient motivation
- Luck ?

Cases

65 yo gentleman

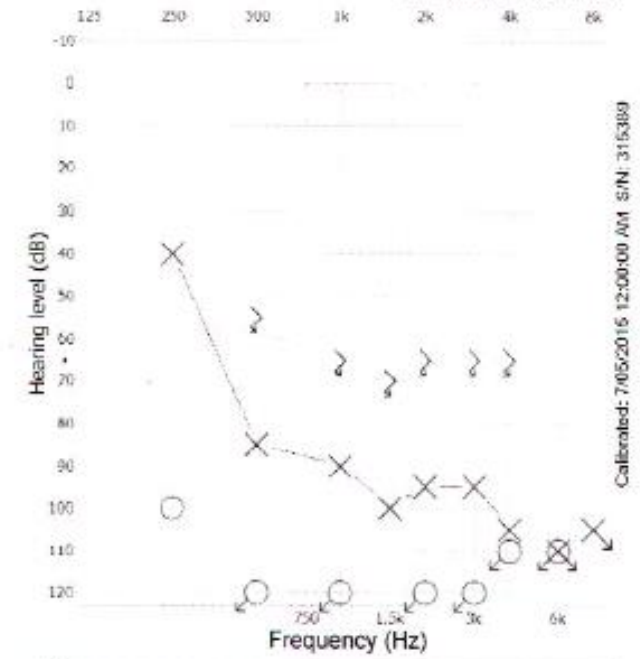


65 year old

- Cerebelloblastoma resected age 4
- Post-op radiotherapy
- Blind age 6
- Significant hearing loss right teens
- Progressive hearing loss left
- Unaided right ear 20 years

AUDIOMETRY (8/12/2015)

AC: Circum-aural, BC: B71



AC	R	
	L	
BC	R	
	L	

PTA (dB HL) / AI (%)

	AC	BC	AI
Right			
Left	90		

Rinne

R: L:

Reliability

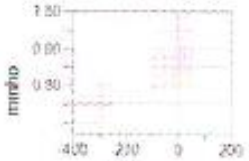
Stenger

T: S:

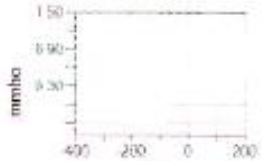
Weber

IMMITTANCE

Right



Left



Tymp

Tone	Hz
SA	mmho
TPP	daPa
ECV	ml
TW	daPa
Type	

Tymp

Tone	Hz
SA	mmho
TPP	daPa
ECV	ml
TW	daPa
Type	

Reflex	Threshold (dB HL)					Decay (s)	
	500	1k	2k	4k	BBN	500	1k
R Ipsi							
L Ipsi							
R Contra							
L Contra							

Probe tone:

Speech Legend

	R	L	Masked
Unaided			

Legend

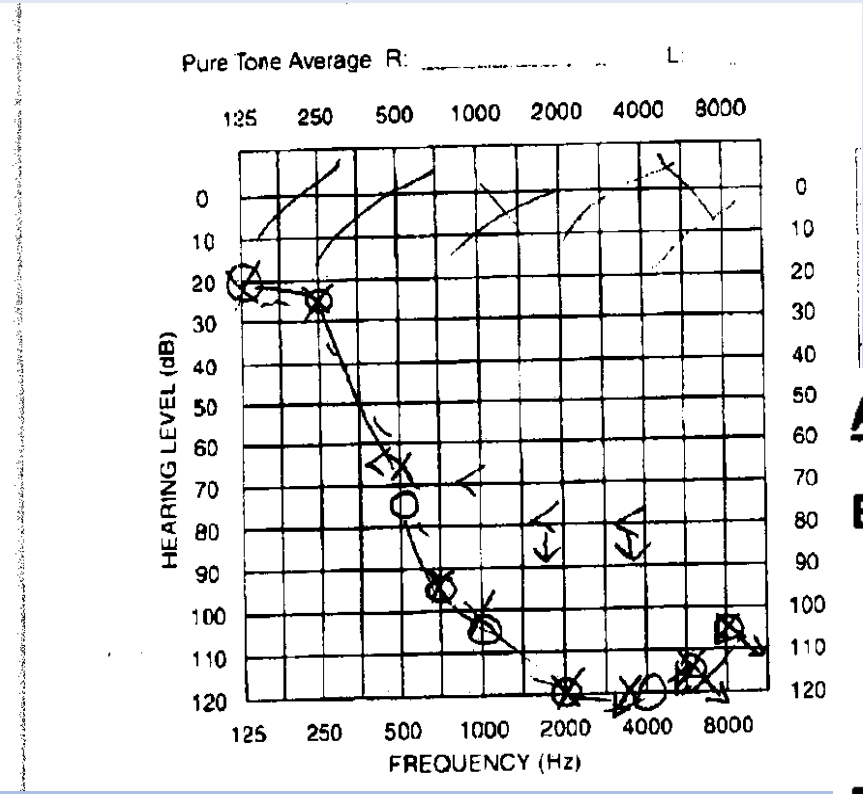
L	R	Masked
	AC	
	BC	

Present audiometric findings indicate profound sensorineural hearing loss in the right ear. The left ear also had moderate-to-profound hearing loss with some residual hearing at low frequencies. However, the left ear is capable of only speech awareness and no speech discrimination ability.

In summary, David has profound loss in the right ear with no residual hearing. The Left ear also has moderate-to-profound sensorineural hearing loss with some residual hearing at low frequencies which provides only speech awareness and significantly reduced speech discrimination ability (12%). I am confident that a Cochlear implant would certainly enhance his speech intelligibility and thereby improve his quality of life.

Which ear

60 year old woman with ‘ski jump’ hearing loss



Aided Speech Perception Testing:

BKB Open Set Sentences (Live Voice)

- Binaural aided Auditory plus Visual: 86%
- Binaural aided Auditory Alone 22%
- Right only aided 14%
- Left only aided 20%

BKB Open Set Sentences (Pre-recorded)

- Binaural aided: 10%
- Right only aided 10%
- Left only aided 20%

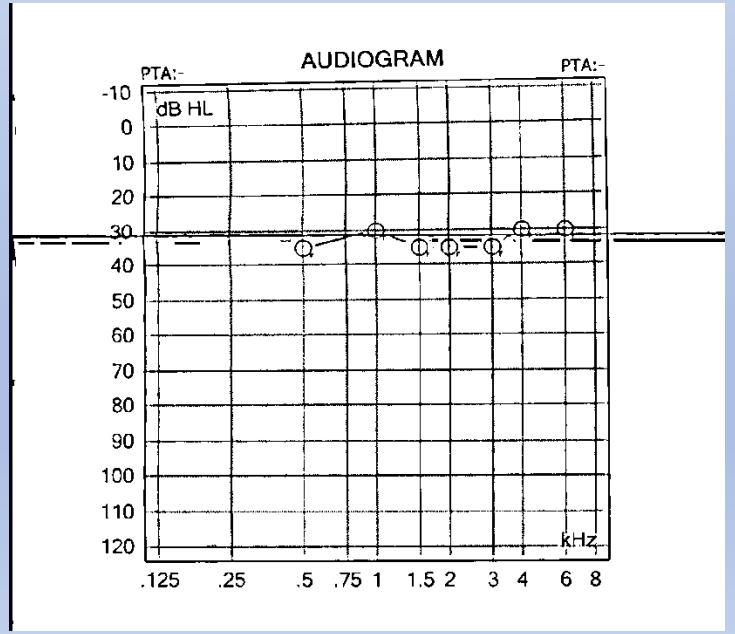
3 weeks post-op

CI Aided Audiogram:
Cochlear implant aided thresholds fall at the top of the long term average speech spectrum at all frequencies. See results attached.

CI Aided Speech Perception Testing:

BKB Open Set Sentences (Live Voice)

- Binmodal aided: 96%
- Left CI alone 84%



What now ?

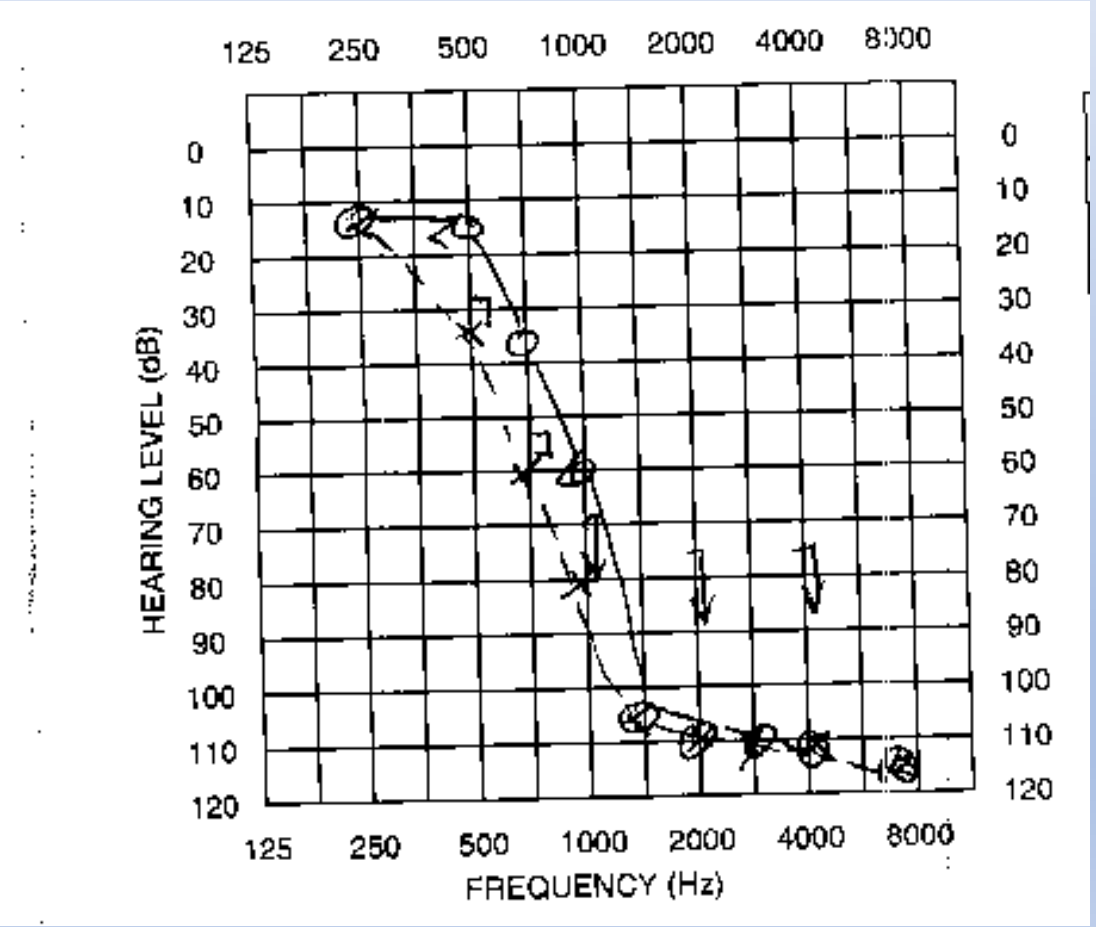
2 months following 2nd implant

Speech perception results are below.

BKB Open Set Sentences (Pre-recorded)

- Binaural CI: 100% Correct
- Right CI: 98%

SB, 60 year old
Sound editor for TV shows



Aided Audiogram

Aided thresholds are close to the bottom of the long term average speech spectrum (LTASS) from 500 to 1000 Hz. The left 1000 Hz aided threshold is well below the LTASS. There is no aided hearing for frequencies above 1000Hz.

Speech Perception Testing

BKB Open Set Sentences (live voice)

- Plus Visual Binaural 90%
- No Visual Binaural 66%

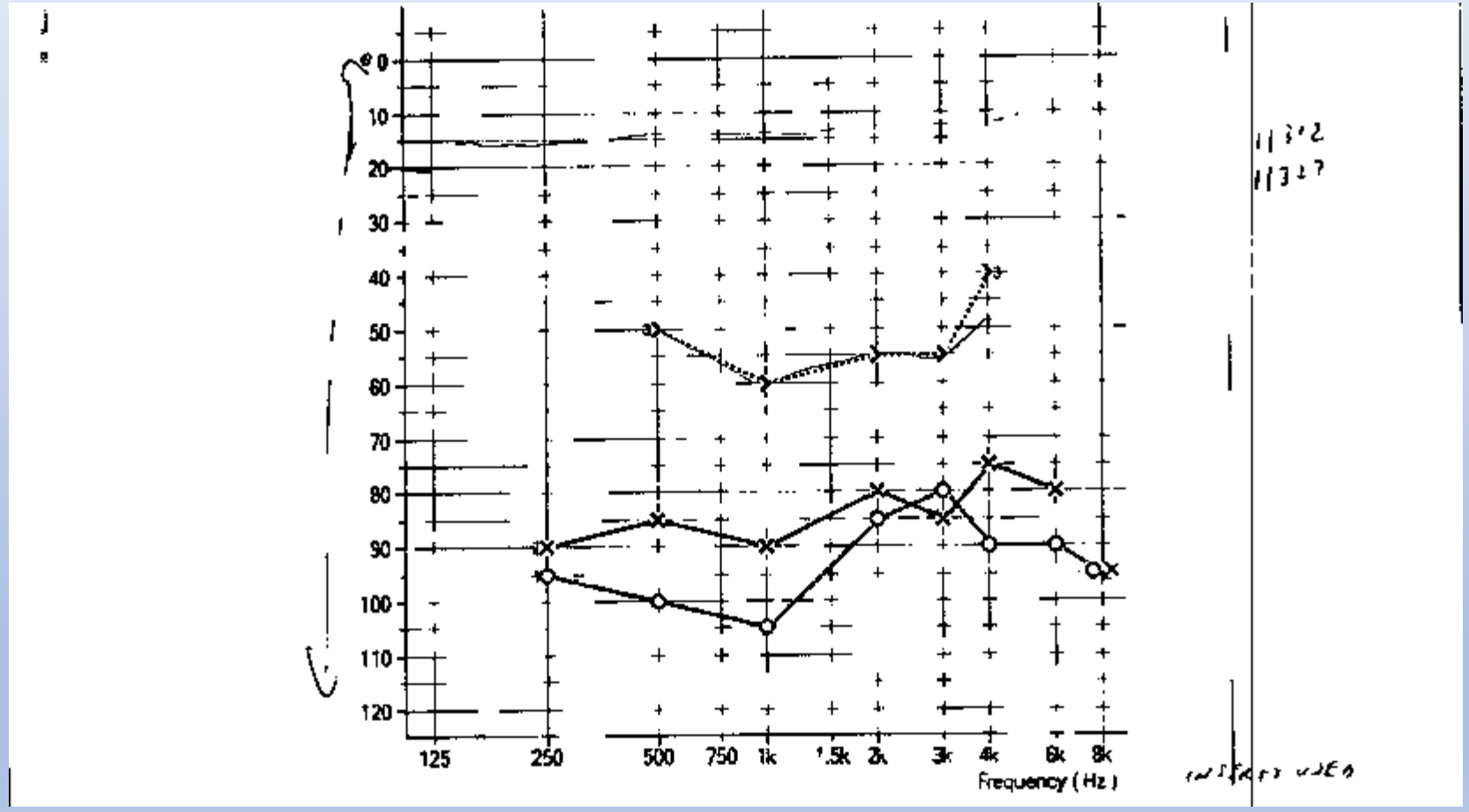
BKB Open Set Sentences (Pre-recorded)

- Binaural aided 46%
- Right aid 46%
- Left aid 27%

These results demonstrate how difficult it is for Steve to hear speech, and how he relies on visual cues to accurately follow conversation. The speech perception results obtained from both ears are within the current criteria for a cochlear implant.

