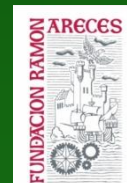


Blake Papsin

Programa de Implantes Cocleares. The Hospital for Sick Children
Departamento de ORL, University of Toronto
Toronto, Canadá



- Pionero en la implantación coclear pediátrica bilateral simultánea y secuencial a corto plazo
- Director del programa de implantes cocleares pediátricos, The Hospital for Sick Children
- Numerosas contribuciones sobre la técnica y resultados de la implantación coclear pediátrica



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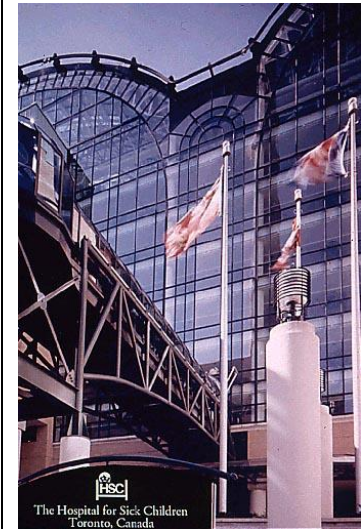


Implantes cocleares: consideraciones
quirúrgicas en bebés y niños pequeños

*Surgical considerations in infants and
children receiving cochlear implants*



Cochlear Implantation in Infants: Searching for the Moth



Deteccion, Diagnostico Y Tratamiento Precoz de la Sordera en la Infancia, Madrid – May 28, 2011

Cochlear Implant Research Team

DIRECTORS

- Karen Gordon
- Blake Papsin

RESEARCH ASSISTANTS

- Jerome Valero
- Stephanie Jewell

STUDENTS

- Daniel Wong
- Claire Salloum
- Sho Tanaka
- Patrick Yu
- Brad Hubbard
- Lauren Schofield
- Brittany Harrison
- Brooke Allemang

FELLOWS

- Talar Hopyan
- Neil Chadha
- James Ramsden



COLLABORATORS

Local - SickKids

- Bob Harrison
- Tracy Stockley
- Susan Blaser
- Adrian James

- Paolo Campisi
- Vicky Papaioannou
- Mark Crawford
- Maureen Dennis
- Gina Sohn
- Naureen Sohail
- Laurie MacDonald
- Mary Lynn Feness
- Pat Di Santos
- Nancy Greenwald-Hood
- Susan Druker

Local - external

- Sandra Trehub
- Frank Russo

International

- Robert Cowan
- Richard van Hoesel

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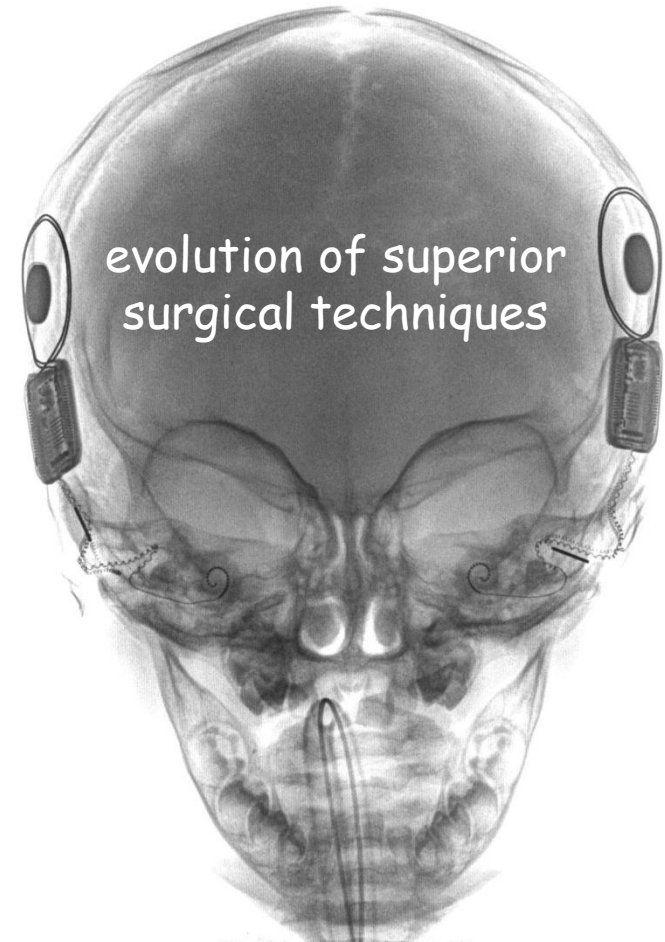
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- Frank Russo

International

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- Richard van Hoesel

Pediatric Cochlear Implantation

- >200,000 implants
- focus
 - safety
 - outcomes (oralism)
 - cost effectivity
 - candidacy



Soft Tissue Complications

Author – Date	Patients	Number of Patients	Minor Complications	Major Complications	Total Complications
De Jong* '98	<18 yr	52	3.8	3.8	7.6
Bhatia '04	<18 yr	300	16	2.3	18.3
Venail '08	<18 yr	500	5.6	1.4	7
Ovansen '08	All ages	313	11.2	4.5	15.7
Loundon '10	<16 yr	434	1.1	3.4	4.5
Dauids * '09	<18 yr	462	0.4	1.5	1.9



Soft Tissue Complications (<1)

Author – Date	Patients	Number of Patients	Minor Complications	Major Complications	Total Complications
Bhatia '04	<5 yr	300	16	2.3	18.3
Ovansen '08	All ages	313	11.2	4.5	15.7
Rolland '09	<1 yr	50	10	6	16
Das '10*	<1 yr*	80/112	2.5/1.8	1.3/0.9	3.8/2.7

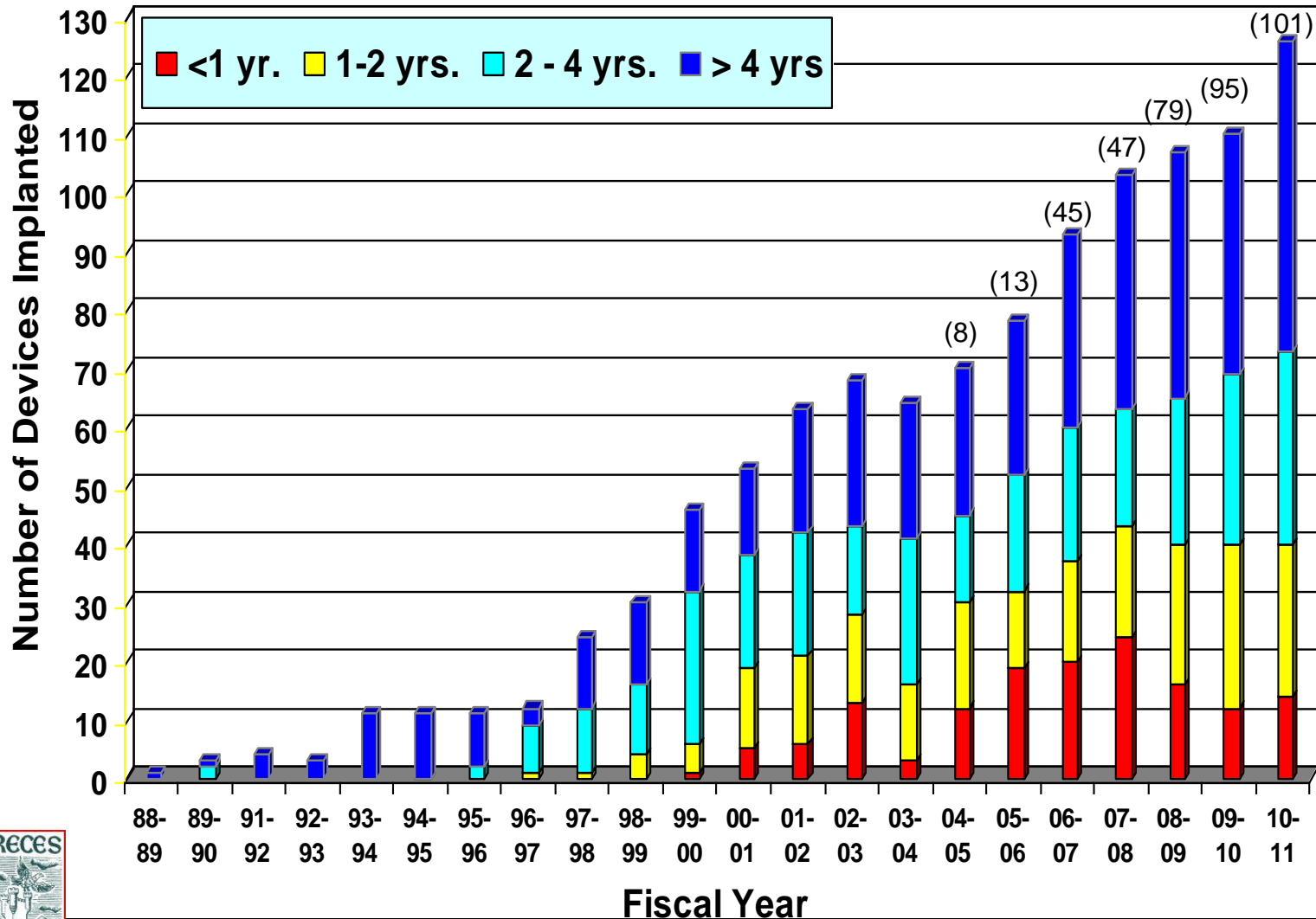


Results

- 971 devices in 738 children (5575 implant-yrs)

	N= (%) or Median (Range)	
CIs requiring re-implantation	35	Rate 3.6%
Original Implant at another center	7 (20%)	↓ Rate 2.9%
Time in months between initial and re-implant	46 (12-154)	
Model difference between first and second device	20 (57%)	
Etiology of Deafness		
- Congenital – Unknown	13 (37%)	
- Congenital – Genetic	11 (31%)	
- Meningitis	7 (20%)	vs. 8%
- Mondini Deformity	3 (9%)	overall
- Other cochleo-vestibular anomaly	1 (3%)	p <0.01

Annual Cochlear Implants by Age



Surely we will end up where we are headed
if we do not change direction

Lao Tzu (?6th – 4th century BCE)



It is only the wisest and stupidest that do
not change

Confucius (551 -479 BCE)



Searching for the Moth

- how did we get here?