73 year old lady

- For many years left better ear
- Last 12 months decline in left ear
- Now wears aid only in right ear
- Significantly struggling


0
10
20
30
40
50
60
70
80
90
100
110
120
125
250
500
750
1k
1.5k
2k
3k
4k
6k
8k
Frequency (Hz)

List 9 Ear (L) Level 100 Mask

		Score
MATH	av/	3
HIP	✓	19
GUN	dove	3
RIDE	✓	10
SEIGE	sed	3
VEIL	vail	7
CHOSE	shoes	7
SHOTT	✓	10
WEB	door	7
COUGH	cow	7

Phoneme Score 63 %

List 10 Ear (L) Level % Mask

		Score
WISH	fish	7
DUTCH	duck	7
JAM	am	7
HEATH	f	-
LAZE	daze	-
BIKE	like	3
ROVE	flow	3
PET	ef	3
FOG		-
SOON	✓	10

Phoneme Score 40 %

List 12 Ear (R) Level %Mask

		Score
BADGE	✓	10
HUTCH	✓	10
KILL	✓	10
THIGHS	five	3
WAVE	way	7
REAP	✓	10
FOAM	-o	3
GOOSE	✓	10
NOT	knot	7
SHED	✓	10

Phoneme Score 80 %

List 12 Ear (R) Level % Mask

		Score
FISH	✓	10
DUCK	funk	7
PATH	-	-
CHEESE	chor	3
RACE	egg	3
HIVE	-	-
BONE	b	3
WEDGE	fridge	3
LOG	-	-
TOMB	Tom	7

Phoneme Score 36 %

List 13 Ear Level Mask

	Score
FIB	
THATCH	
SUM	
HEEL	
WIDE	
RAKE	
GOES	
SHOP	
VET	
JUNE	

Phoneme Score %

List 14 Ear Level

FILL	
CATCH	
THUMB	
HEAP	
WISE	
RAVE	
GOT	
SHOWN	
BED	
JUICE	

Phoneme Score %

MOON

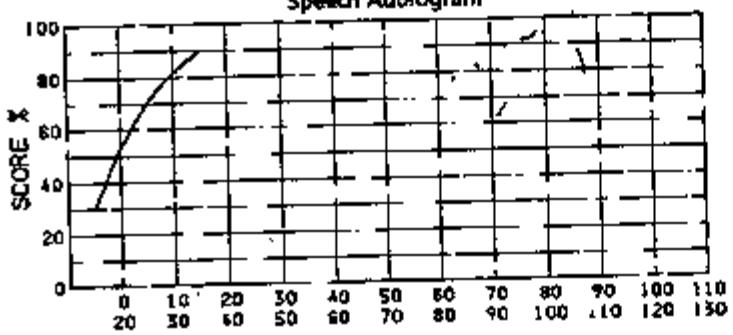
Phoneme Score %

SAVILLE, Mrs Sandra
11 Narooma Place, GYMEA BAY NSW 2227
Ph:H 9525 7345
DOB: 18.11.1939 Sex: F
MC #: 2010197606/2 Exp: 12/2014
HF: Medibank Private 14056337F/
DVA:

90dBHL -
(R) 36%
(L) 40%

100dBHL
(R) 80%
(L) 63%

Speech Audiogram



Right O	Left X
Earphones/TF	
Aided/Unaided	
Scoring: Phoneme/Word	
Masking: Left	Right

Left CI September 2013

- Which electrode:

- Perimodiolar vs Lateral wall
  - Hearing and balance preservation
  - Reduced current leak and facial nerve stimulation in otospongiotic cochlear

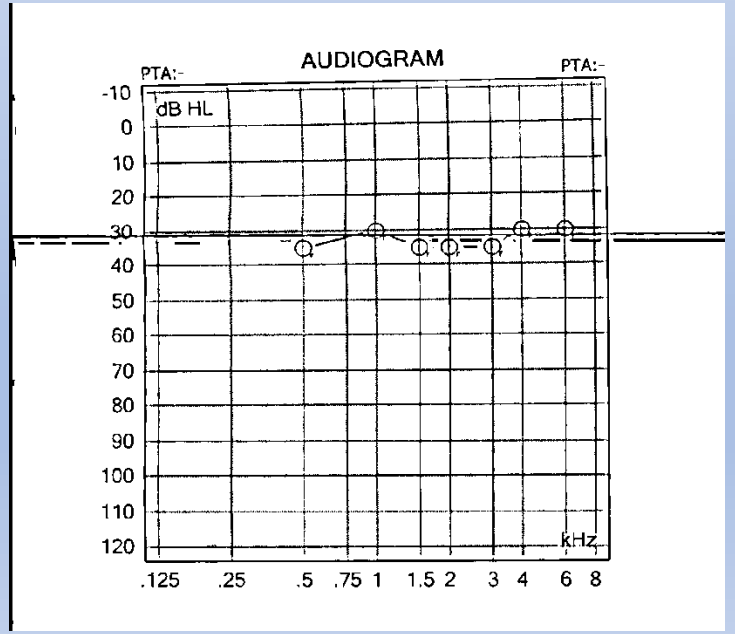
3 weeks post-op

CI Aided Audiogram:
Cochlear implant aided thresholds fall at the top of the long term average speech spectrum at all frequencies. See results attached.

CI Aided Speech Perception Testing:

BKB Open Set Sentences (Live Voice)

- Binmodal aided: 96%
- Left CI alone 84%



Sequential Bilateral Cochlear Slim Straight Electrodes

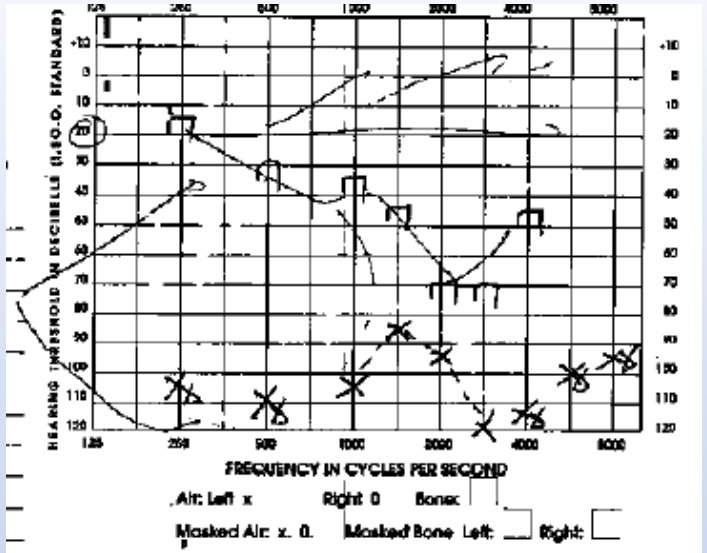
Aided speech perception testing scores using BKB sentences are as follows:

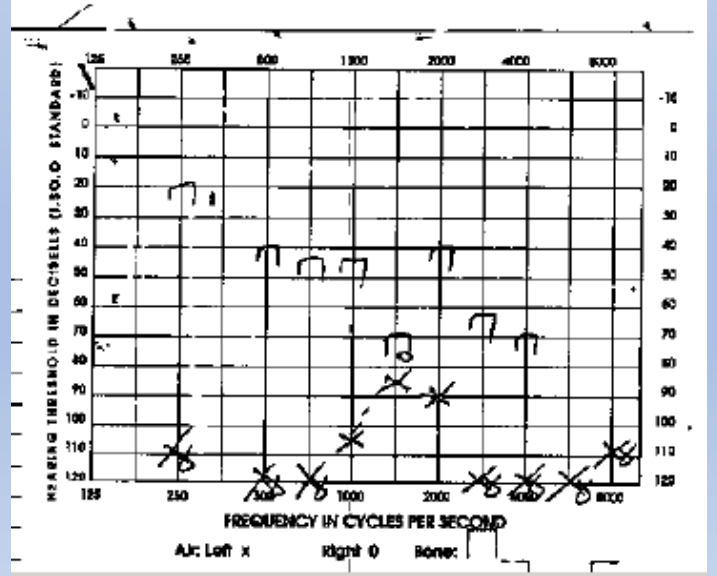
Pre-recorded bilateral cochlear implants	90%
Live Voice bilateral cochlear implants	100%

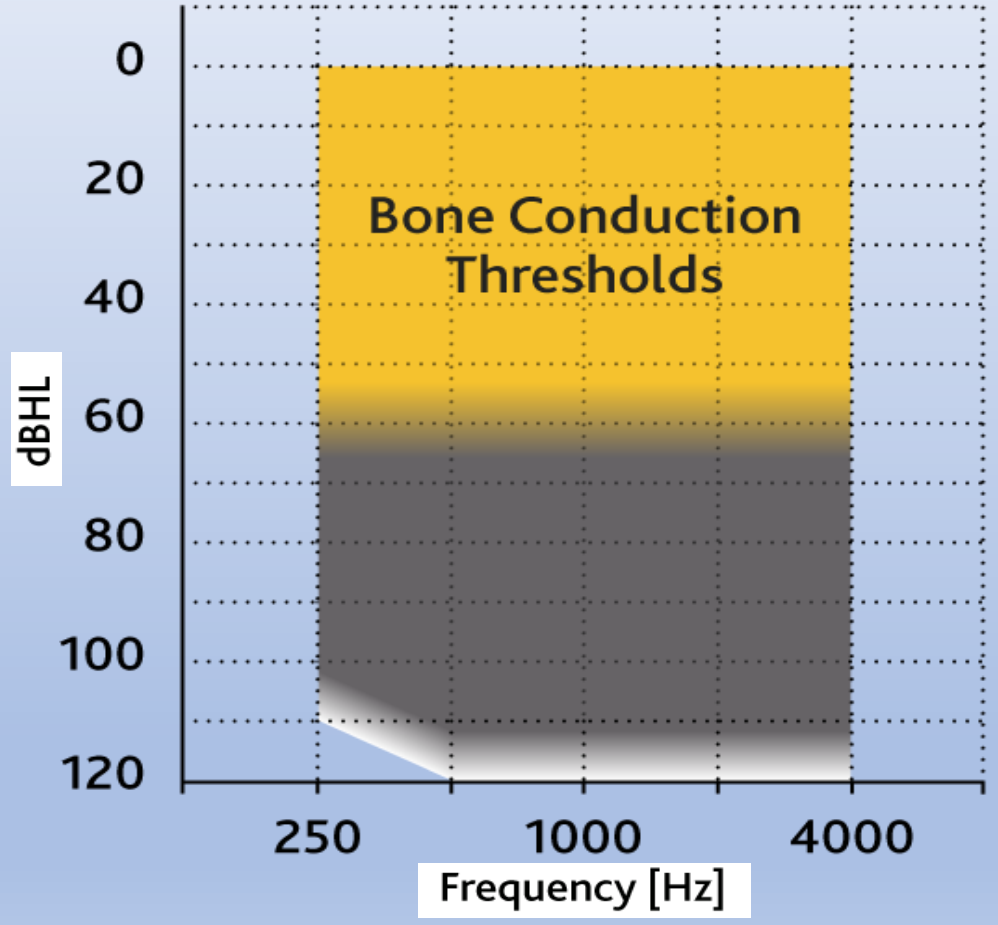
74 year old man

- Right fenestration at age 14 years old
- Dead ear within 1 month
- Progressive hearing loss left ear

2015
2016


FREQUENCY IN CYCLES PER SECOND
Air: Left x Right 0 Bone:
Masked Air: x. 0. Masked Bone Left: Right:
SPEECH DISCRIMINATION
M.C.L.
M.C.L.

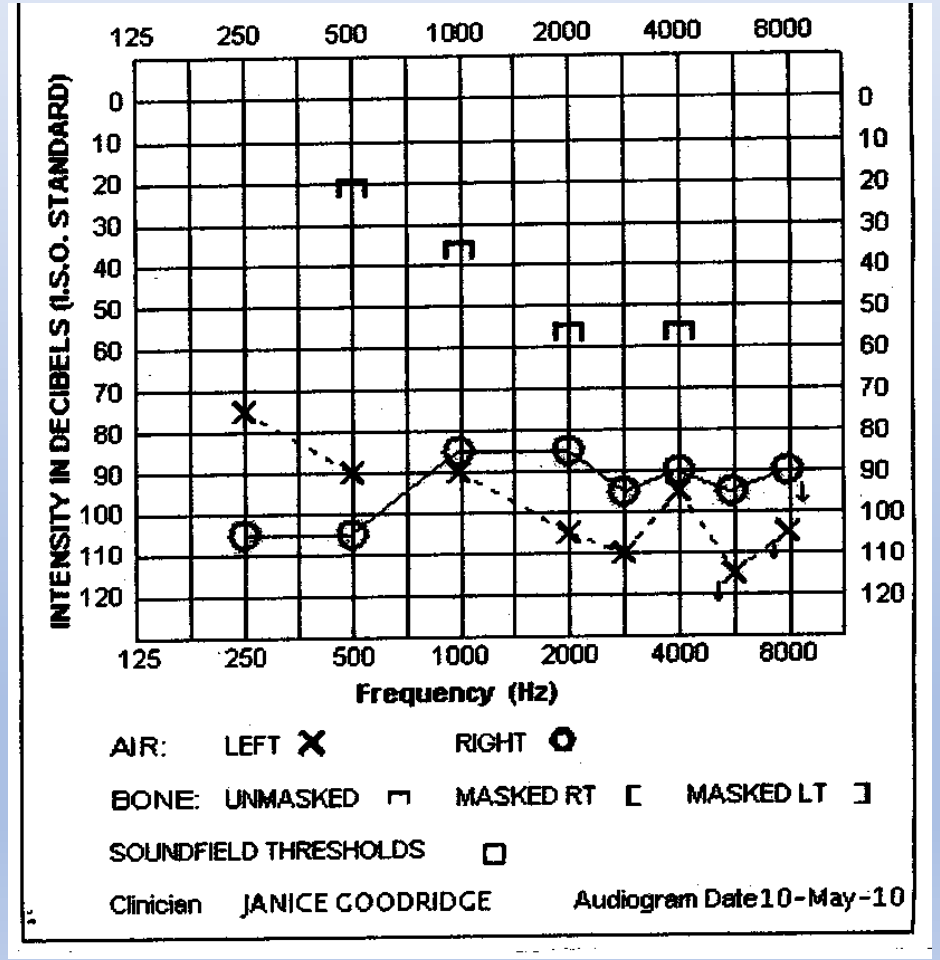

FREQUENCY IN CYCLES PER SECOND
Air: Left x Right 0 Bone:



1. Norrman, J, Review of fitting ranges. Cochlear Bone Anchored Solutions AB, D773528, 2015.

84 year old nun

- Left stapedectomy more than 20 years ago
- Significant sensorineural loss
- Bilateral high powered aids: significant feedback and poor speech discrimination



BAHA Trial Right Ear

- Subjective Improvement
- Better hearing in noise when used with power BTE aid on the left

sean@sydneyentclinic.com

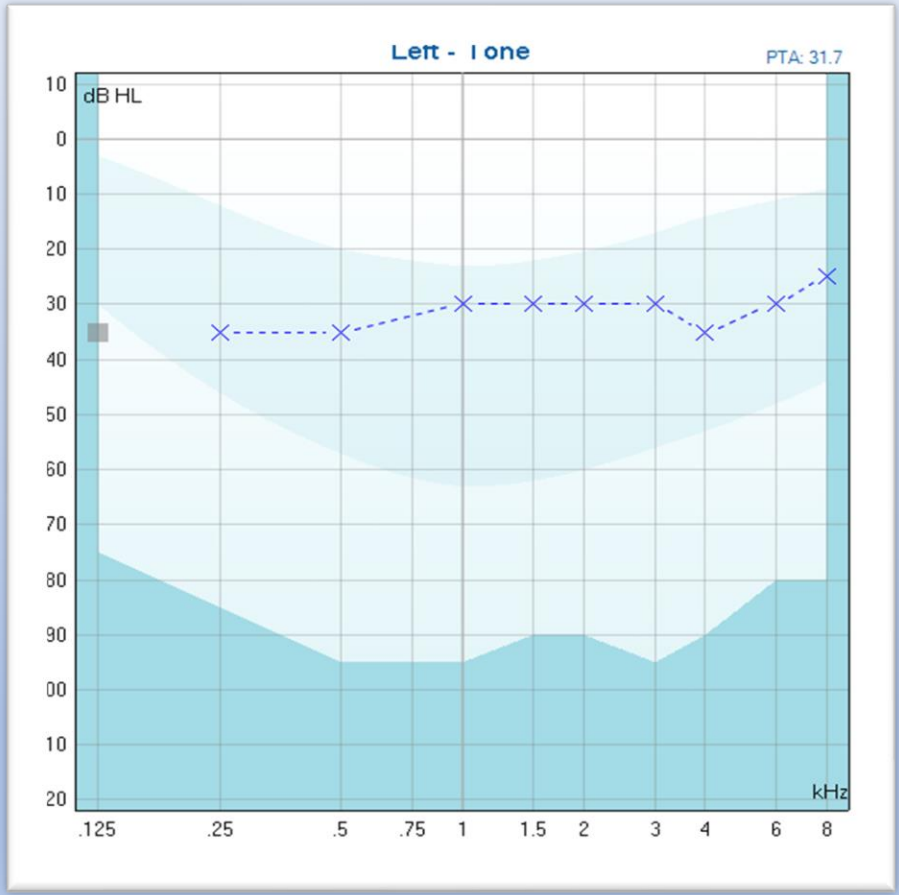
Post BAHA

- Initially an improvement but after 6 months:
- Sub-optimal subjective result despite body worn Cordelle
- 29.5.2012
- Speech discrimination maximally aided
    - 66% right
    - 56% left

Cochlear implantation

- February 2013
    - Left CI: Obliterated round window

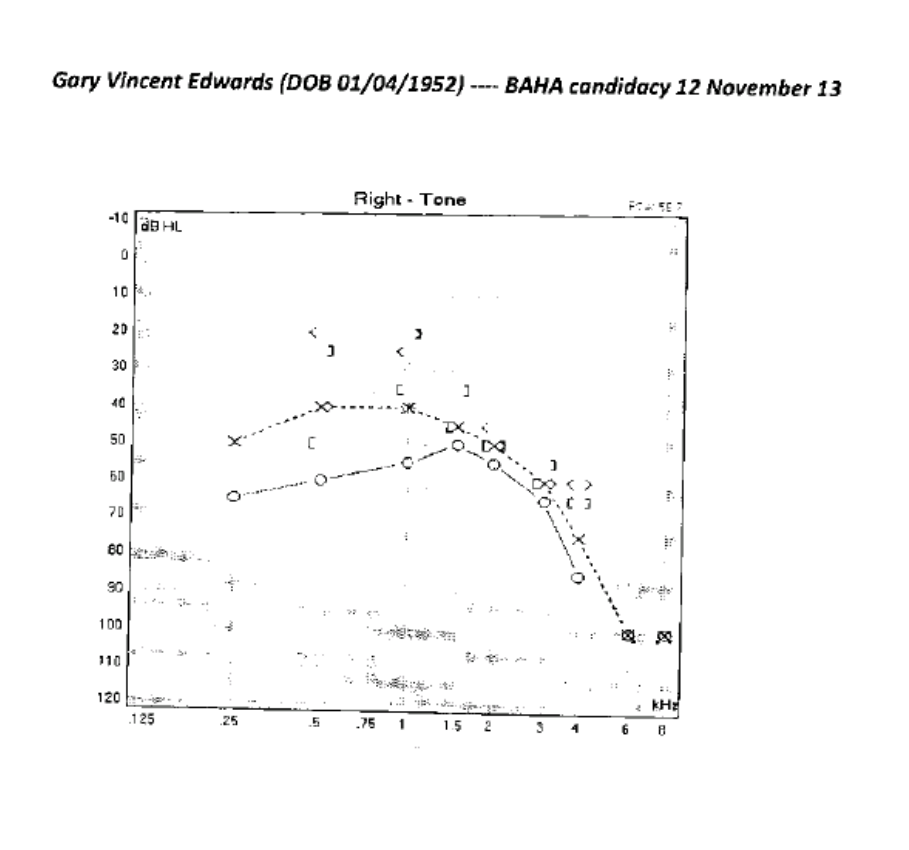
6 months post implantation

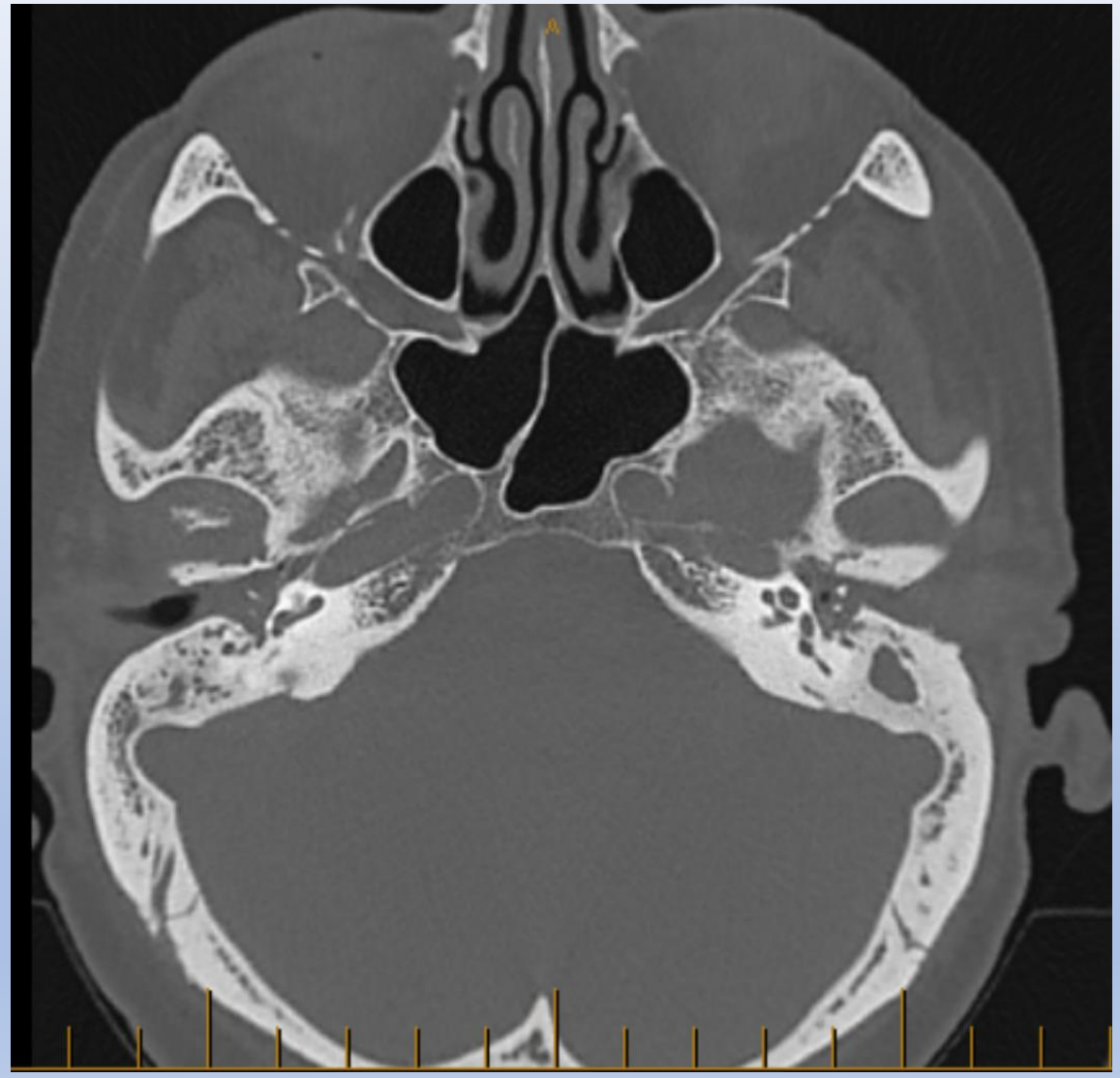


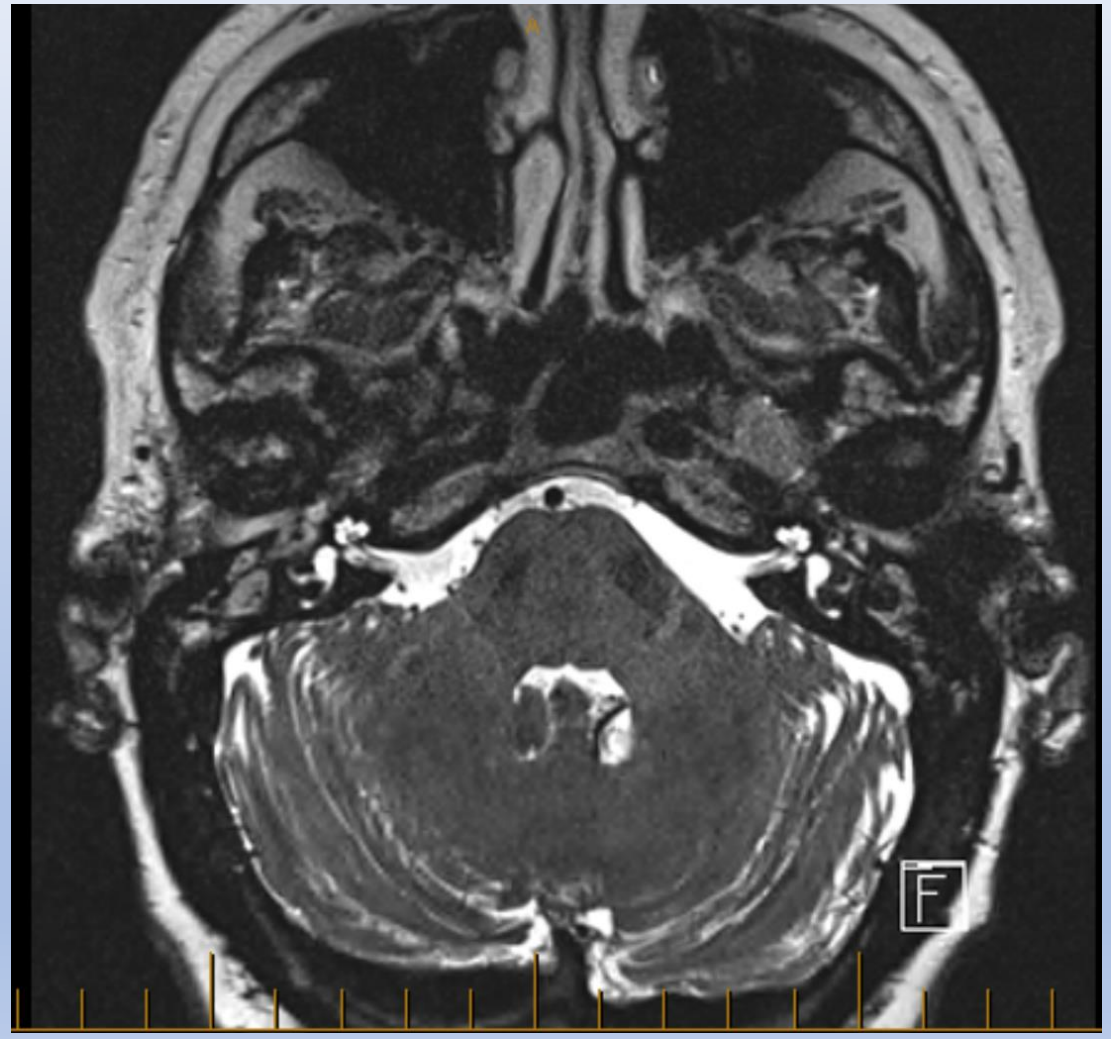
- Speech discrimination 81%

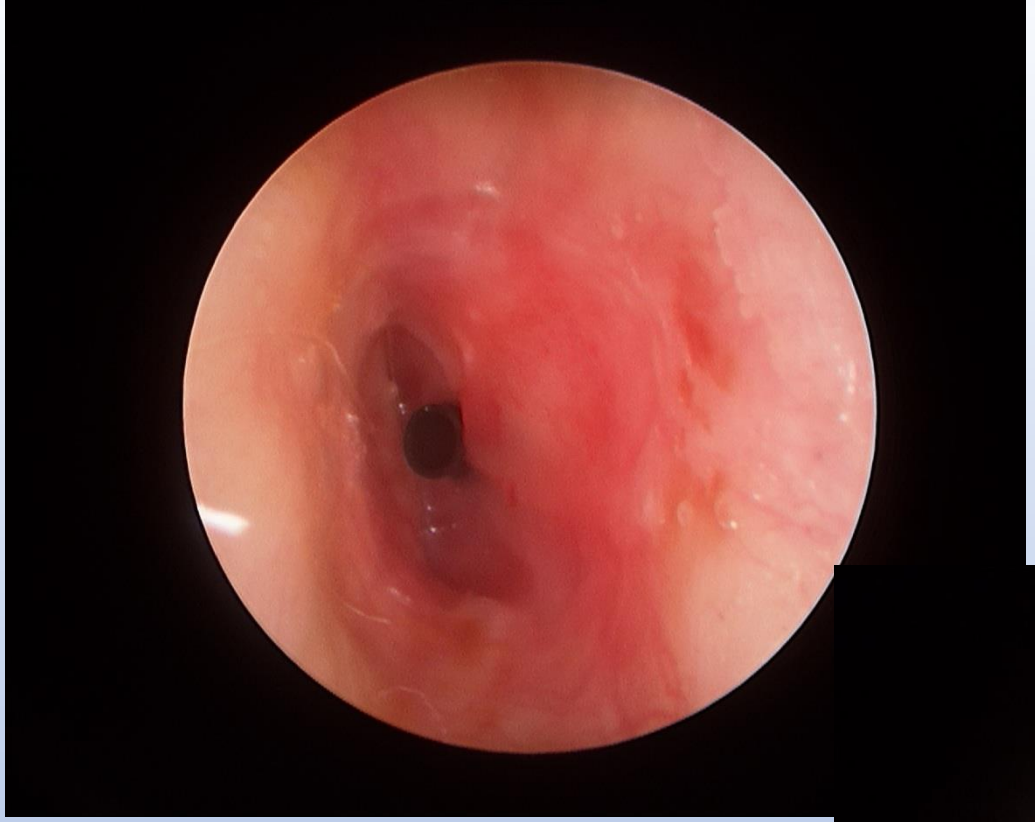
60 year old renal transplant patient

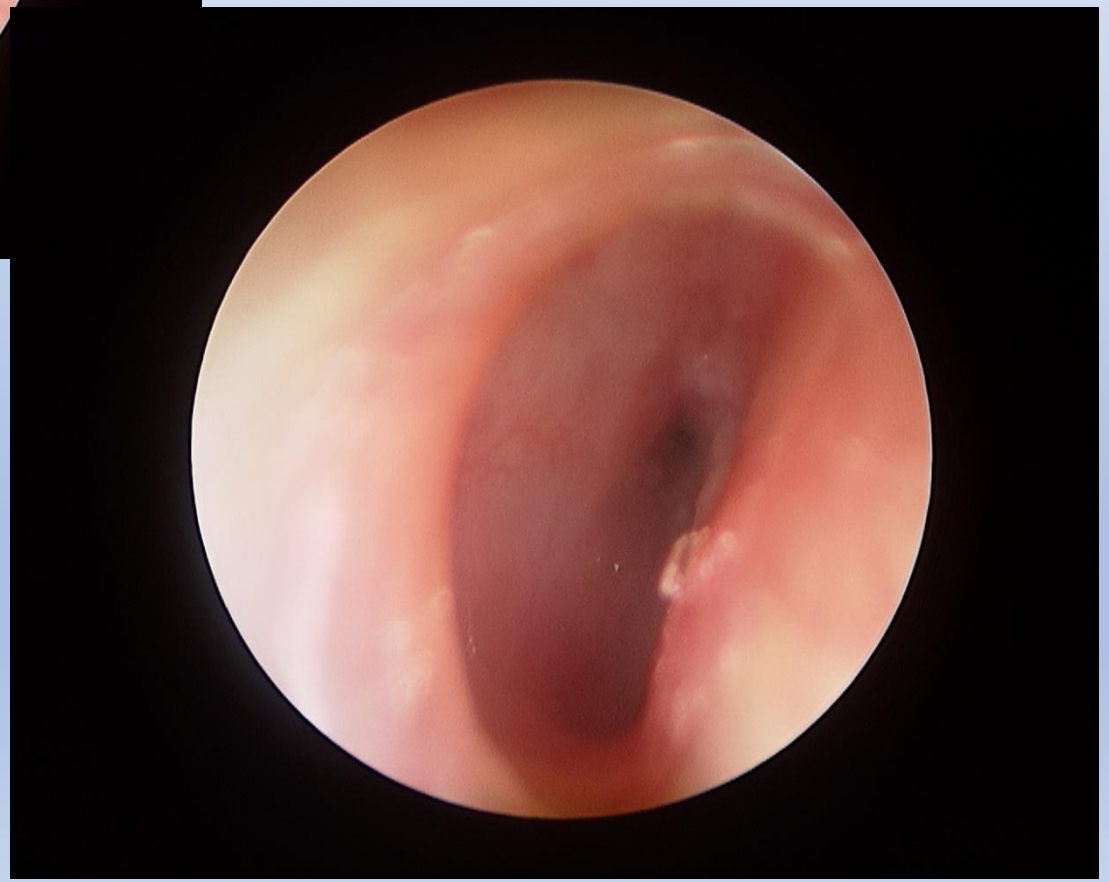
- CSOM minimising use of hearing aids
- Bone conduction SD 77% left
- 38% right