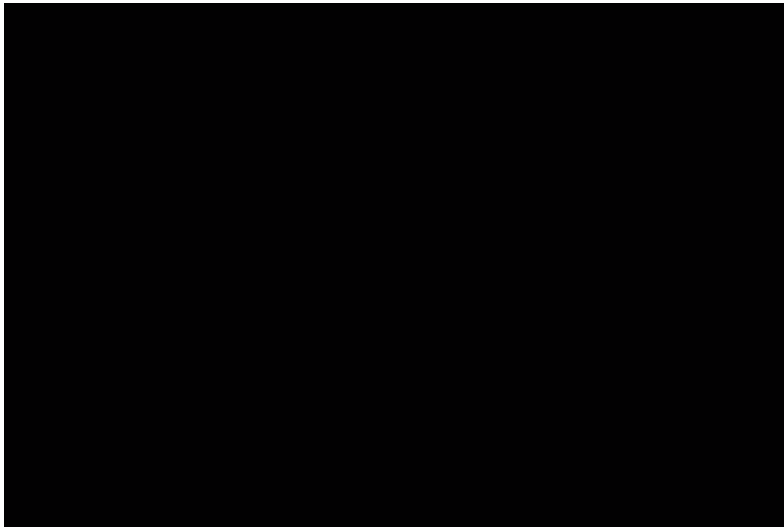
Xanthopan morganii praedicta 1903



Angraecum sesquipedale 1862

Searching for the Moth

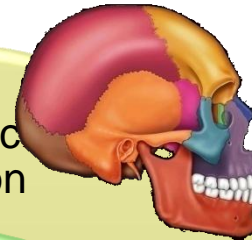
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Xanthopan morganii praedicta 1903



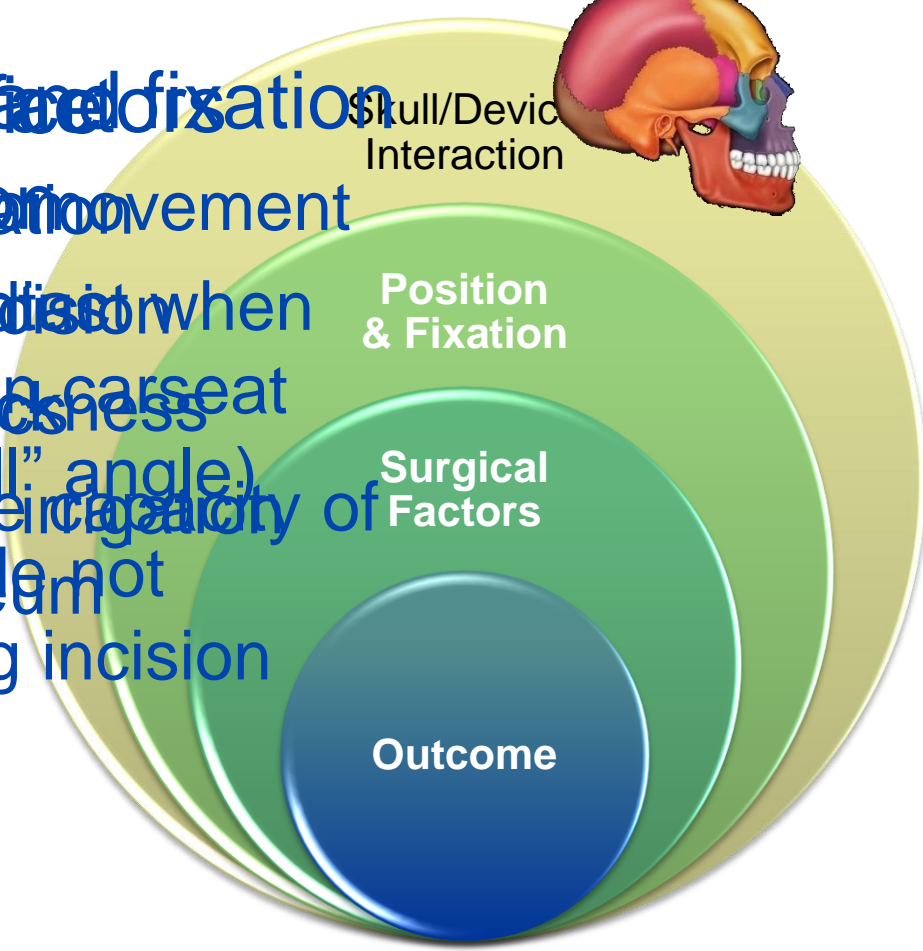
Angraecum sesquipedale 1862



Searching for the Moth

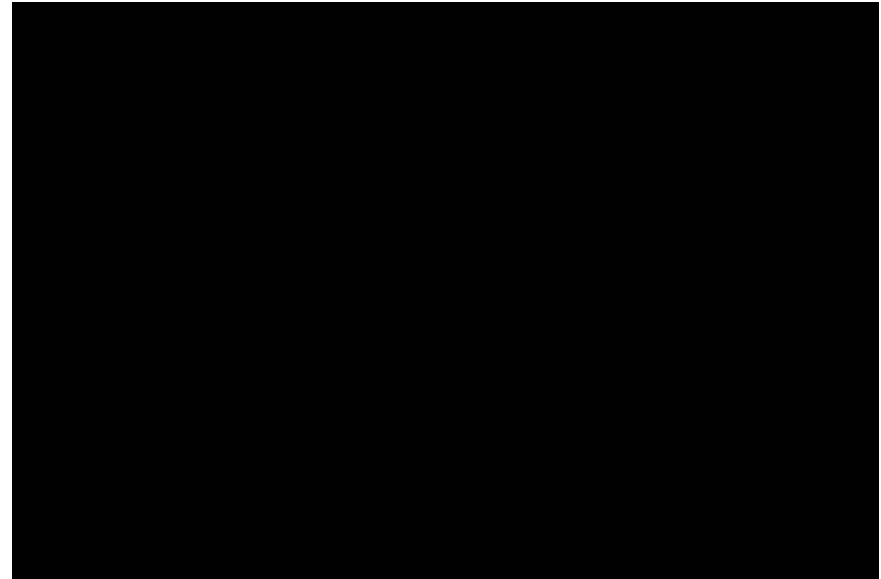
● position and fixation interaction

- skull/Device Interaction
- Position & Fixation
- Surgical Factors
- Outcome



Site of our Search

- retentive capacity (RC) of subpericranial pocket (SpP)
- experiments
 - measure RC
 - forces
 - i) contact with head roll
 - ii) RC must resist



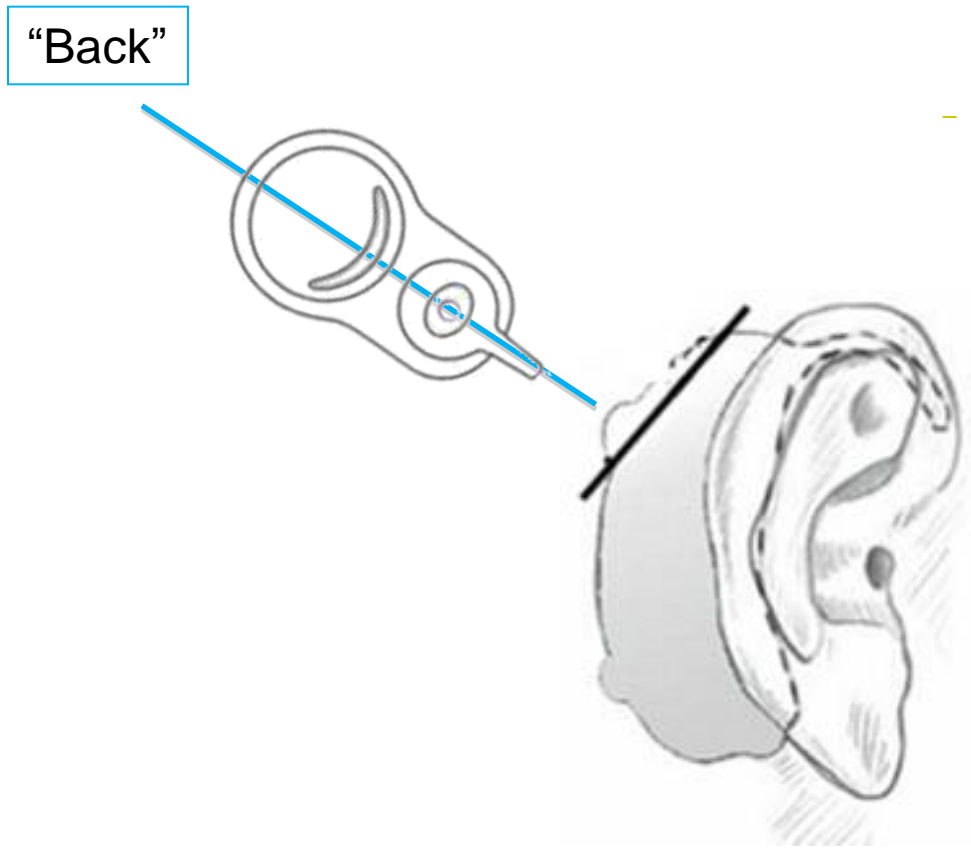
Surgical Technique

- minimal incision approach
- incision far from R/S
- anterosuperior placement of device



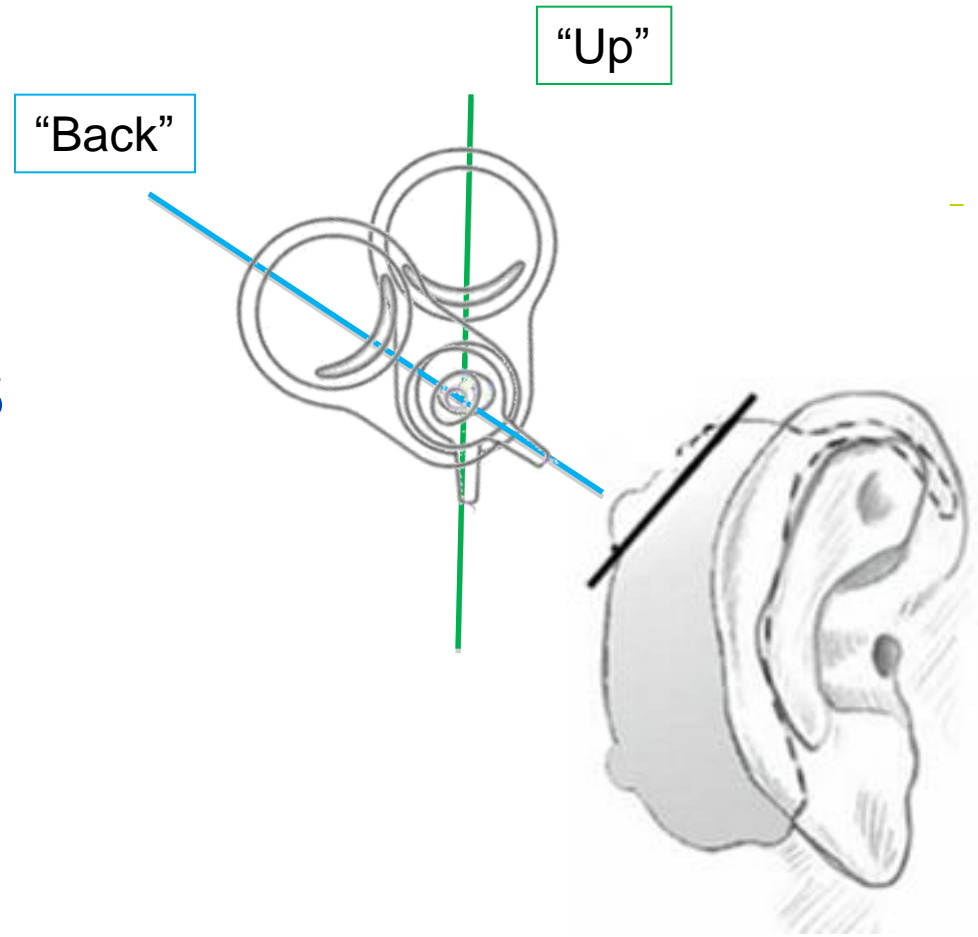
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- minimal incision approach
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Surgical Technique