F





Blind sac closure on right and BAHA attract left

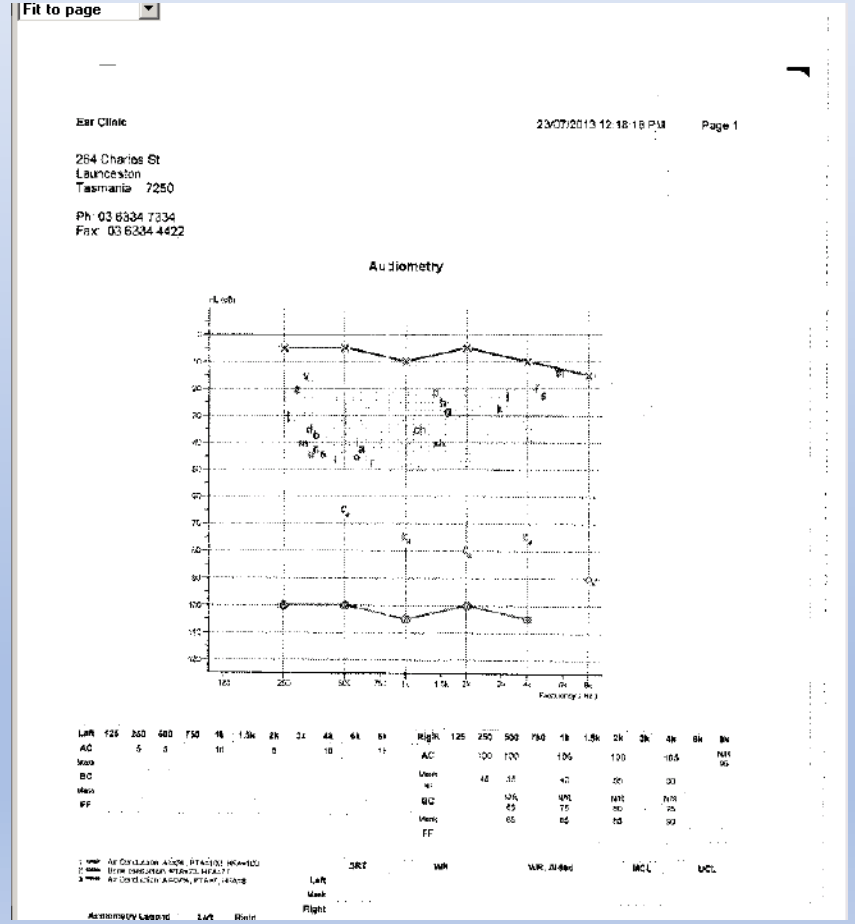
Vashishth A, Fulcheri A, Prasad SC, Dandinarasaiah M, Caruso A, Sanna M. **Cochlear Implantation in Chronic Otitis Media With Cholesteatoma and Open Cavities: Long-term Surgical Outcomes**. Otol Neurotol 2018;39:45-53.

Rak K, Volker J, Schendzielorz P, et al. **Cochlear Implantation in Chronic Otitis Media: Investigation of Long-term Speech Comprehension and Rate of Complications**. Otol Neurotol 2018

Second stage CI right side

43 year old man with SSNHL July 2013

- Maximal steroid treatment
- MRI normal



Options

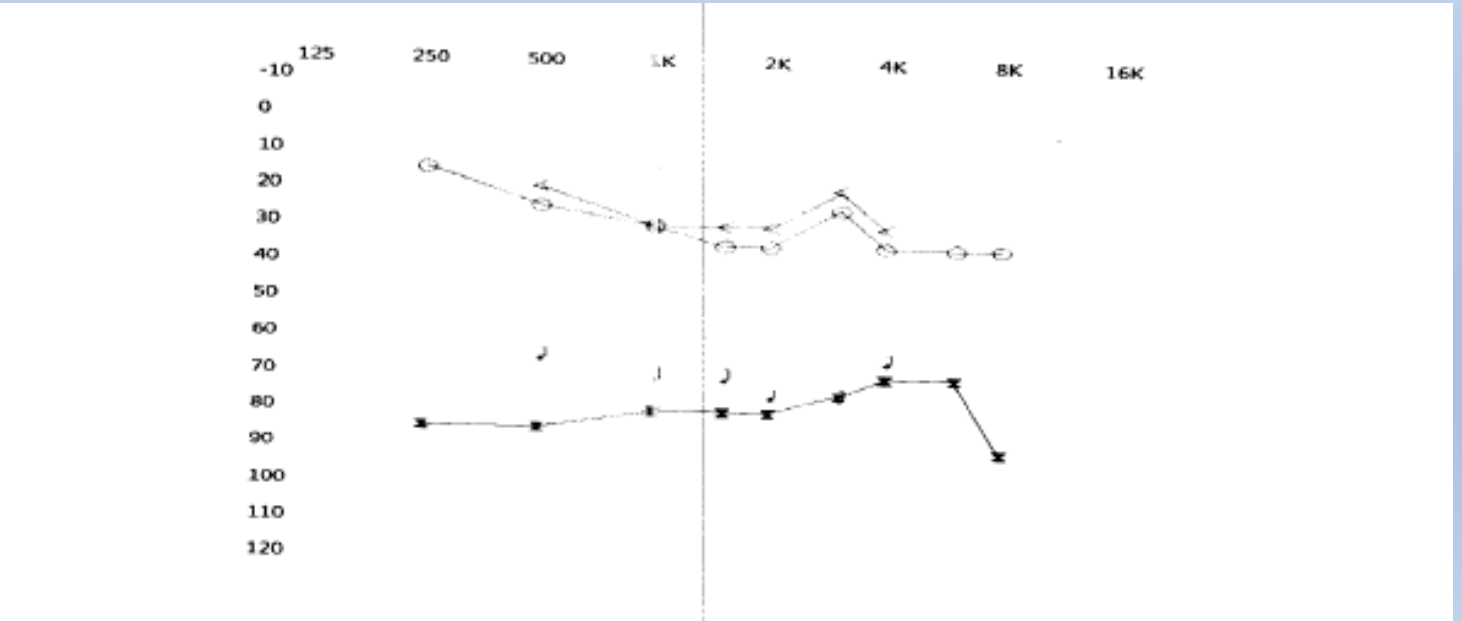
- Continue
- BiCros
- BAHA
- Cochlear implant

Cochlear CI522 2 years post hearing loss

- 100% open set pre-recorded within 3 weeks of switch on
- 96% phone within 5 months

59 year old lady with severe Meniere's Disease

- Regular drop attacks
- SD left 46% at 85dB



Options

- Gentamicin ablation
- Labyrinthectomy

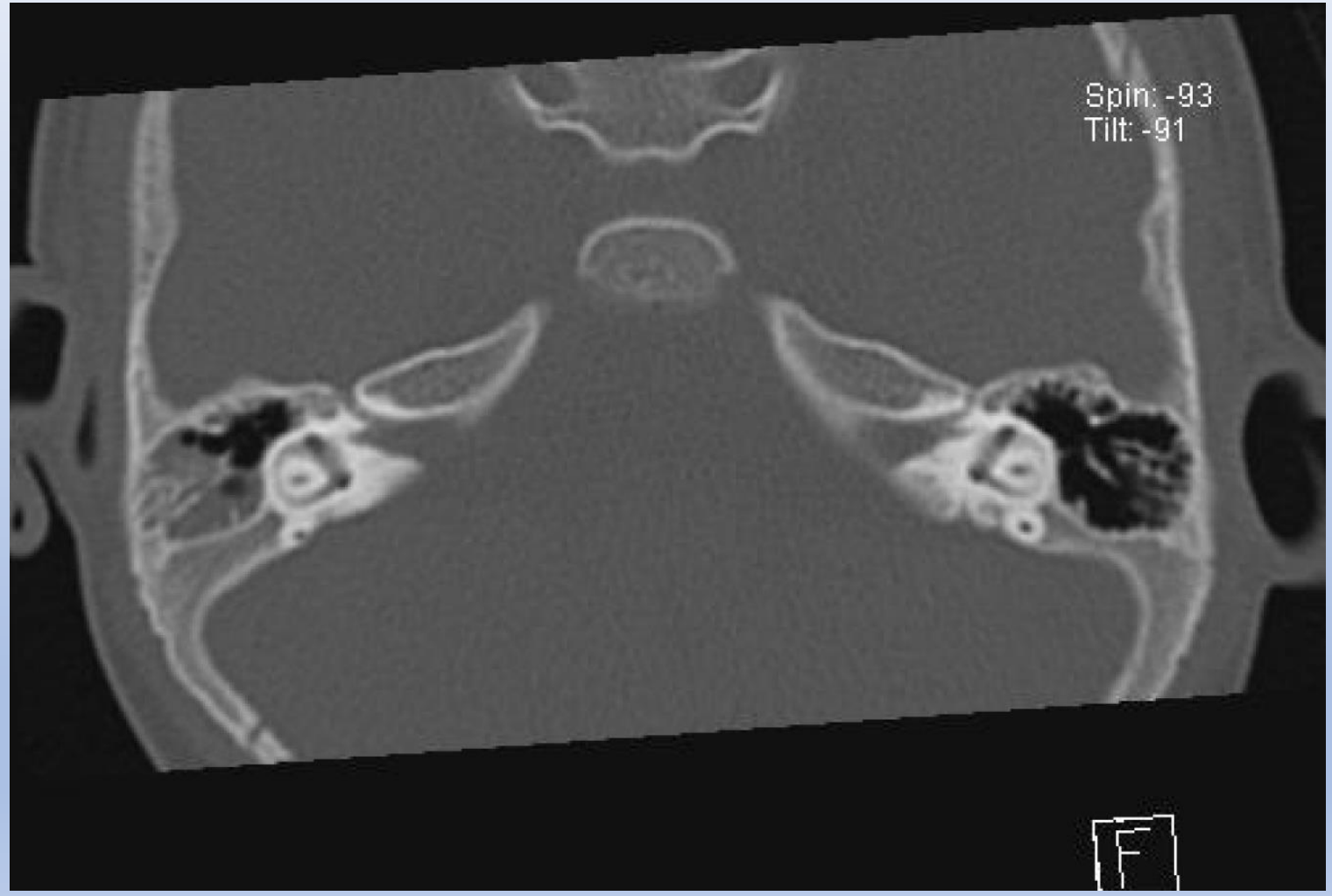
- BiCross
- BAHA
- CI

Concurrent Labyrinthectomy and CI

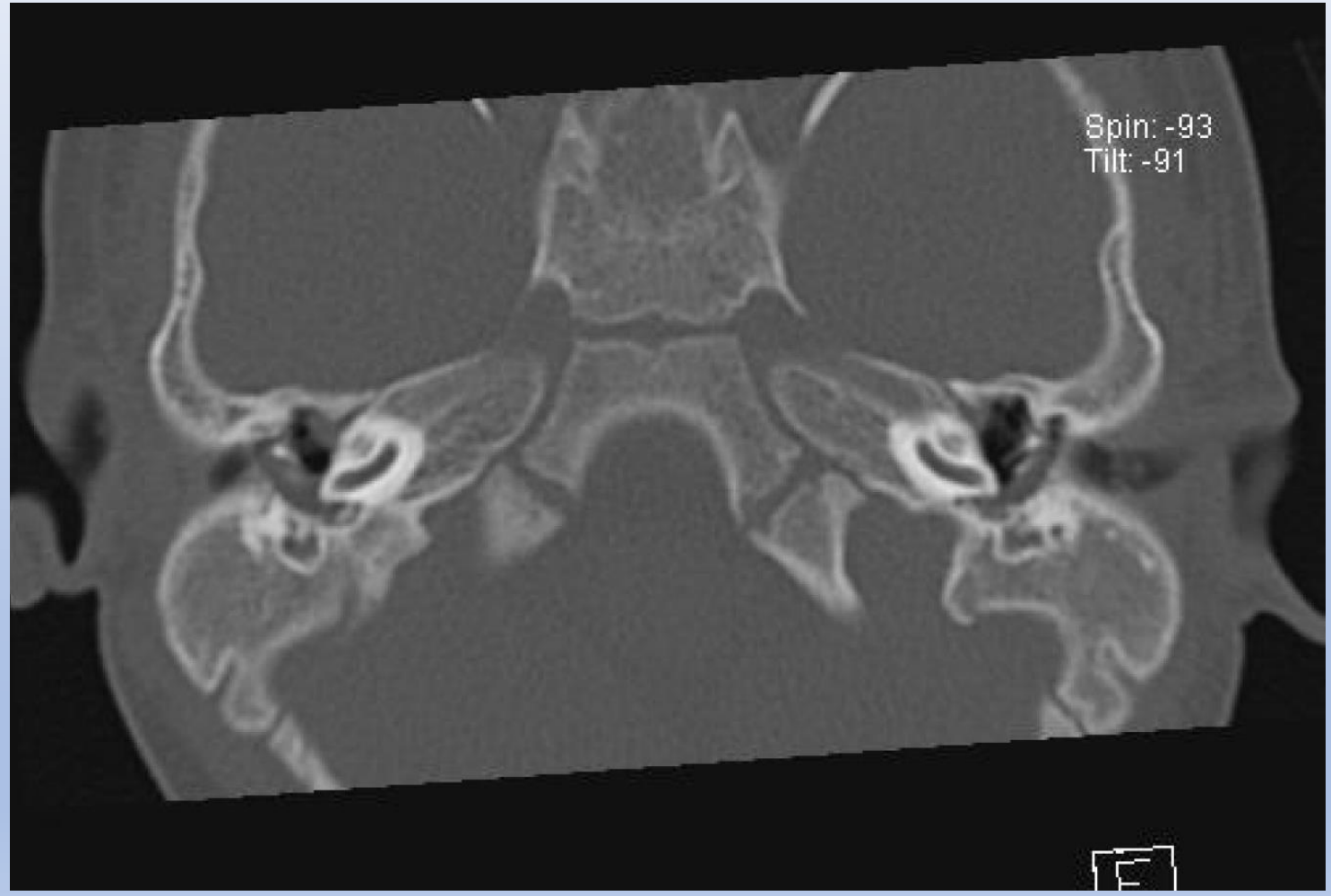
- Expected difficult balance retraining
- Excellent speech recognition and tinnitus control with implant