- minimal incision approach
- incision far from R/S
- anterosuperior placement of device



Device Positioning

- device away from processor
- receiver/stimulator oriented differently in infants

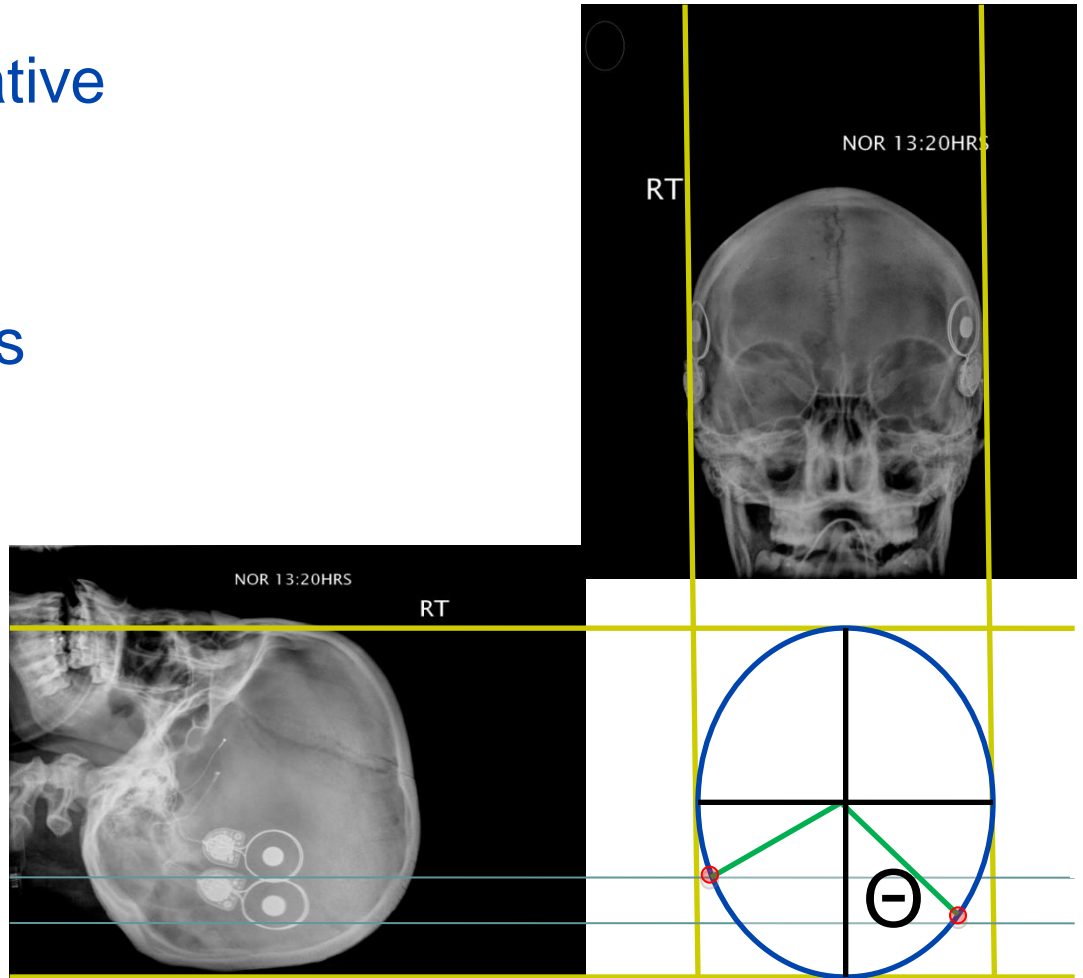


Freeroll Angle in Recumbent Position

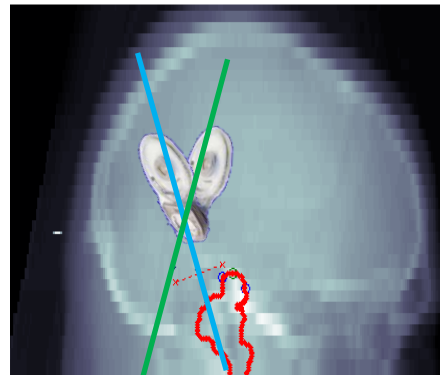
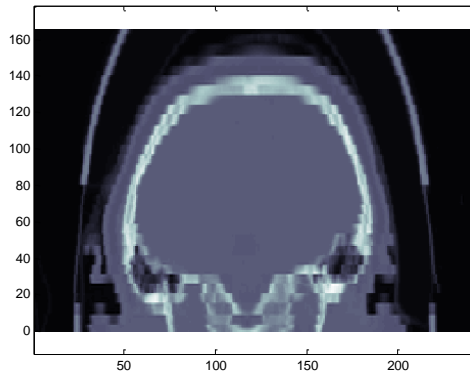
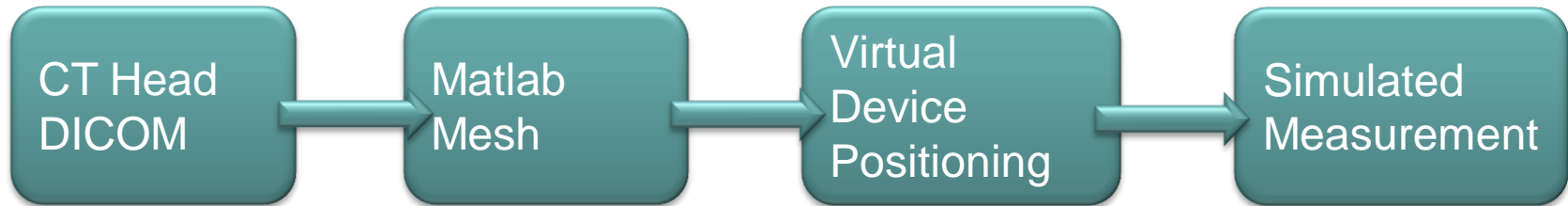
Freeroll in
Recumbent
Position

i) Head Roll Measurement (n=34)

- series of post operative radiographs
- positions of implants calculated
- angle of contact calculated (“up”)



ii) Matlab Model (n=48)



Results – Head Roll / Force

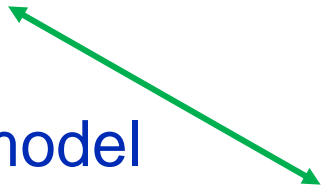
- measured unilateral data (Postop Films)
 - 54.5 +/- 5.5 degrees before device contact
- Matlab model
 - ‘Up’ Position – 52.4 +/- 3.05 degrees
 - ‘Back’ Position – 46.4 +/- 3.1 degrees
 - difference of 6 degrees $p > 0.05$ *

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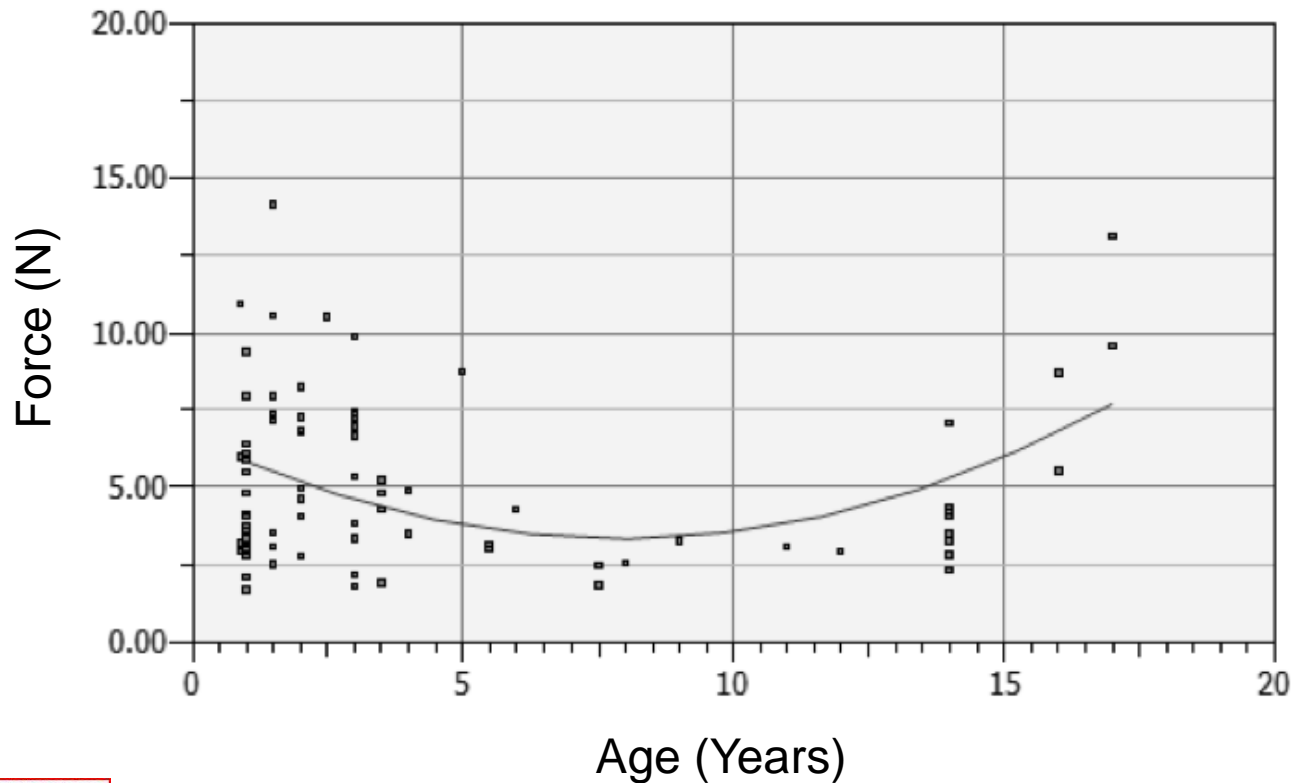
Experimental Procedure (n=123)

- subpericranial flap raised
- dummy implant inserted
- **force** to dislodge recorded

Retentive Capacity
of the Periosteal
Flap with the 500
Series Cochlear
Implant

Results – Retentive Capacity

Average Retentive Capacity Versus Age



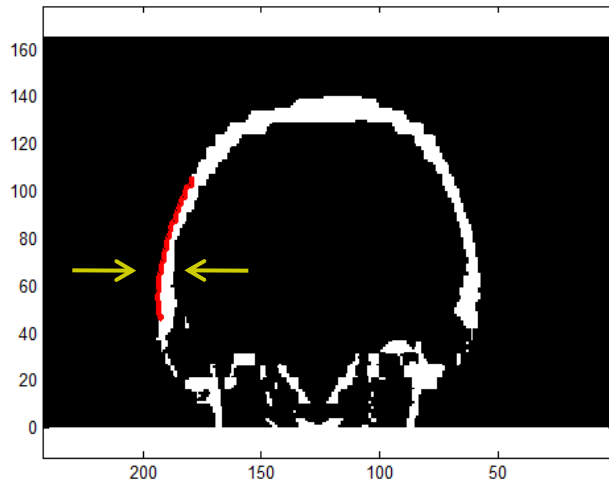
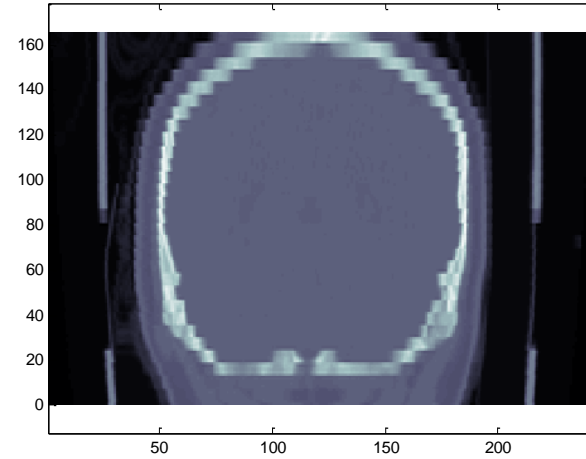
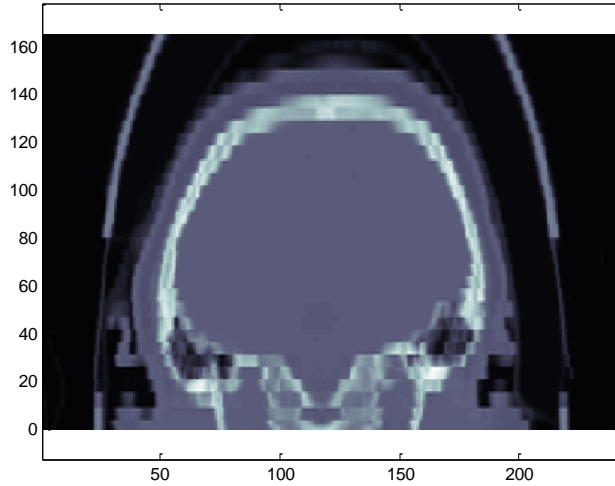
81 Patients
 123 Implants
 - 42 bilateral
 - 39 unilateral

Avg RC = **5.17 +/- 2.56 N**

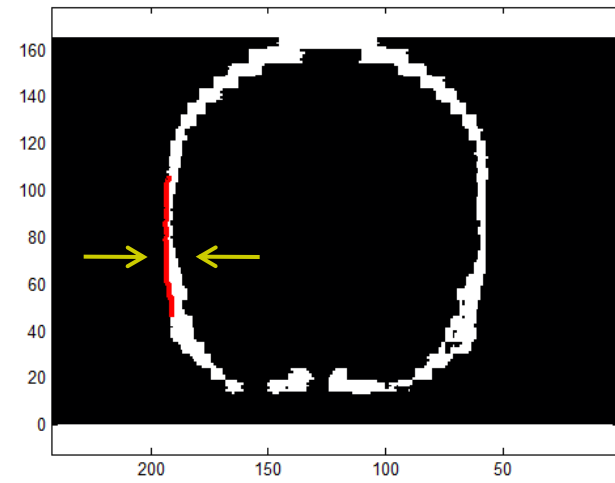
Parabolic Distribution



Implant Plane

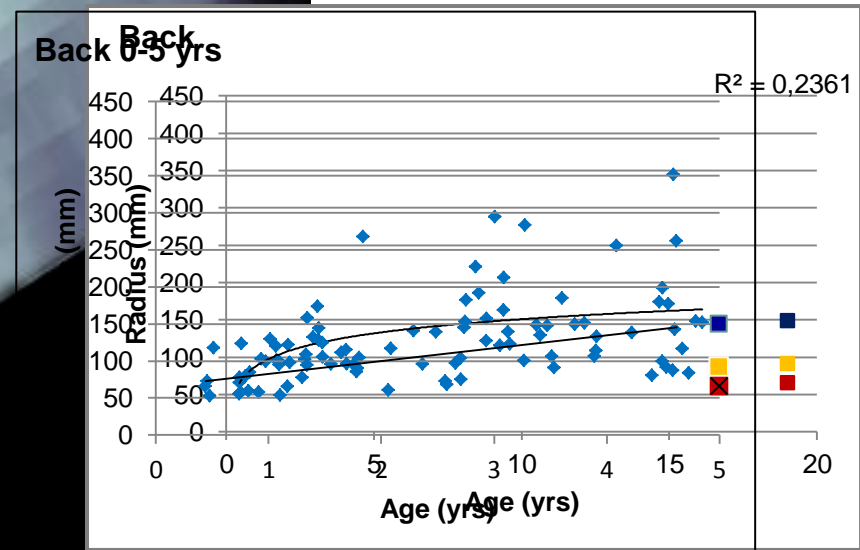
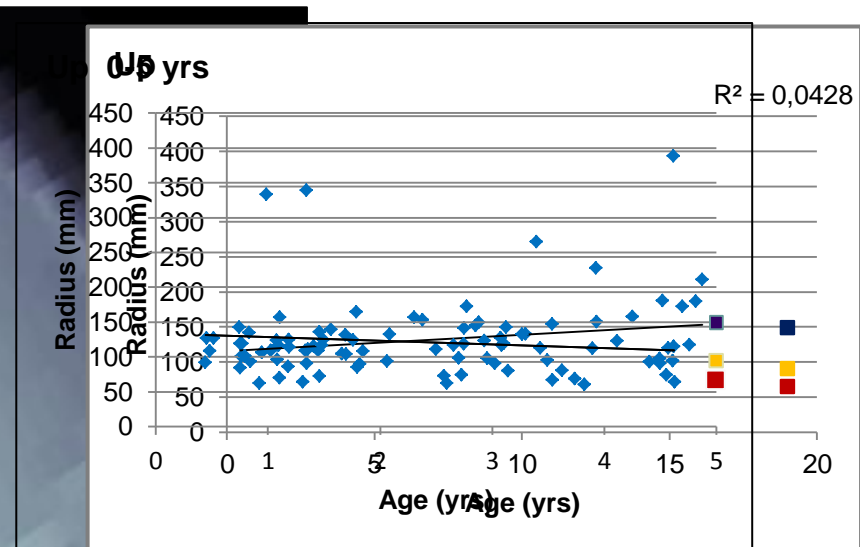
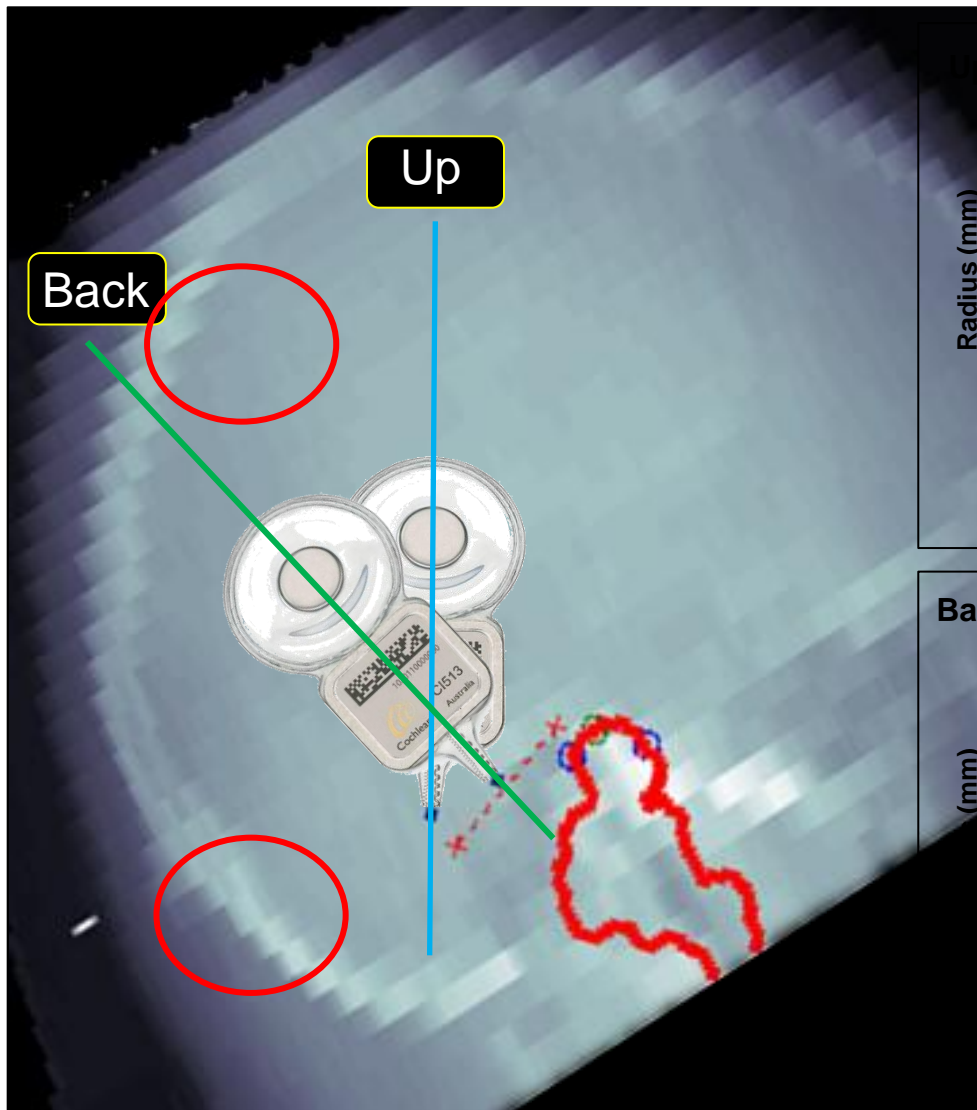