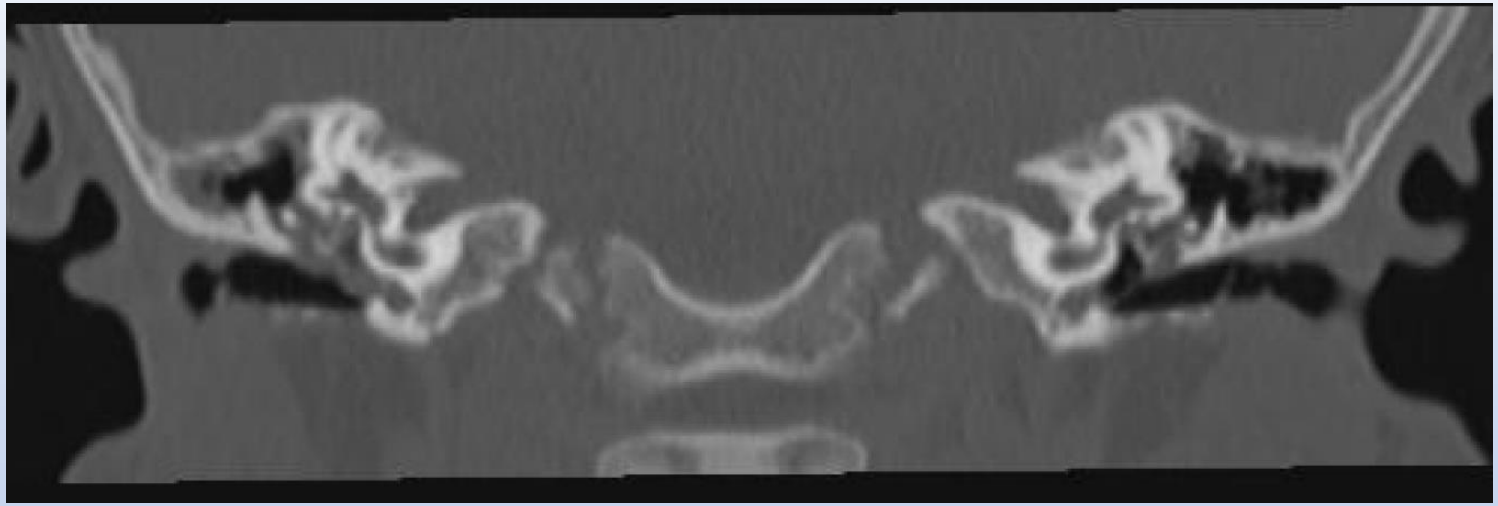
2 year old boy

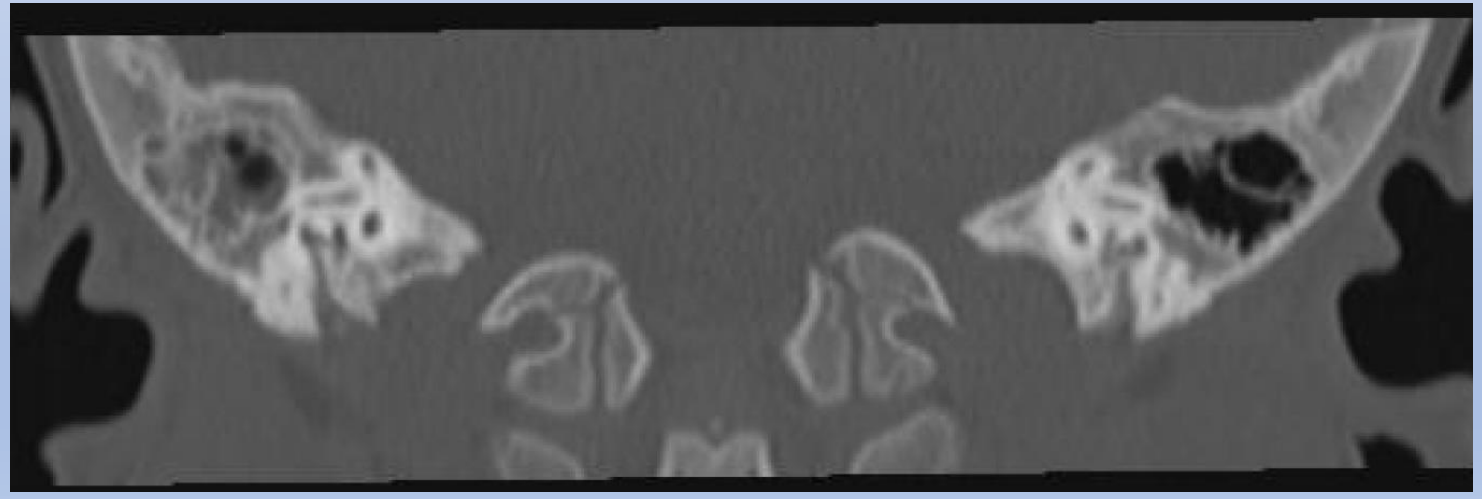
- Bilateral profound hearing loss
- Babbling
- No overt vestibular dysfunction
- No other signs or symptoms
- No family history

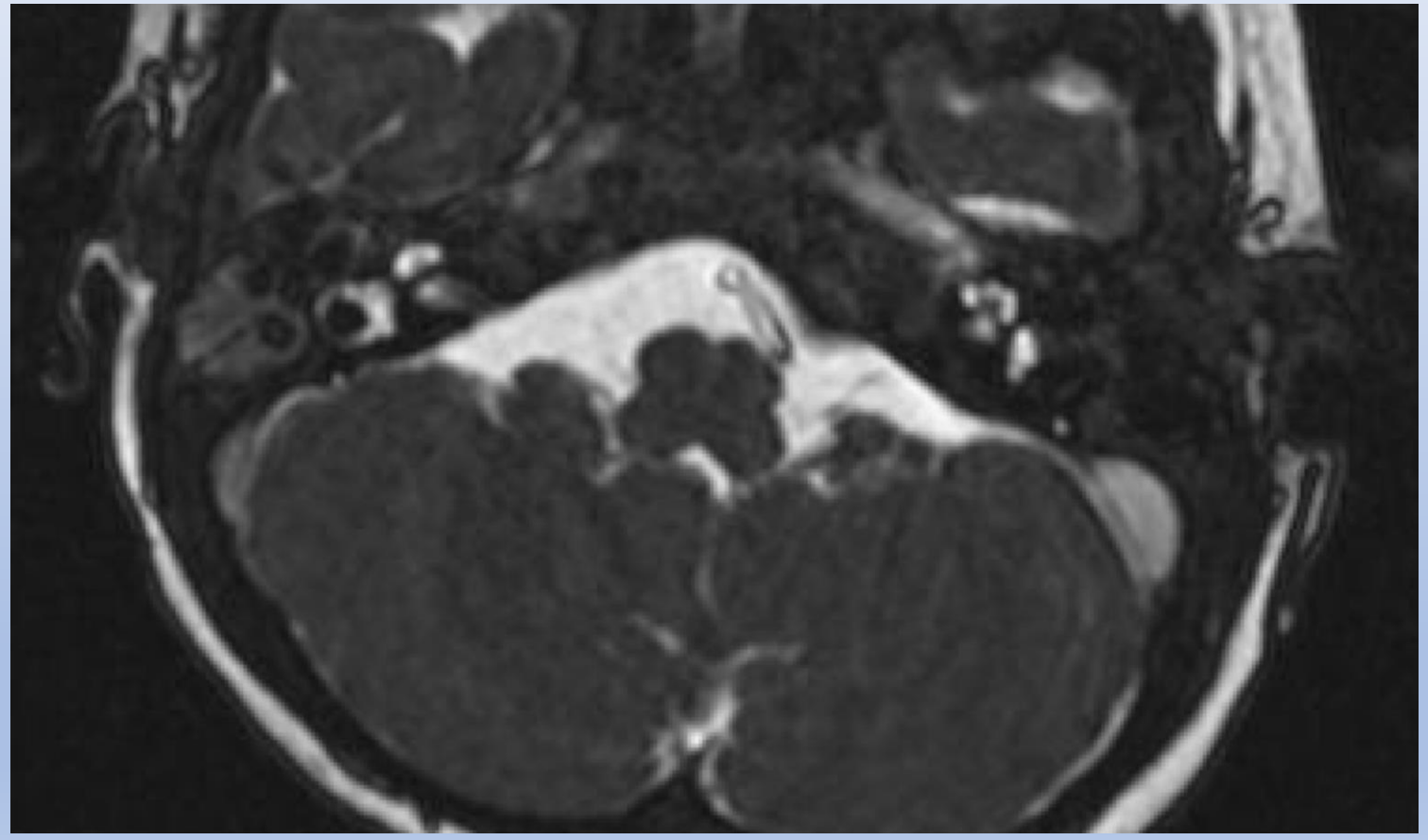

Spin: -93
Tilt: -91
F


Spin: -93
Tilt: -91
F


Spin: -93
Tilt: -91





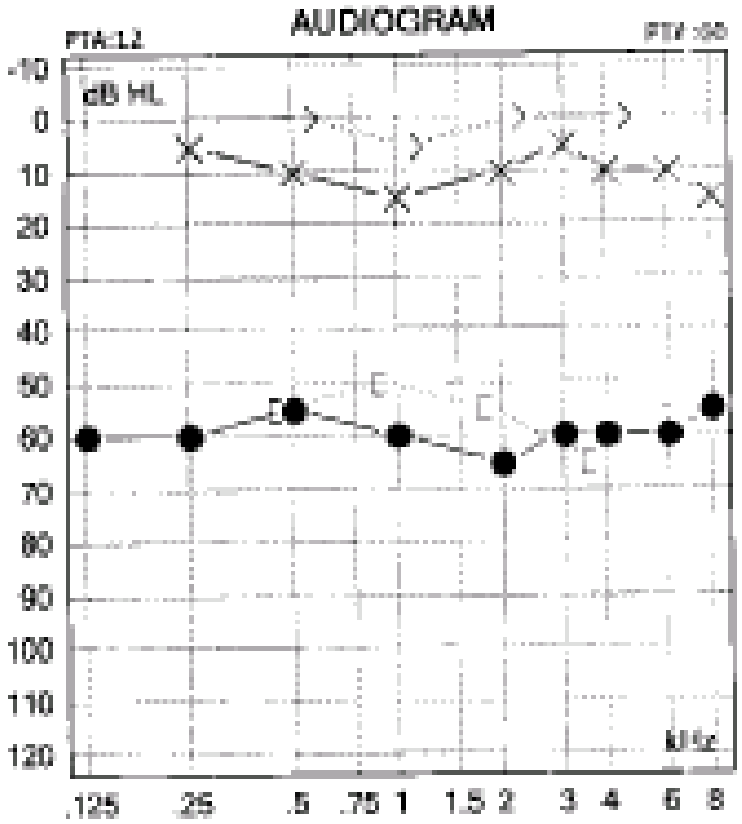


Options and expectations

40 year old SSNHL

- Oral Steroids
- Salvage intratympanic steroids

- Trial Standard HA
- Trial BiCross
- Trial BAHA



Aided Speech Perception Testing:

BKB Open Set Sentences (Pre-recorded)

- Right only aided 56%
- Right only aided 40% (signal to noise ratio + 10dB)

5 weeks

BKB Closed Set Speech Perception
Auditory training sentence exercises isolating right CI alone via direct auditory input indicated:-

- CI alone 95%

3 months

BKB Open Sentences (pre-recorded)

- CI alone 80%

These results indicate that Leanne's cochlear implant hearing is progressing well. She is still acclimatising to the "quality" of the sound, and continues to keep up her auditory training exercises using her auditory input cable to the right implant, to fast track the acclimatisation process. We have arranged a follow up review in three months time.

Her tinnitus level although slightly better is still persistent on the right side.

12 months

The Implant Test results were normal. Mapping indicated that her map has essentially stabilized.

CI Aided Audiogram:
Cochlear implant aided thresholds fall at the top of the long term average speech spectrum at all frequencies (see attached).

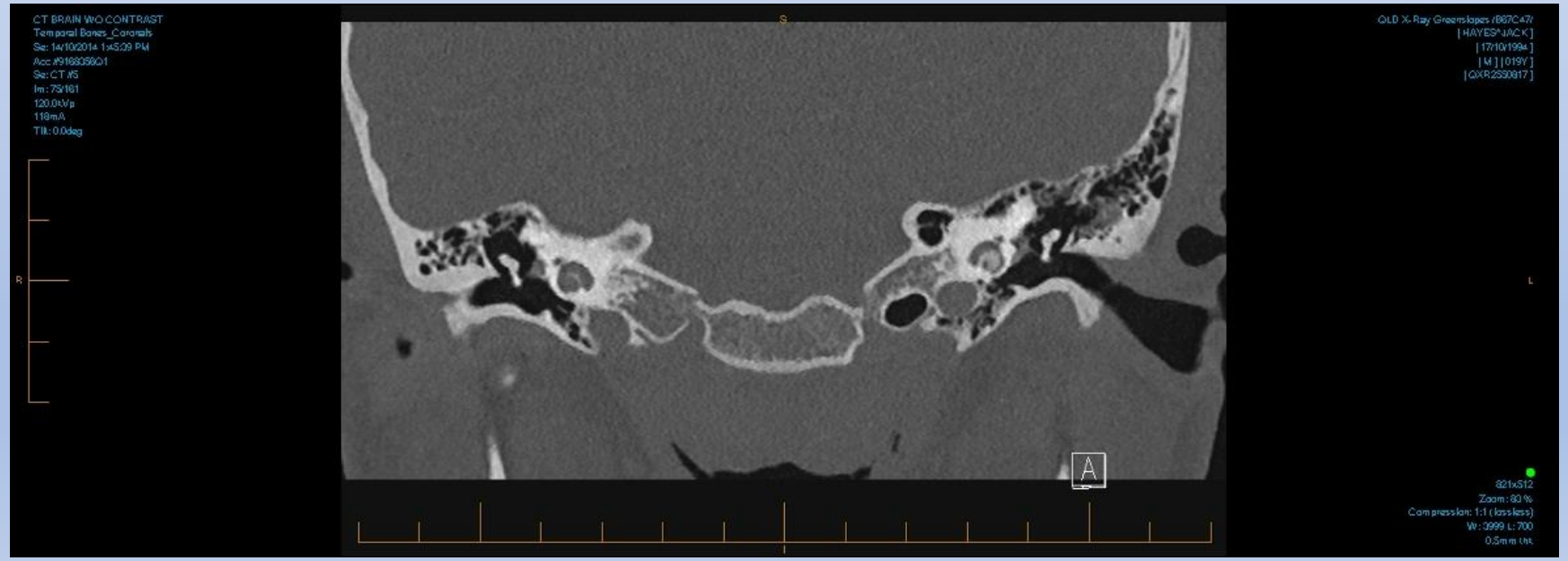
CI Aided Speech Perception Testing:
BKB Open Set Sentences (Pre-recorded)

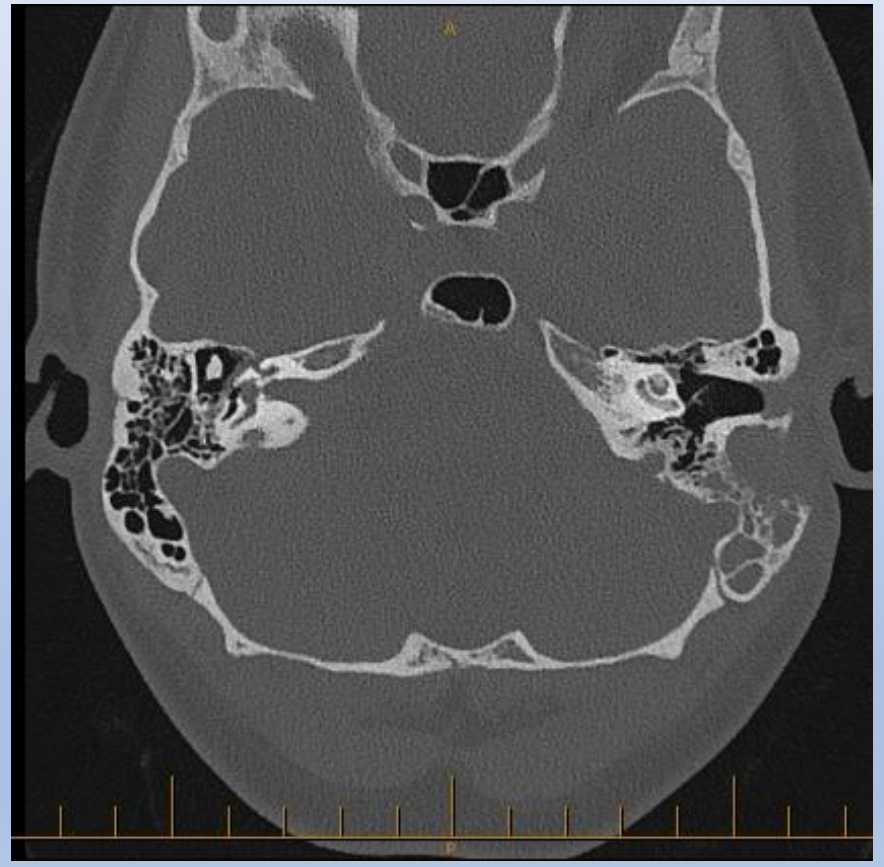
CI alone	70% at 65 dB HL
CI alone	83% at 70 dB HL

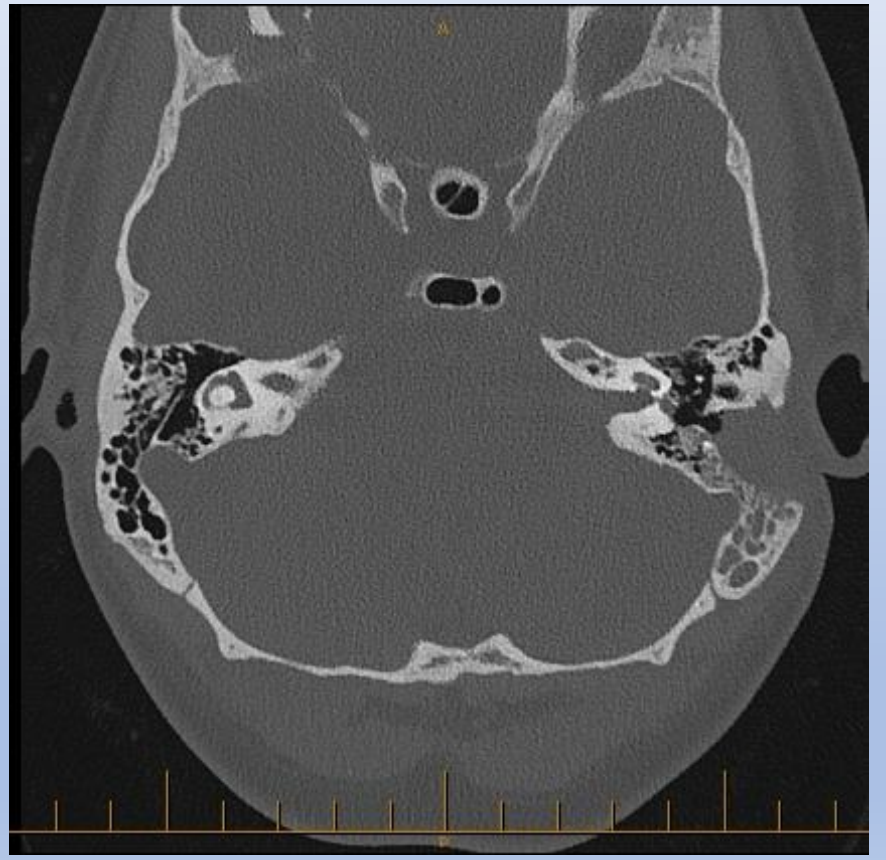
20 year old student JH

- Post meningitis
- SSD and severe tinnitus
- Progressive ossification of the cochlear


CT BRAIN WO CONTRAST
Temporal Bones_Coronals
Se: 14/10/2014 1:45:09 PM
Acc:#9168369Q1
Se: CT WS
Im: 82/161
120.0kVp
119mA
Tilt: 0.0deg
S
R
A
I
QLD X-Ray Greenslopes /B87C47/
[HAYES^JACK]
[17/10/1994]
[M] [019Y]
[QXR2530817]
L
821x512
Zoom: 80 %
Compression: 1:1 (lossless)
W: 3999 L: 700
0.5mm Int.


CT BRAIN WO CONTRAST
Temporal Bones_Coronals
Se: 14/10/2014 1:45:09 PM
Acc:#9168369Q1
Se: CT WS
Im: 75/161
120.0kVp
119mA
Tilt: 0.0deg
S
R
A
I
QLD X-Ray Greenslopes /B87C47/
[HAYES^JACK]
[17/10/1994]
[M] [019Y]
[QXR2530817]
L
821x512
Zoom: 80 %
Compression: 1:1 (lossless)
W: 3999 L: 700
0.5mm Int.



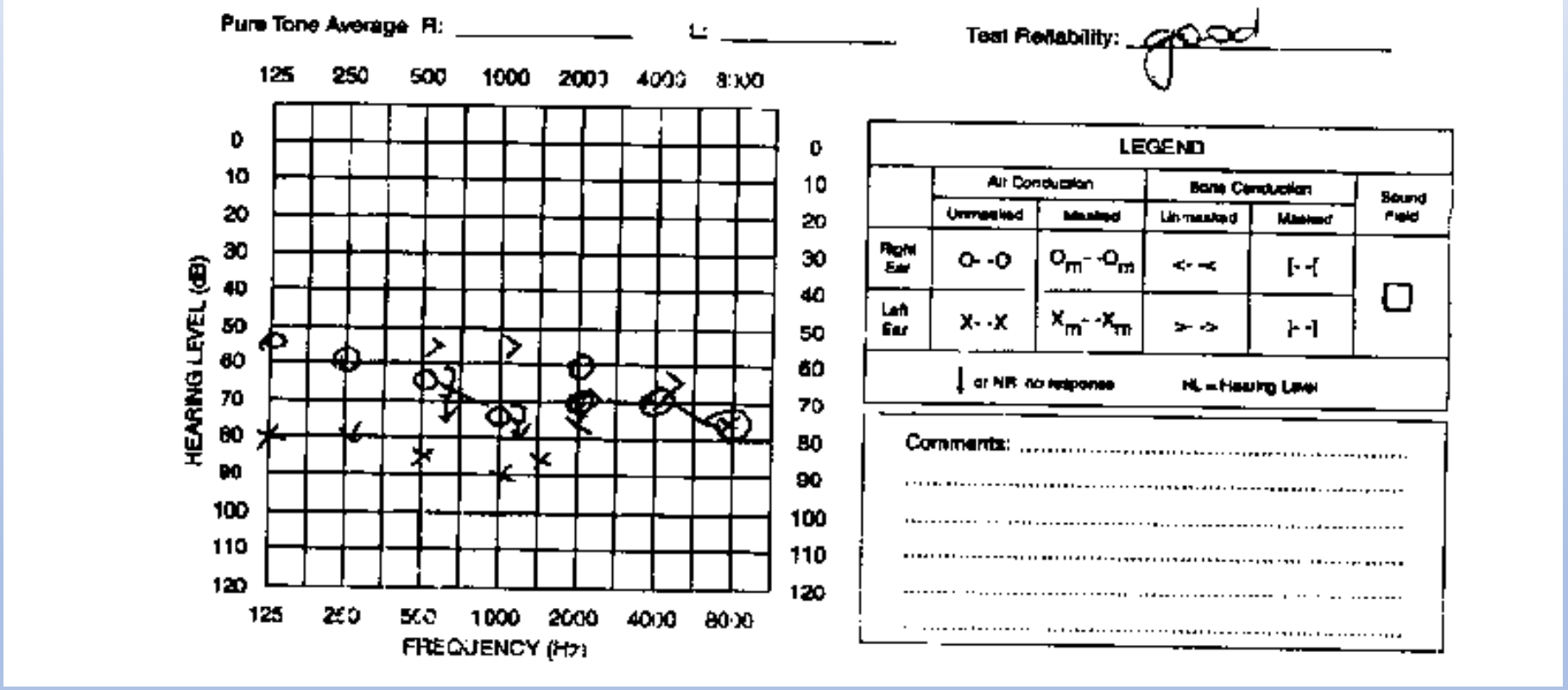


Extended surgical indications

- Tumour cases

sean@sydneyentclinic.com

30 year old woman



CI assessment

Aided Audiogram:
The left aided thresholds fall below the long term average speech spectrum (LTASS) for all test frequencies except between 2000Hz and 4000Hz. This result is consistent with Mrs Smith's report that she can detect speech with her left ear aided, but it is not at all clear.

The right aided thresholds fall below the LTASS only at 500Hz and 6000Hz. All other right aided thresholds are within the LTASS.

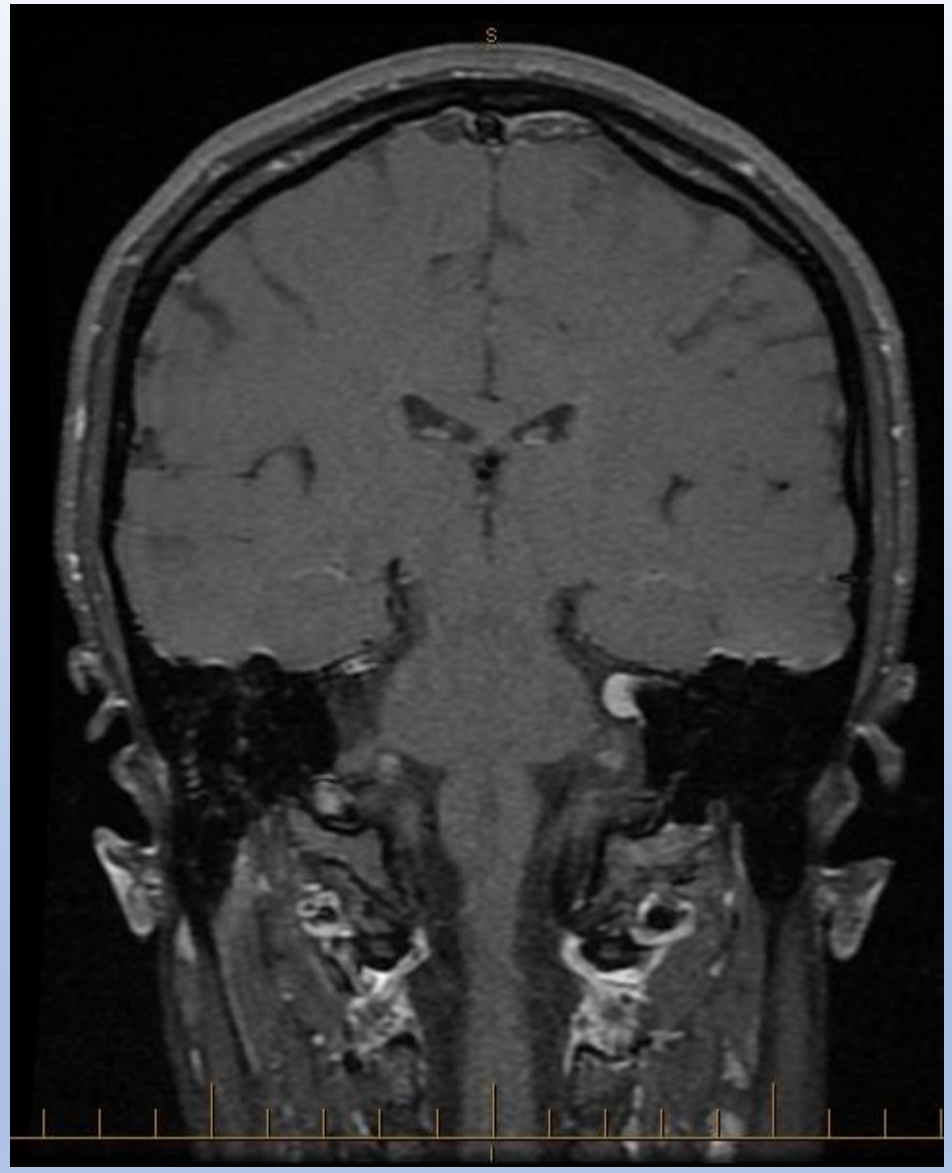
Aided Speech Perception Testing:
BKB Open Set Sentences (Live Voice)

- Binaural aided plus visual 98% correct
- Binaural aided 94%
- Right only aided 98%
- Left only aided 16%

BKB Open Set Sentences (Pre-recorded)

- Binaural aided 92%
- Right only aided 92%
- Left only aided 6%

These results clearly show that Mrs Smith relies almost exclusively on her right hearing. The results fall within the current audiological criteria for a left cochlear implant.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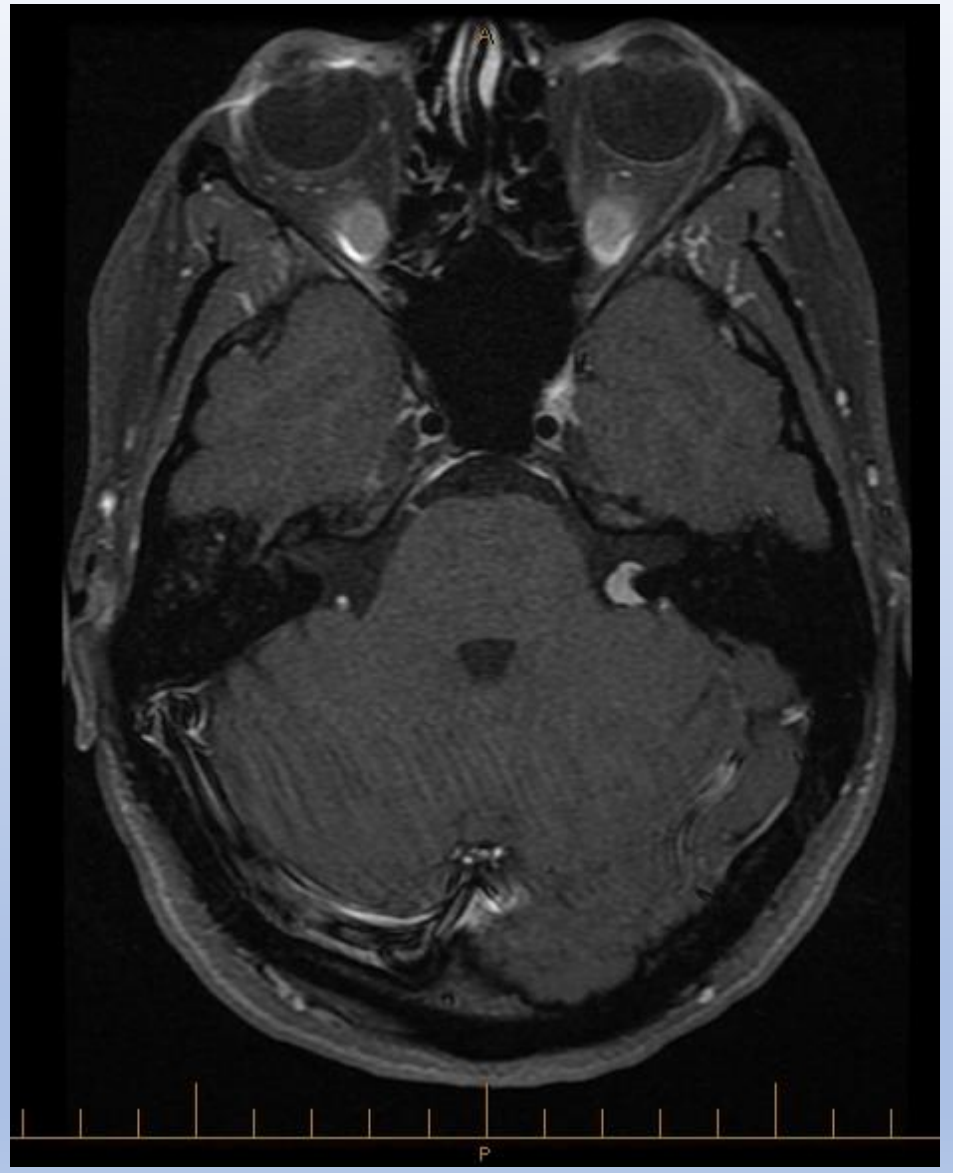
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Post-op flare in migraine headache

2 months post implant

The implant test results were normal. Mapping resulted in a significantly wider dynamic range. Speech perception test results are above what we expect after only two months use:

BKB Open Set Sentences (Live Voice)

- CI alone 86% Correct

BKB Open Set Sentences (Pre recorded)

- Bimodal 84% Correct
- CI alone 76%
- Right hearing aid alone 62%

BKB Open Set Sentences (Telephone)

- CI alone 62% Correct

1 yr post implant

The Implant Test results were within normal limits and stable.