Back



Up

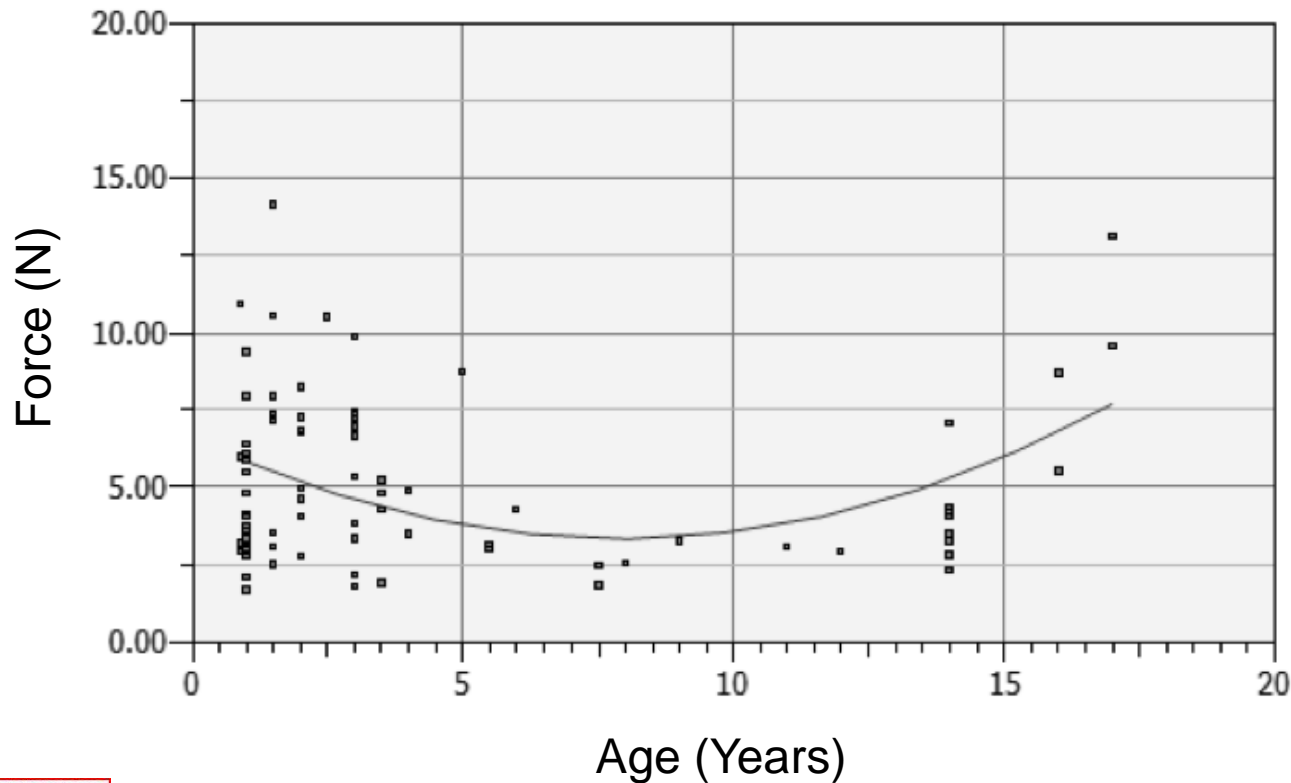
Skull Radius vs. Age



■ Nucleus 5 / Freedom
■ Nucleus 6 / HiRes 90R
■ Nucleus 6 / HiRes 90R / Bonata 5

Results – Retentive Capacity

Average Retentive Capacity Versus Age



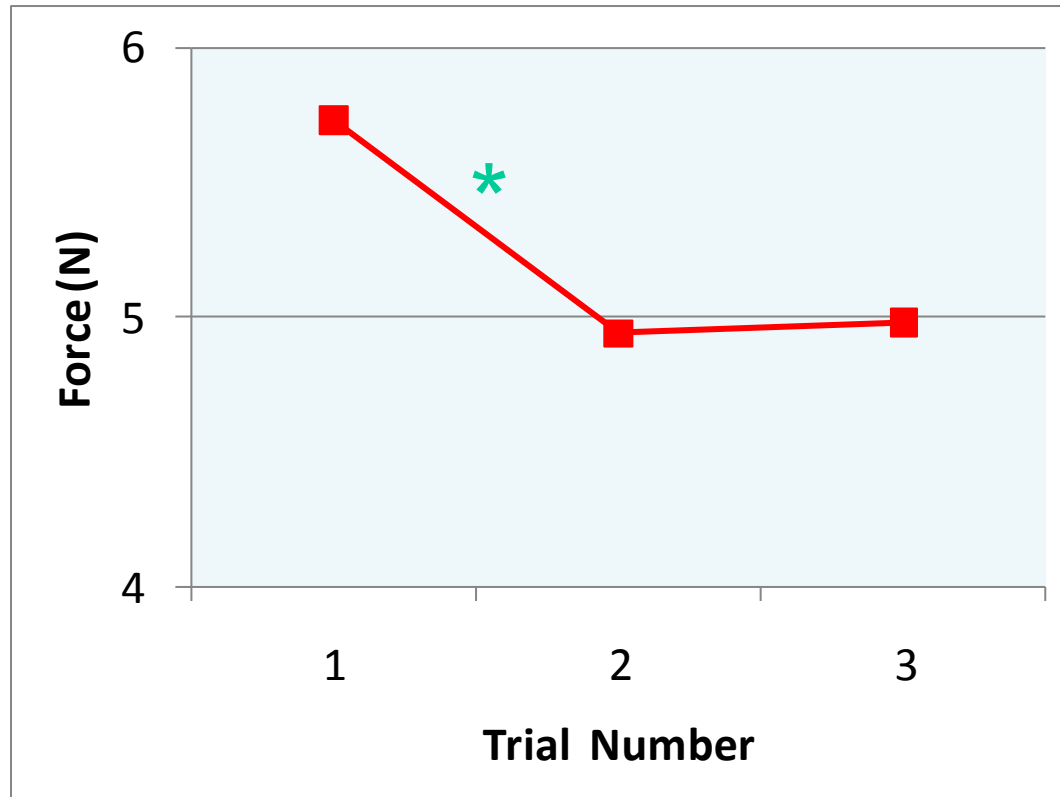
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Parabolic Distribution




Results – Retentive Capacity



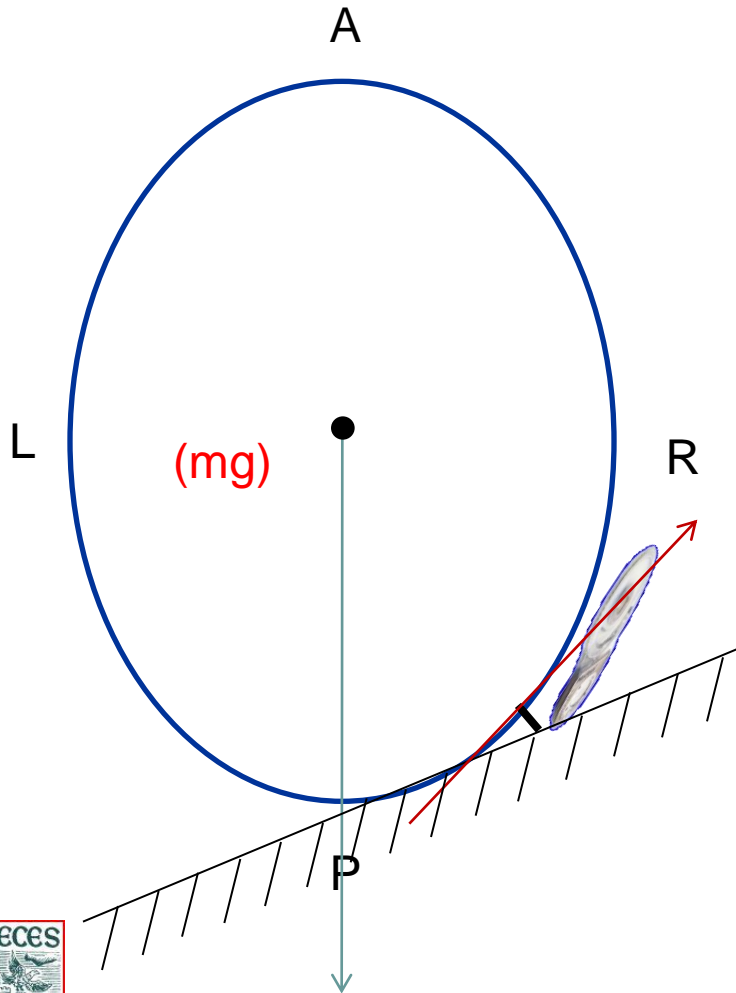
Repeated Measures ANOVA
- Significant Decrease in RC over repeated trials ($p < 0.05$) *



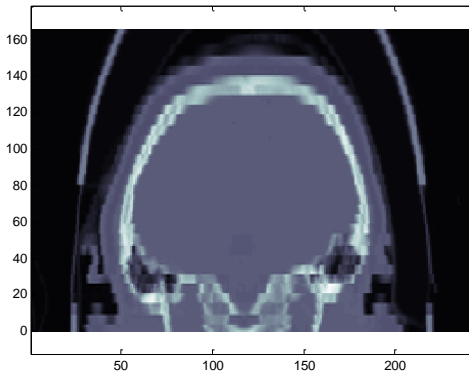
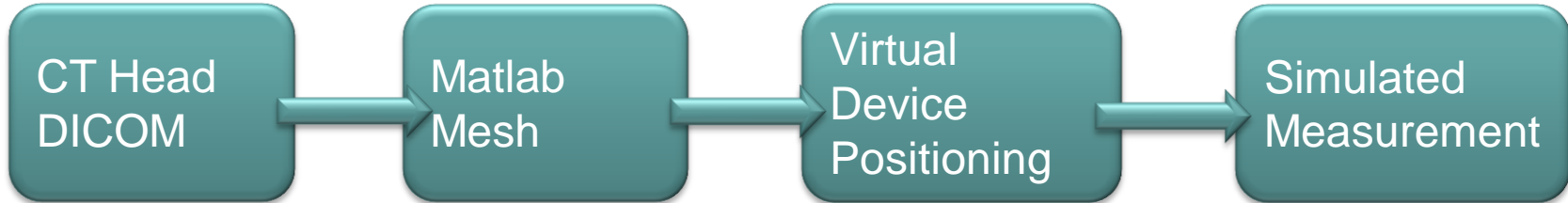
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 - difference of 6 degrees $p > 0.05$ *
- retentive capacity of the subpericranial pocket 
 - 5.17 +/- 2.56 N on average

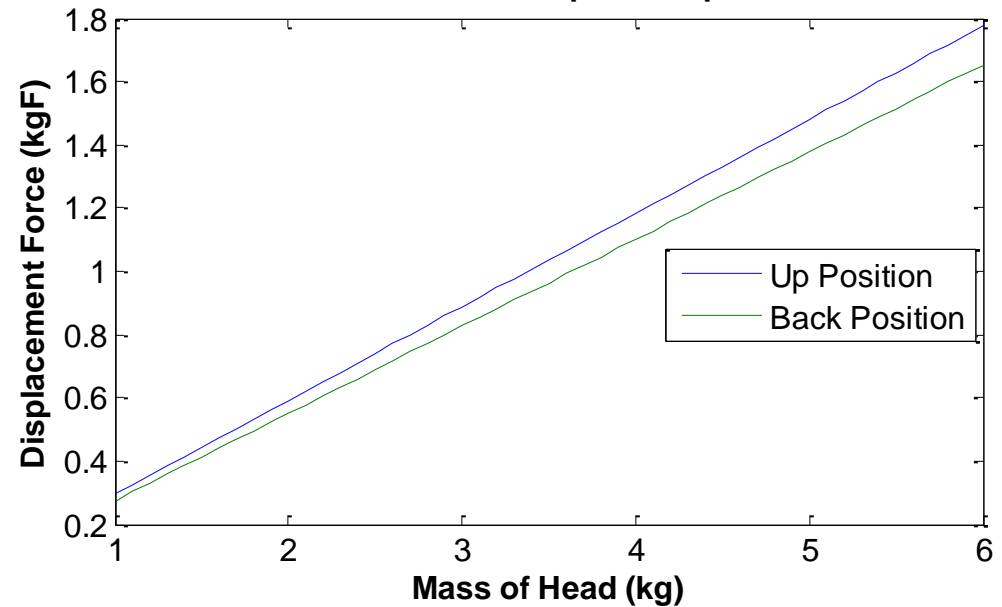
Displacement Force Calculation



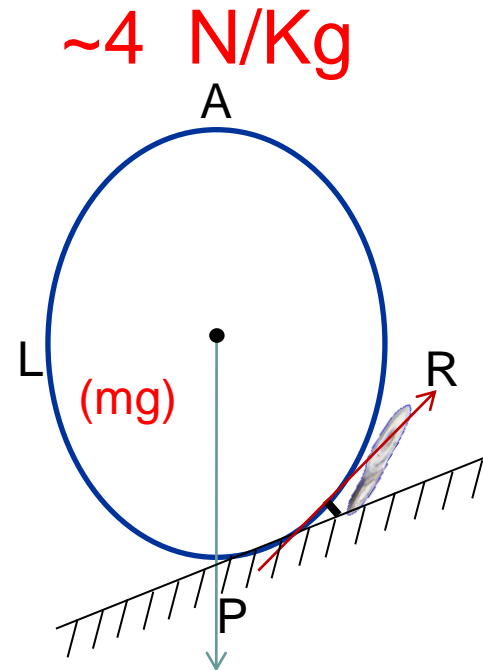
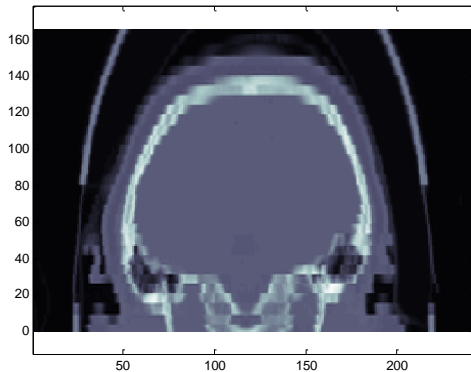
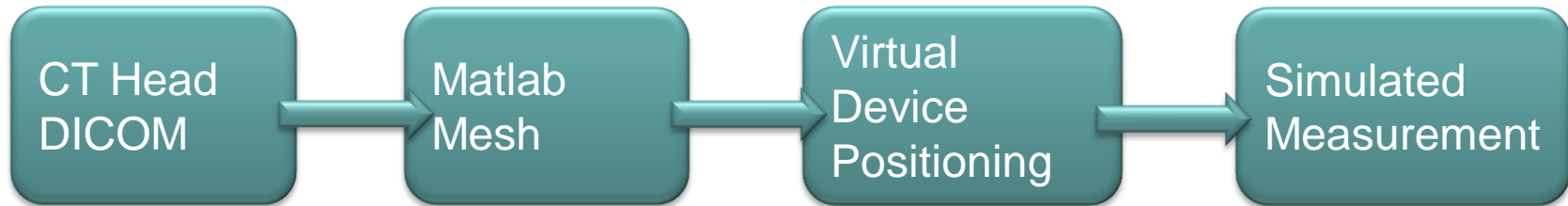
ii) Matlab Model (n=48)



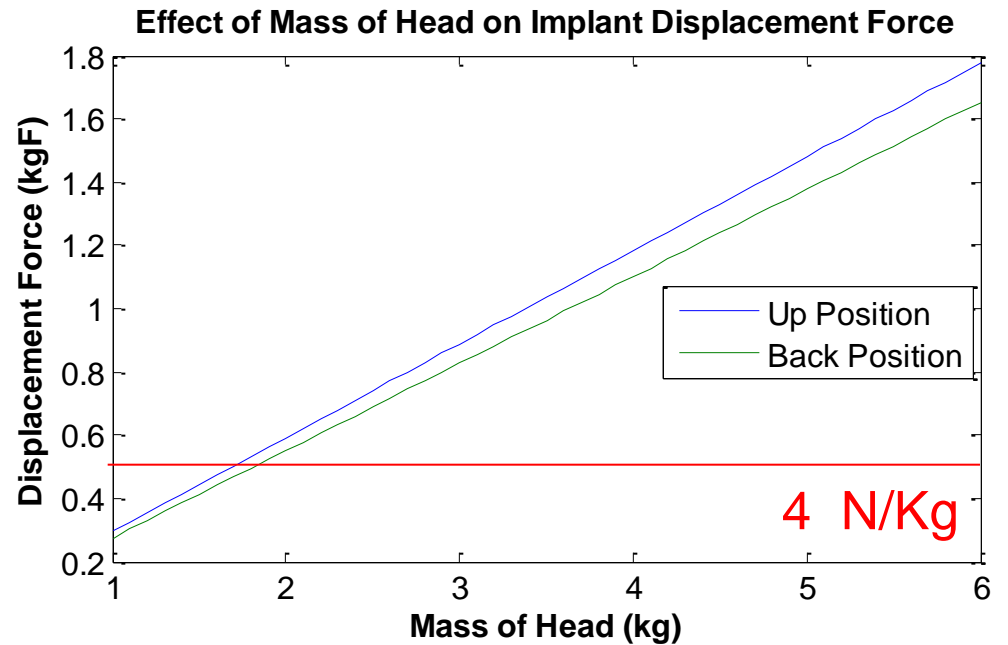
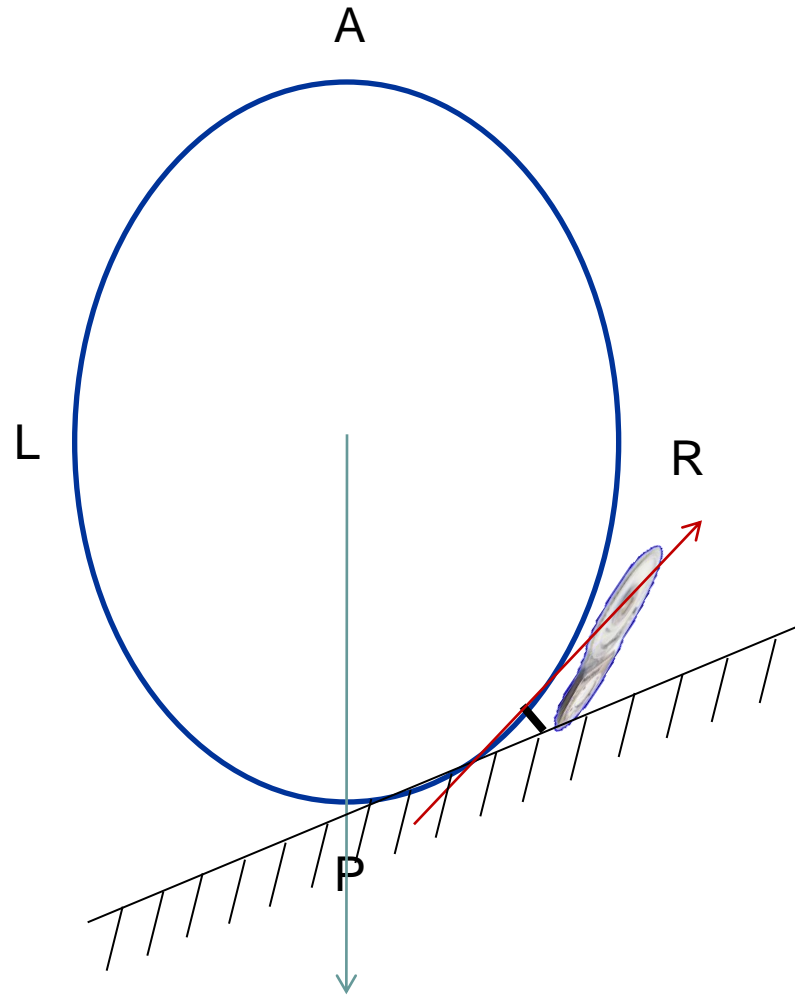
Effect of Mass of Head on Implant Displacement Force