Speech perception test results are below:

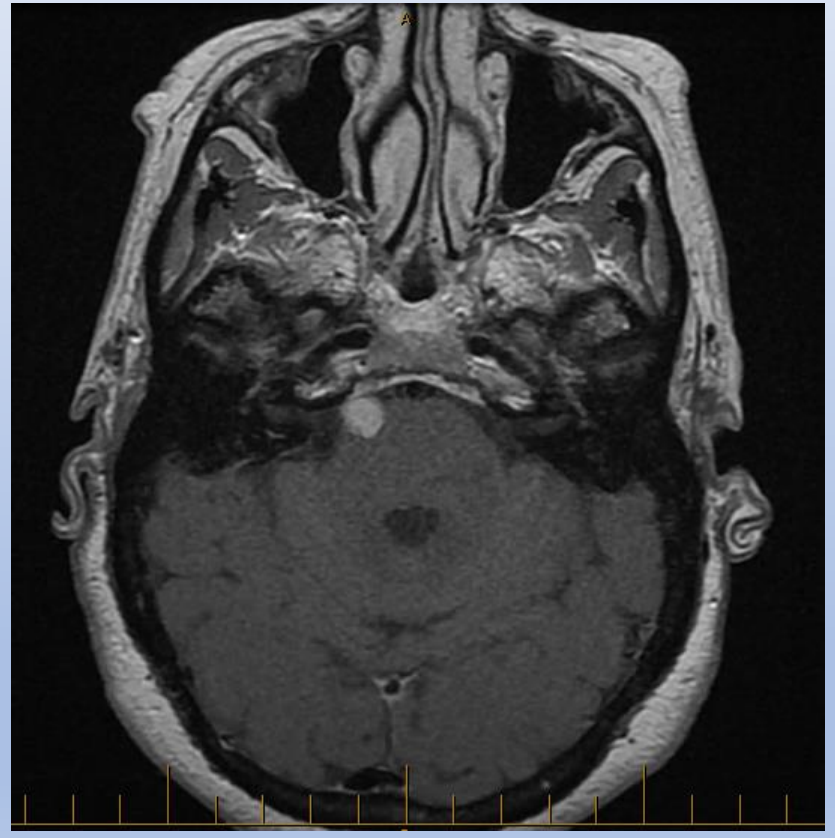
BKB Open Set Sentences (Live Voice)

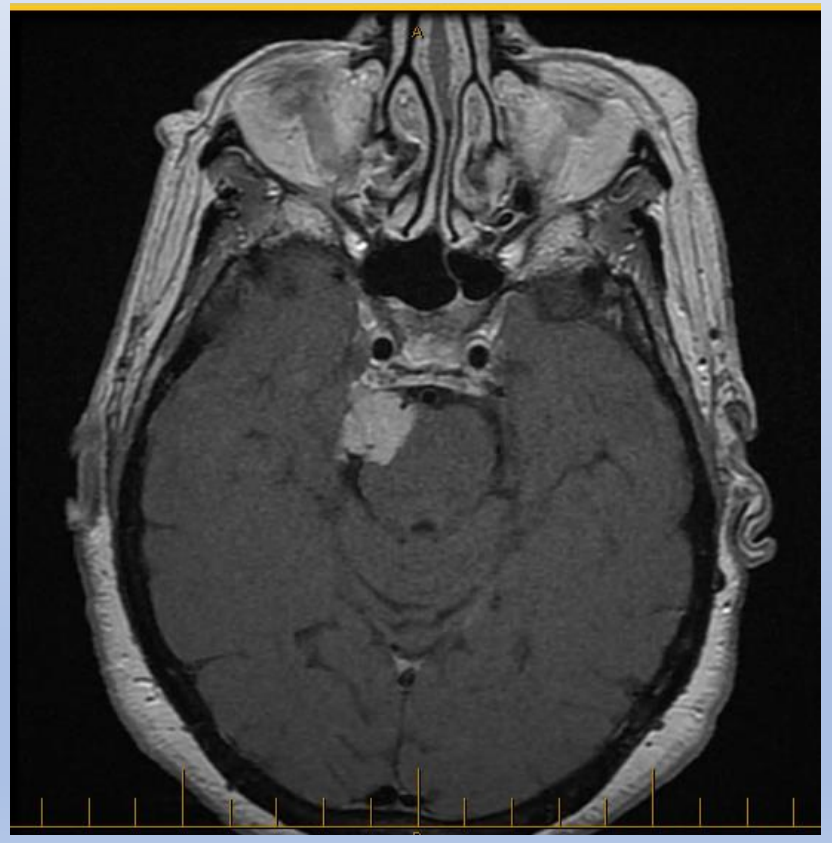
- Bimodal 96%
- CI alone 96%

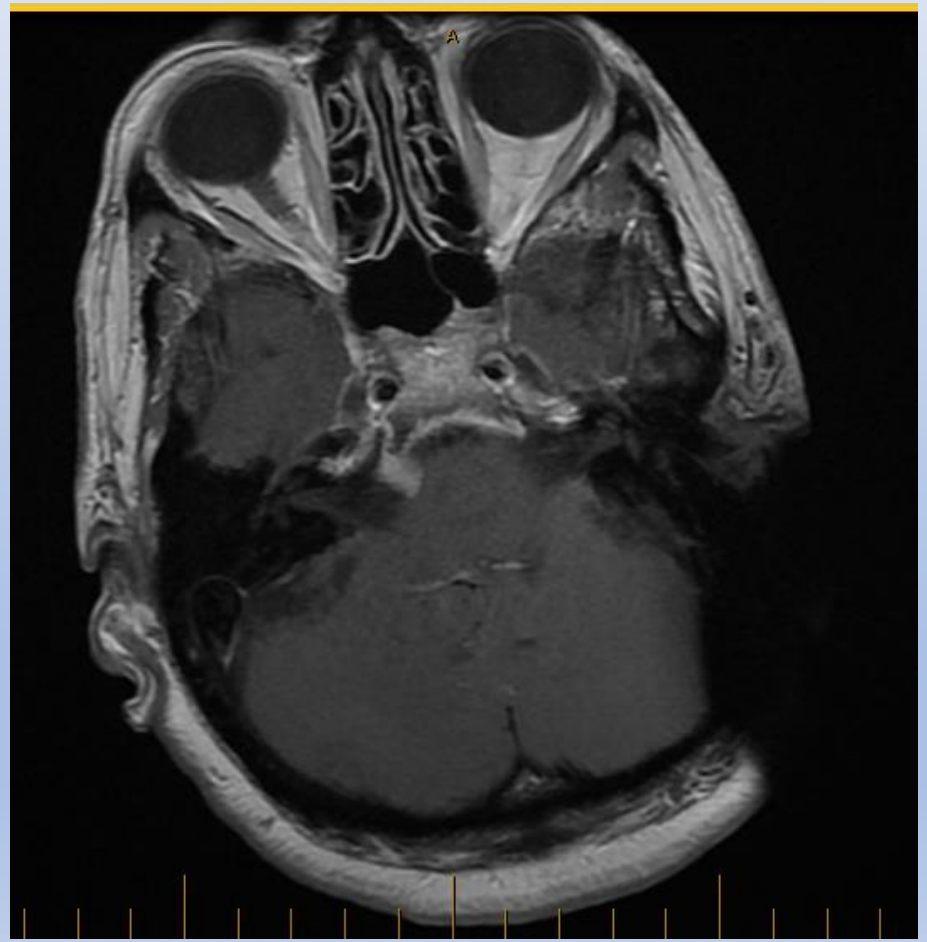
72 year old woman

Present Audiometric findings indicate asymmetrical profound sensorineural hearing loss in the left ear with extremely poor speech discrimination ability (36% at 85 dB HL). *The right ear has moderate-to-profound degree sensorineural hearing loss. Unaided Speech discrimination ability in the right ear at 65 dB HL is 50% which improves to 67% at 85dB HL*

Pre-op MRI



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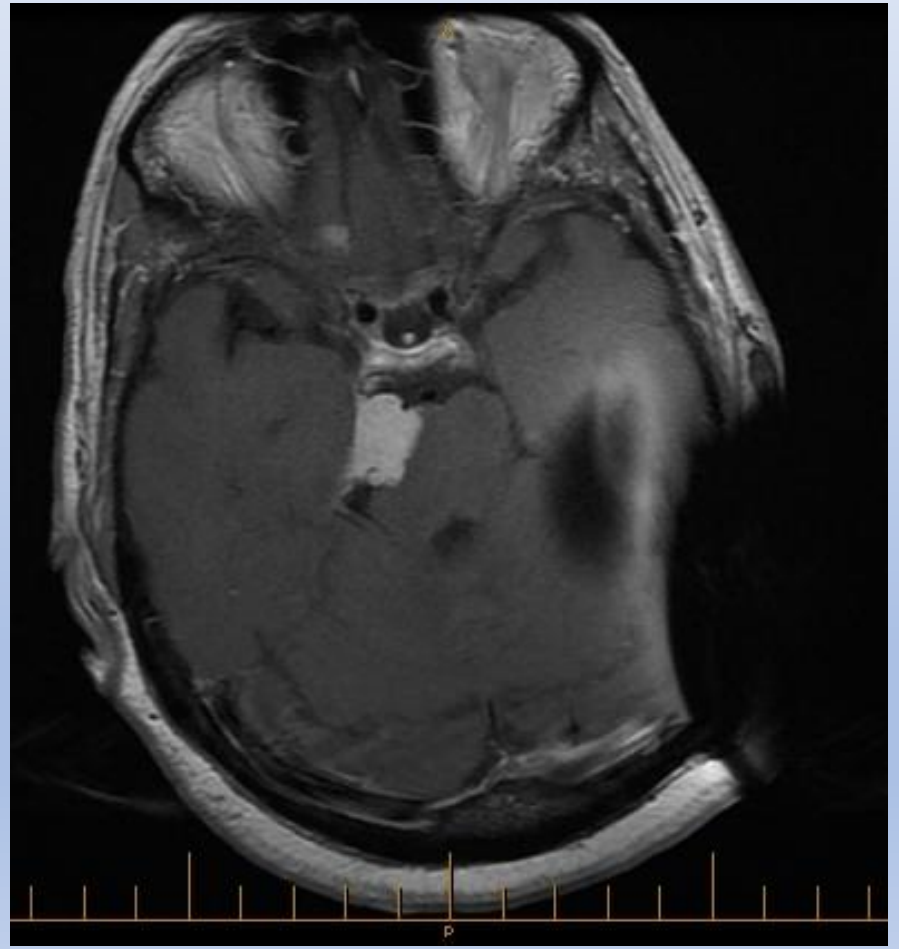
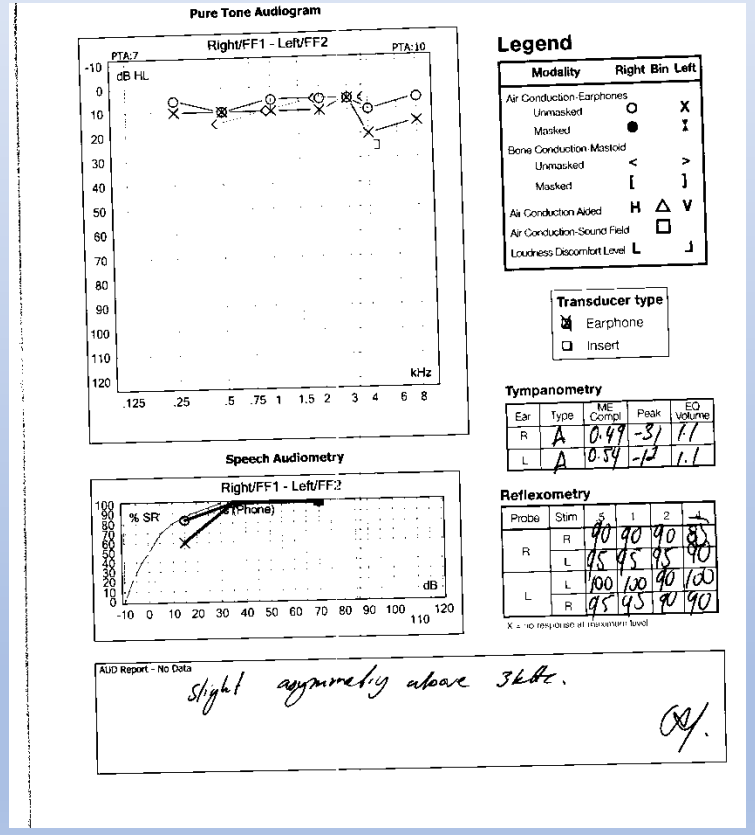

P

62 year old man



Pure Tone Audiogram

Right/FF1 - Left/FF2

PTA:7 PTA:10

dB HL

-10 0 10 20 30 40 50 60 70 80 90 100 110 120

kHz

.125 .25 .5 .75 1 1.5 2 3 4 6 8

Legend

Modality	Right	Bin	Left
Air Conduction-Earphones			
Unmasked	O		X
Masked	●		⧗
Bone Conduction-Mastoid			
Unmasked	<		>
Masked	[		]
Air Conduction Aided	H	△	V
Air Conduction-Sound Field		□	
Loudness Discomfort Level	L		⌟

Transducer type

Earphone

Insert

Speech Audiometry

Right/FF1 - Left/FF2

% SR (Phone)

100 90 80 70 60 50 40 30 20 10 0

-10 0 10 20 30 40 50 60 70 80 90 100 110 120

dB

Tympanometry

Ear	Type	ME Compl	Peak	EQ Volume
R	A	0.49	-31	1.1
L	A	0.54	-12	1.1

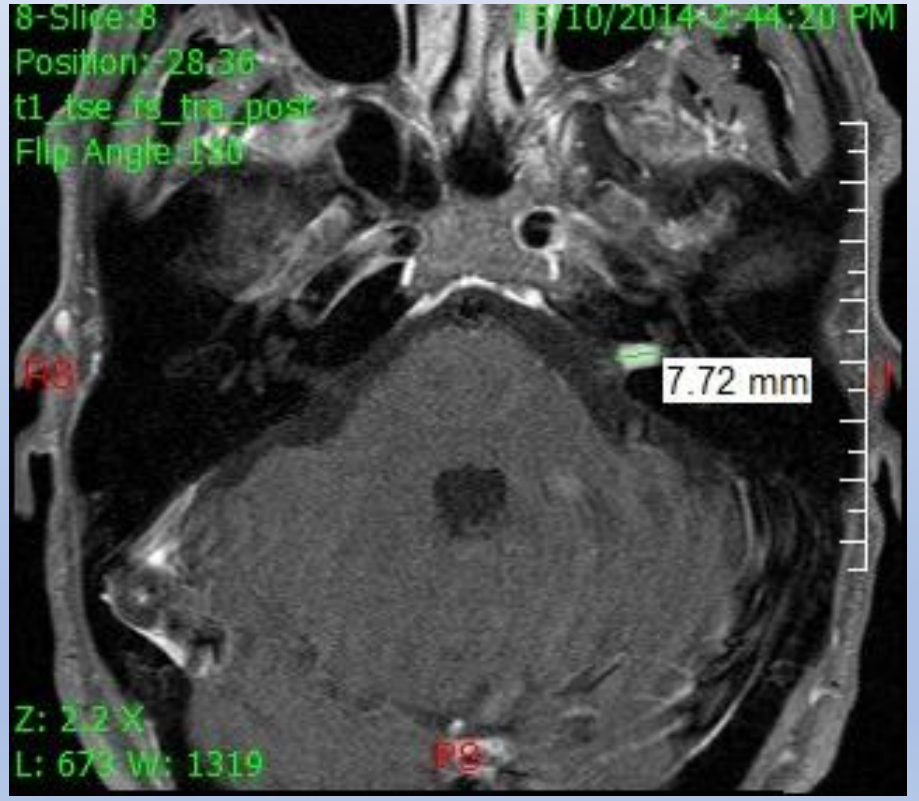
Reflexometry

Probe	Stim	.5	1	2	4
R	R	90	90	90	85
	L	95	95	95	90
L	L	100	100	90	100
	R	95	95	90	90