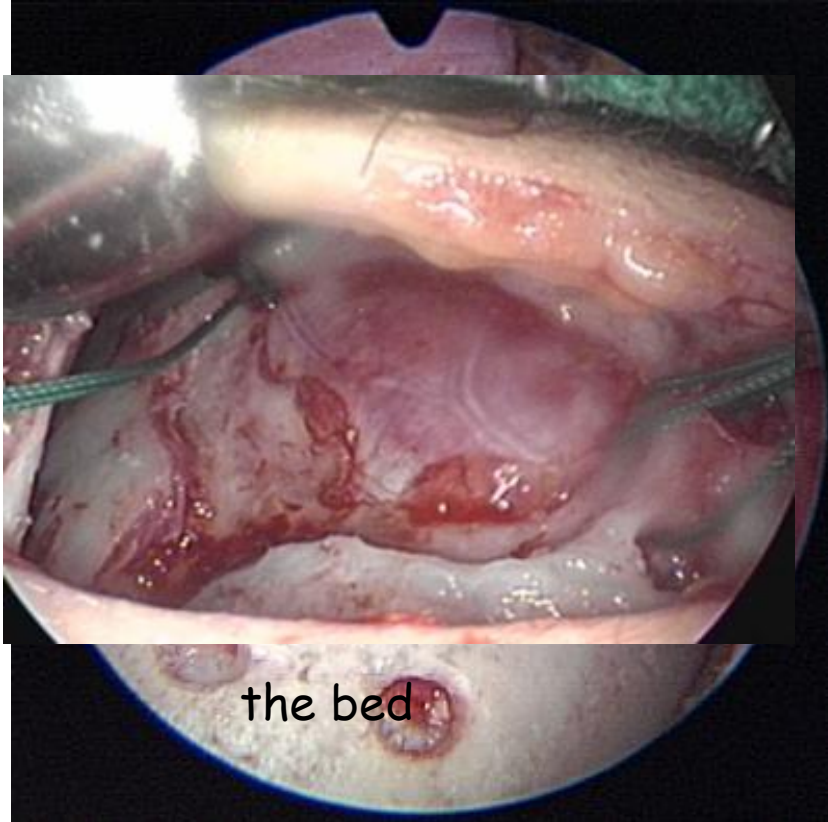
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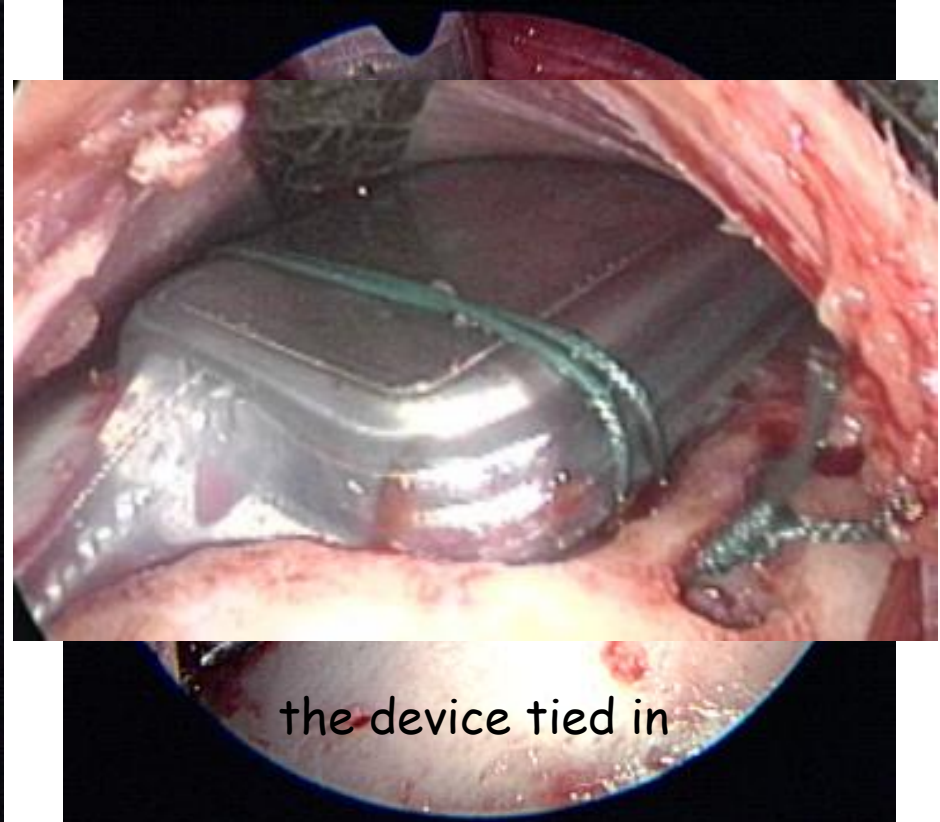
Is Periosteum Retentive Enough?



Tie-down – Devices with and without a Pedestal



the bed



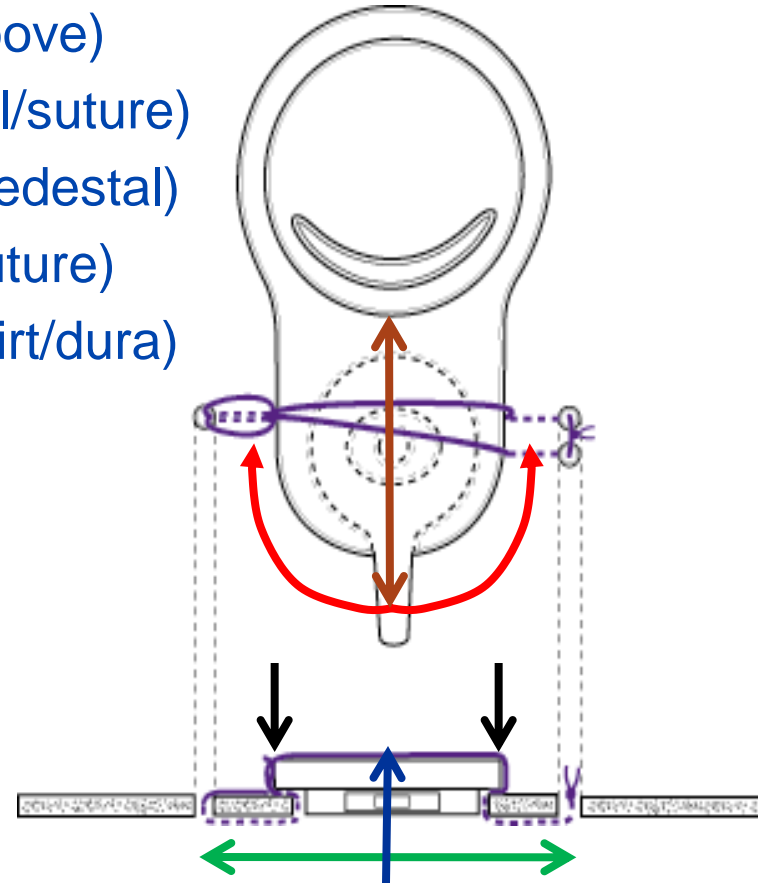
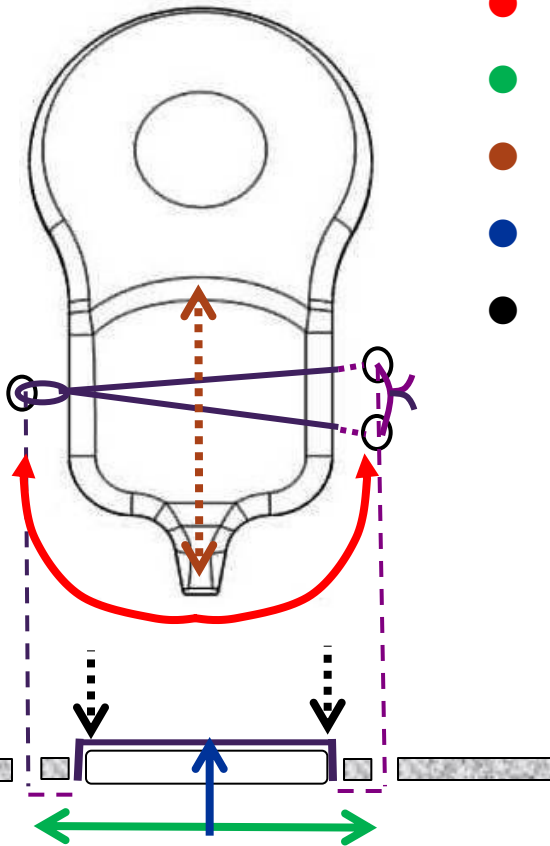
the device tied in

the bed

the device tied in

Suture Fixation and Well

- resists displacement
 - rotation (fantail groove)
 - sideways (pedestal/suture)
 - superior/inferior (pedestal)
 - lateral (tie down suture)
 - medial (silicone skirt/dura)



Pedestals

- stabilize the device
- prevent displacement
 - in 5 axes

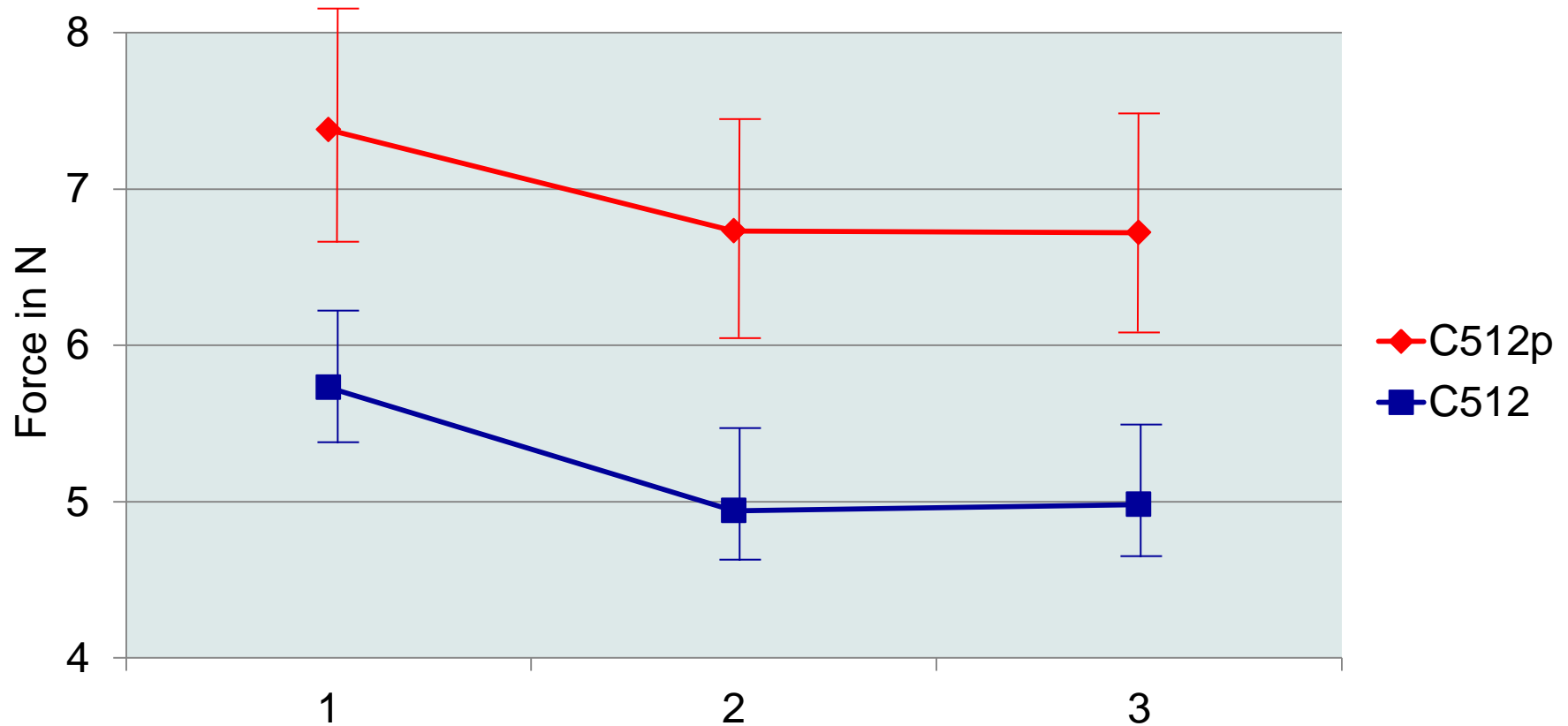


Pedestals

- no exposed dura
- minimize well
 - drilling
 - time
- resists displacement



Displacement Force (in N) Required to Remove Device from a Subpericranial Pocket



Next Steps - Electrode

- round window vs. cochleostomy
- electrode position/depth
- atraumatic insertion