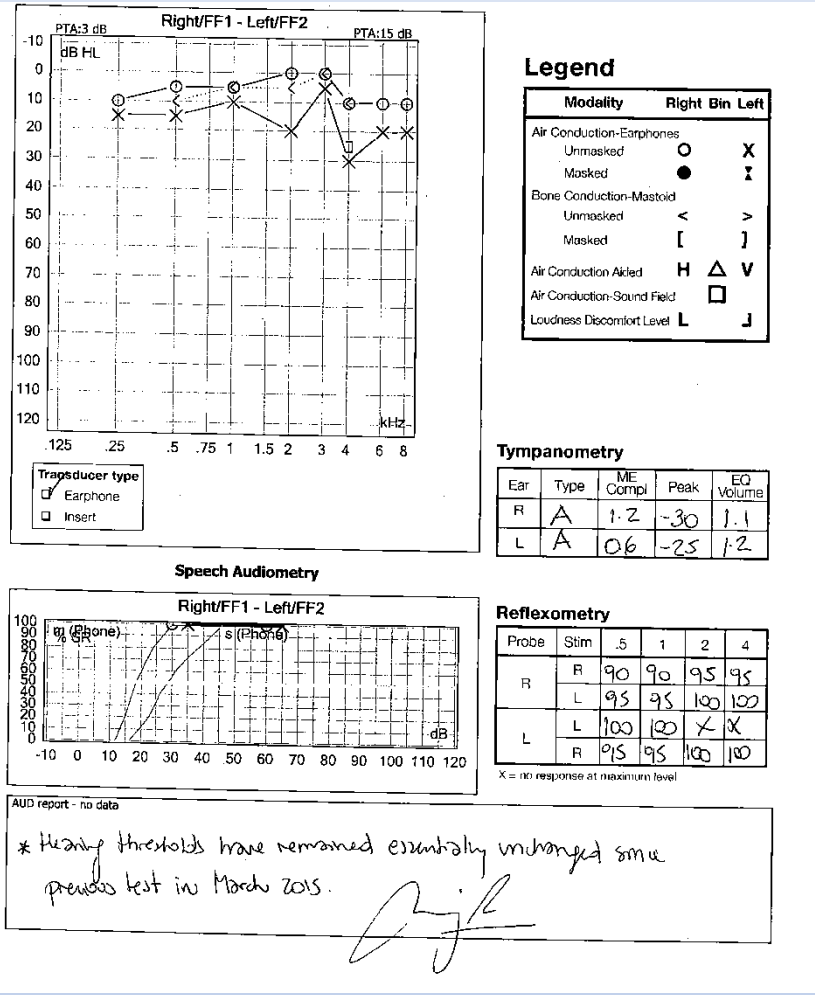
X = no response at maximum level

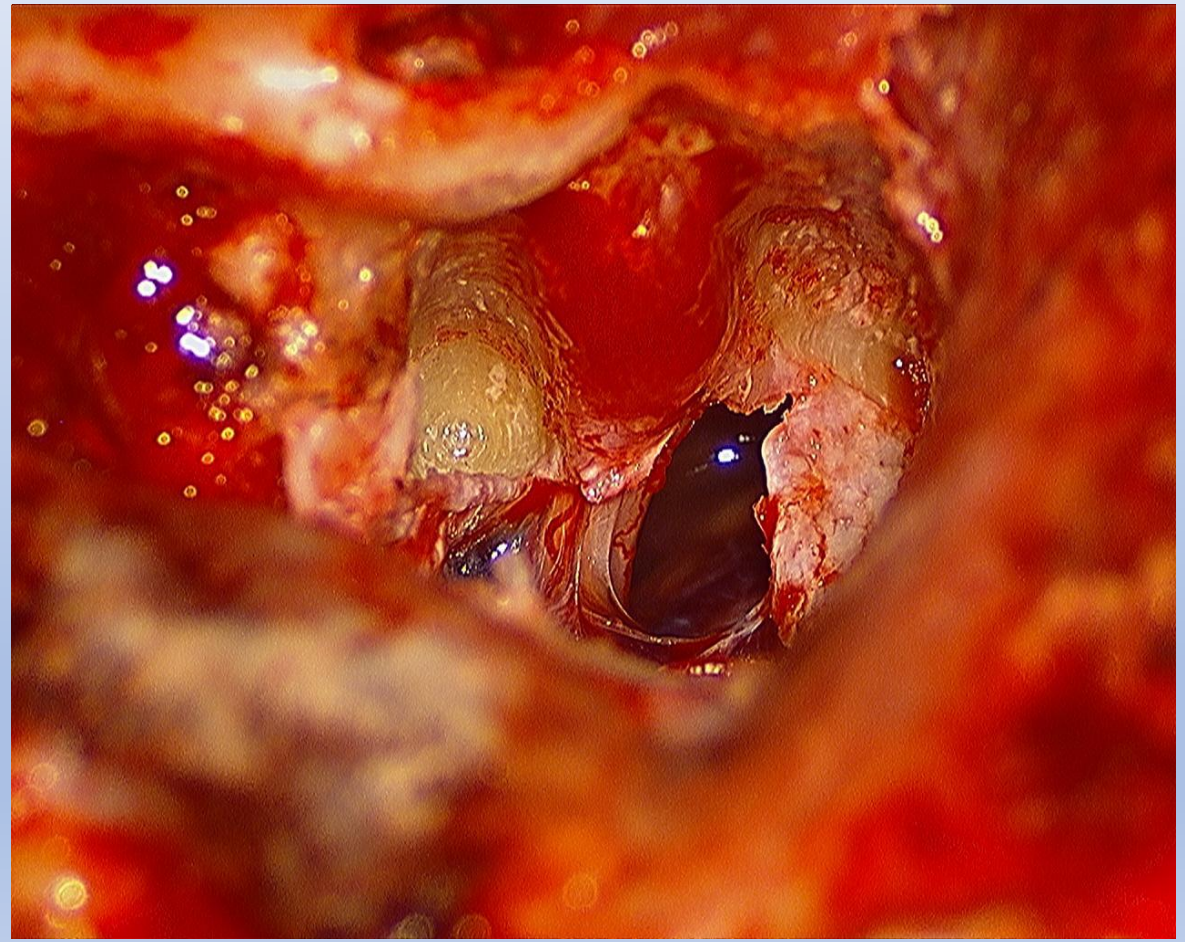
AUD Report - No Data

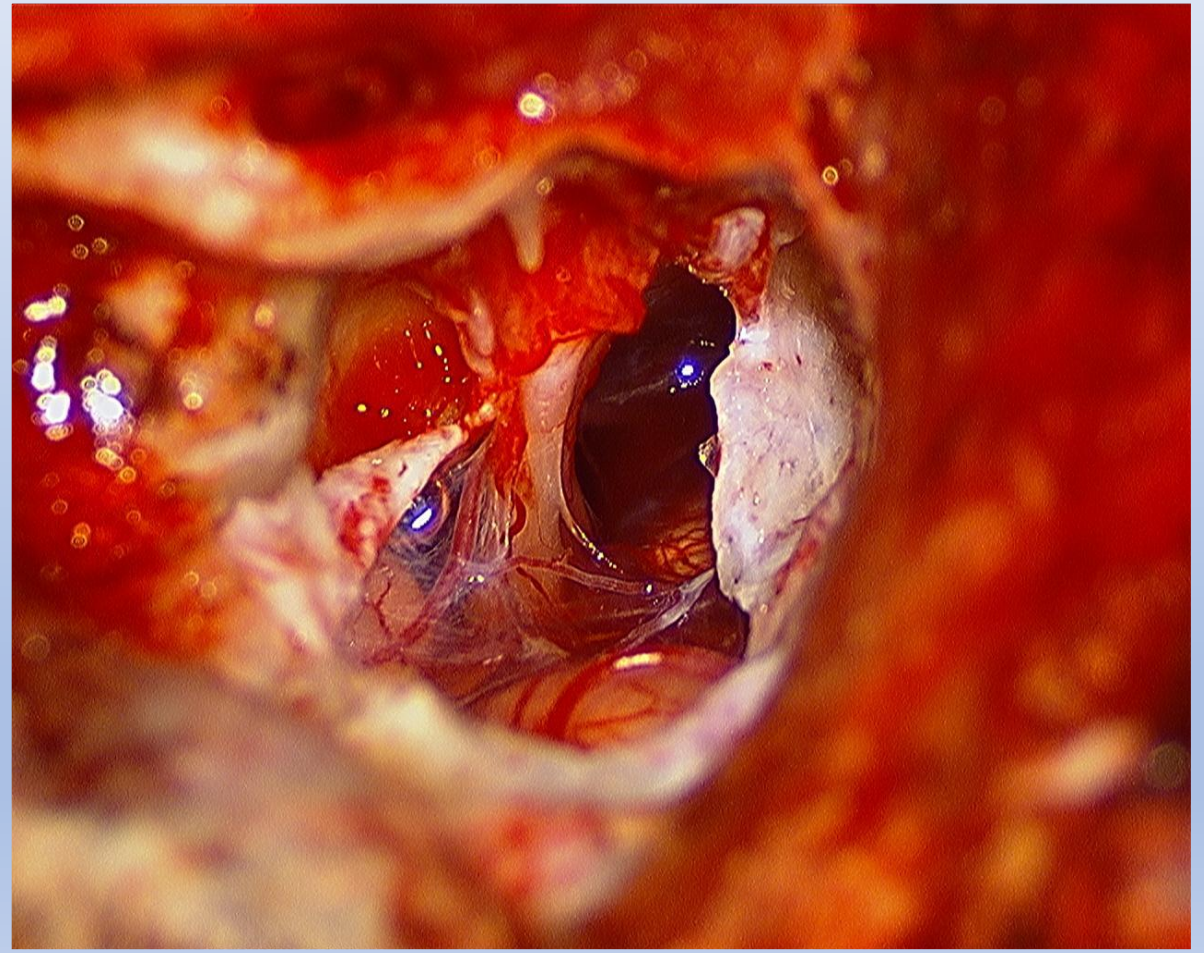
Slight asymmetry above 3kHz.

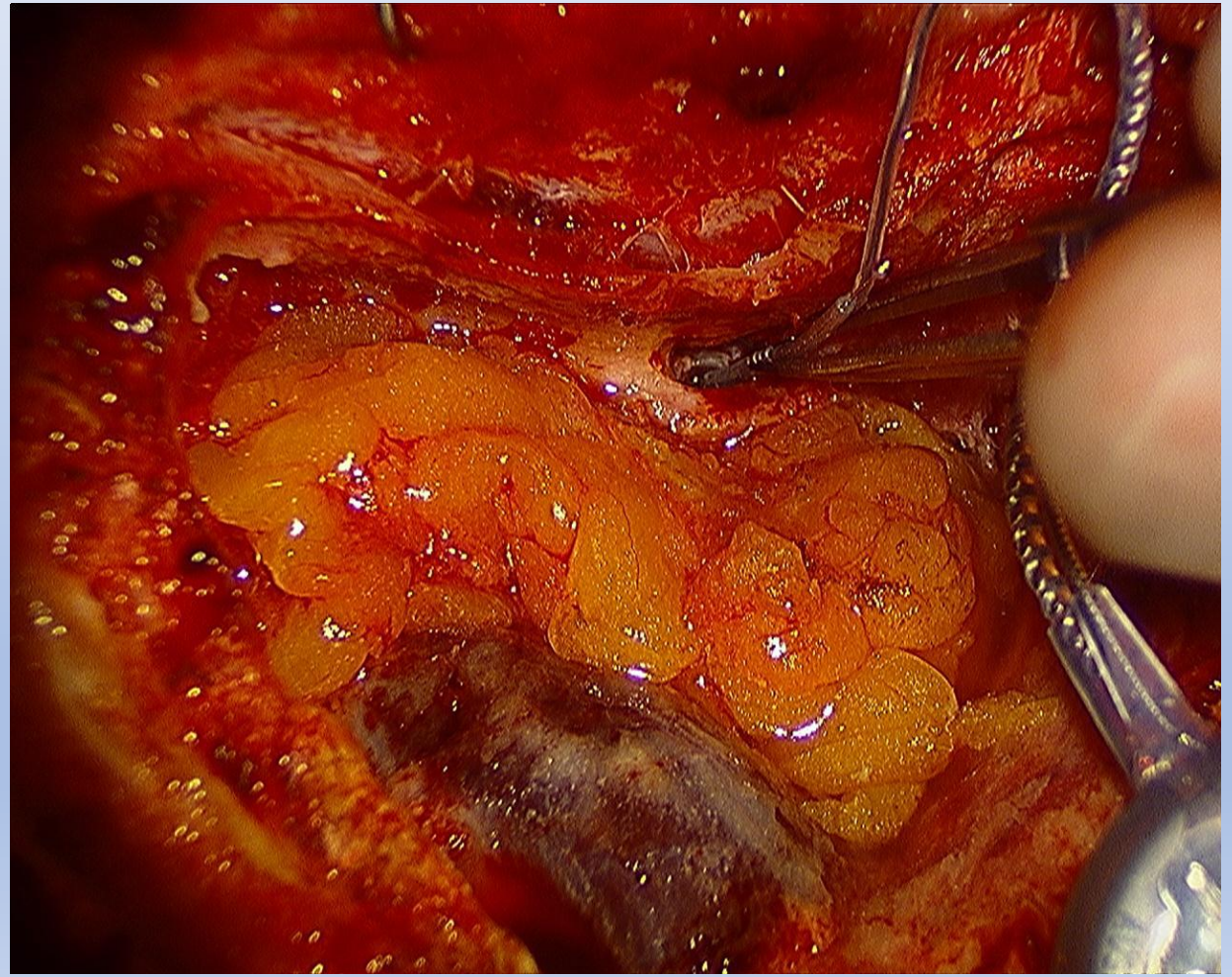

8-Slice:8
Position:-28.36
t1_tse_fs_tra_post
Flip Angle:130
7.72 mm
Z: 2.2 X
L: 673 W: 1319


8-Slice:8
7/10/2015 9:23:35 AM
Position:-30.67
t1_tse_fs_tra_post
Flip Angle:150
R
A
Z: 2.2 X
L: 634 W: 1210
P


Right/FF1 - Left/FF2
PTA:3 dB
PTA:15 dB
dB HL
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
.125
.25
.5
.75
1
1.5
2
3
4
6
8
kHz
Transducer type
Earphone
Insert
Legend
Modality
Right
Bin
Left
Air Conduction-Earphones
Unmasked
Masked
Bone Conduction-Mastoid
Unmasked
Masked
Air Conduction Aided
Air Conduction-Sound Field
Loudness Discomfort Level
Tympanometry
Ear
Type
ME Compl
Peak
EQ Volume
R
A
1.2
-30
1.1
L
A
0.6
-2.5
1.2
Speech Audiometry
Right/FF1 - Left/FF2
% SR
s (Phone)
dB
Reflexometry
Probe
Stim
.5
1
2
4
R
R
90
90
95
95
L
95
95
100
100
L
L
100
100
X
X
R
95
95
100
100
X = no response at maximum level
AUD report - no data
* Hearing thresholds have remained essentially unchanged since previous test in March 2015.







ST VINCENT'S HOSPITAL SYDNEY

ST VINCENT'S PRIVATE HOSPITAL SYDNEY

- St Vincent's Hospital Temporal Bone Dissection Course and Live Surgery (October)
- Audiology Conference and Live Surgery (November)
- Clinical observerships
- Otology and Skull Base Surgery Fellowship