Access into Scala Tympani

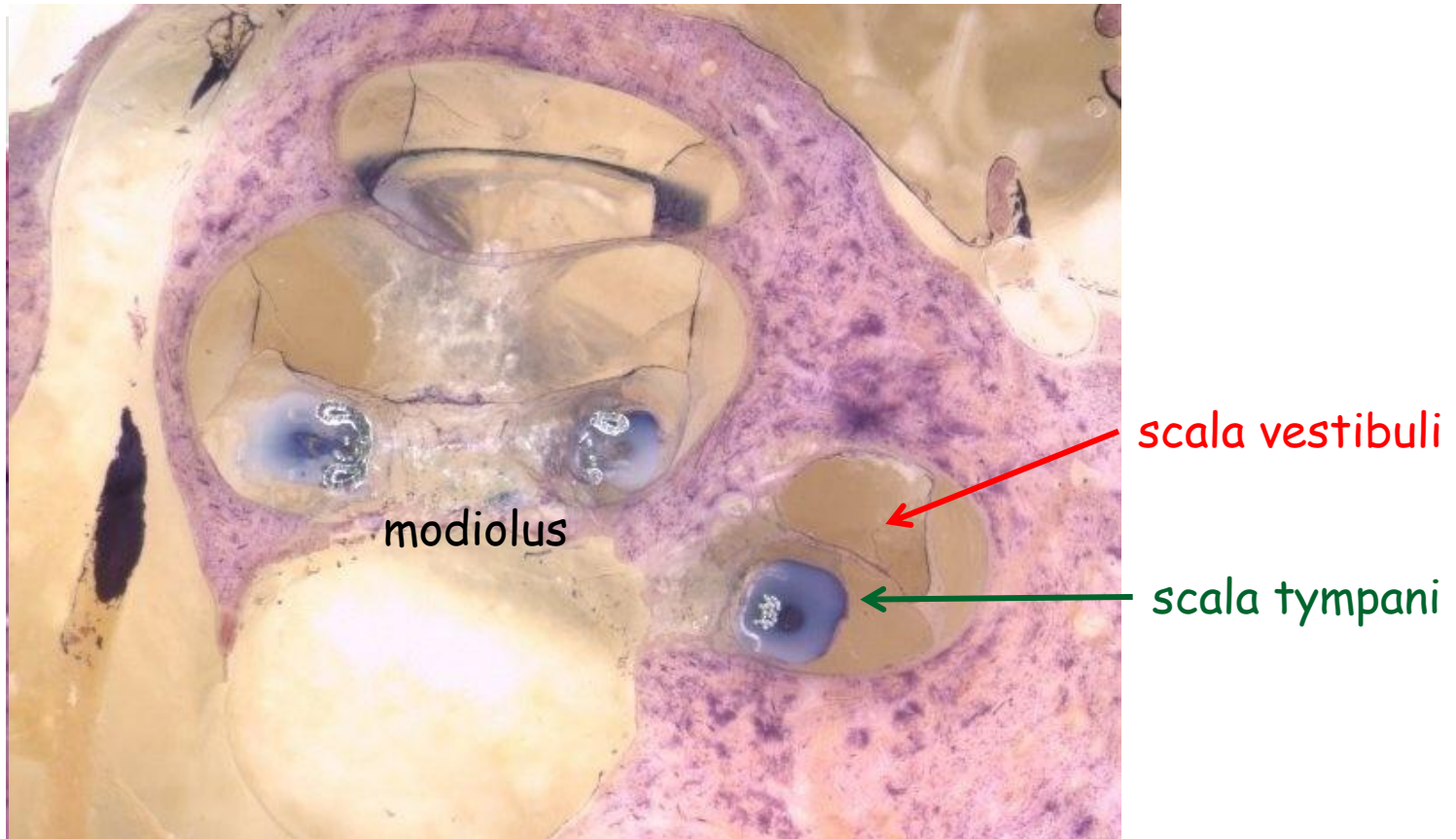
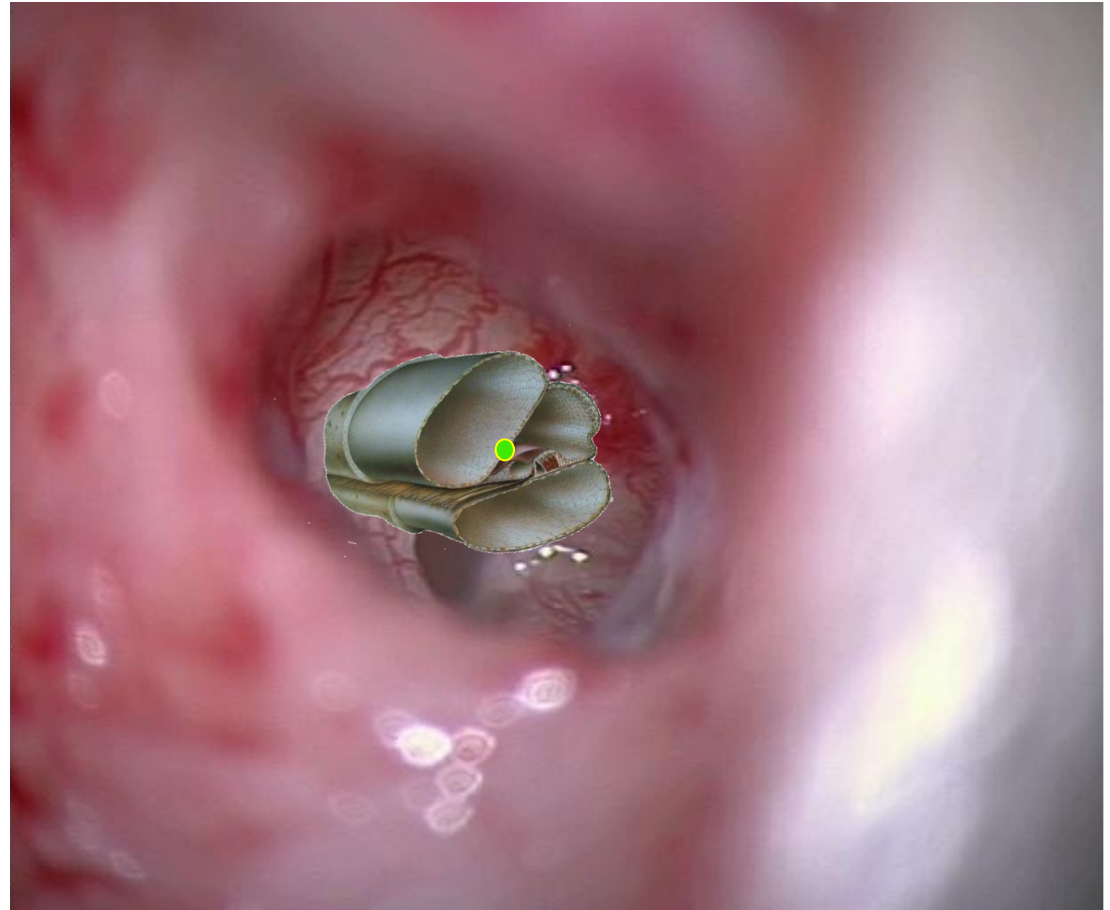


Photo courtesy CRC for Cochlear Implant and Hearing Aid Innovation, MELBOURNE

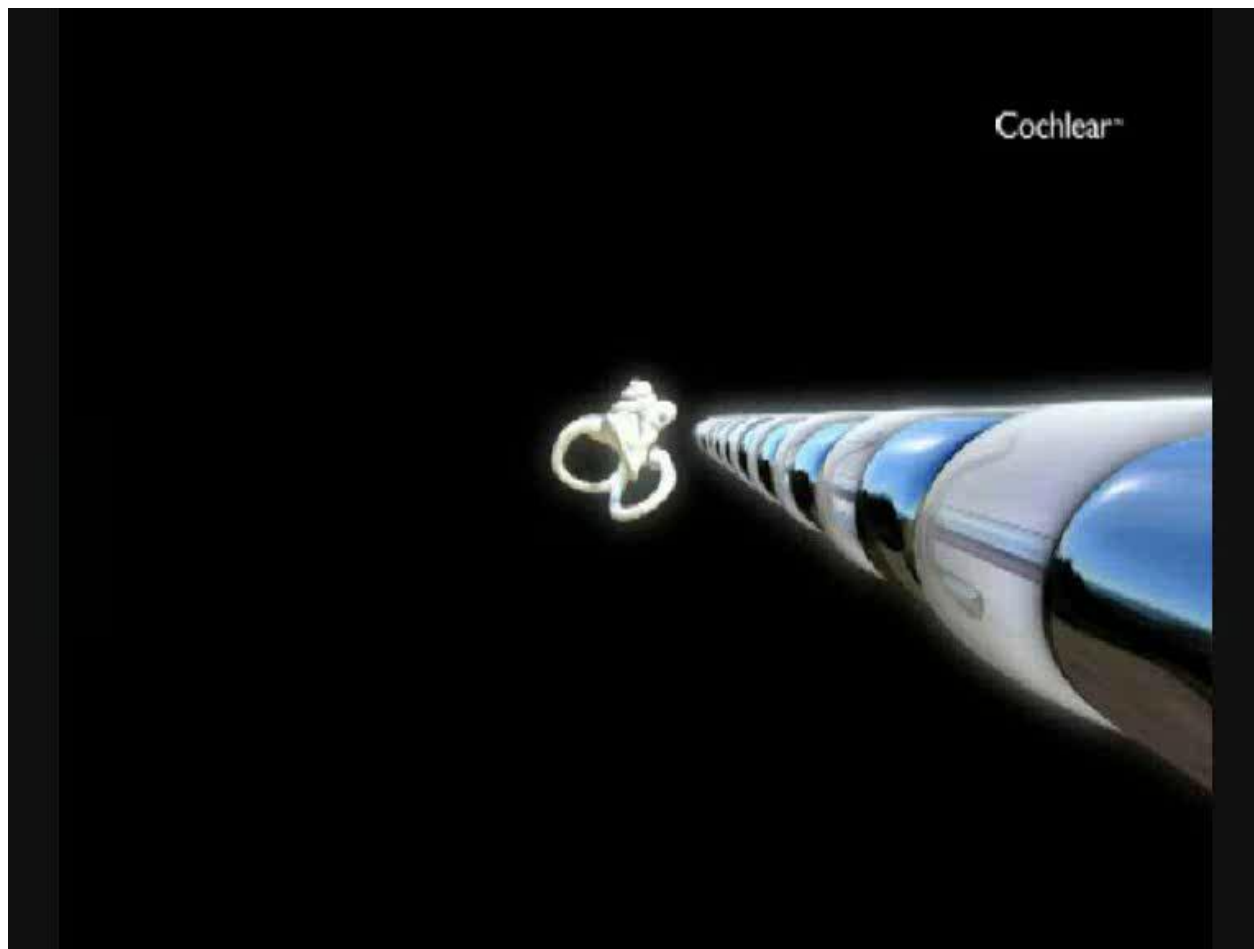
Deteccion, Diagnostico Y Tratamiento Precoz de la Sordera en la Infancia, Madrid – May 28, 2011

Round Window

- cochleostomy
 - direction
 - entry into the scala tympani

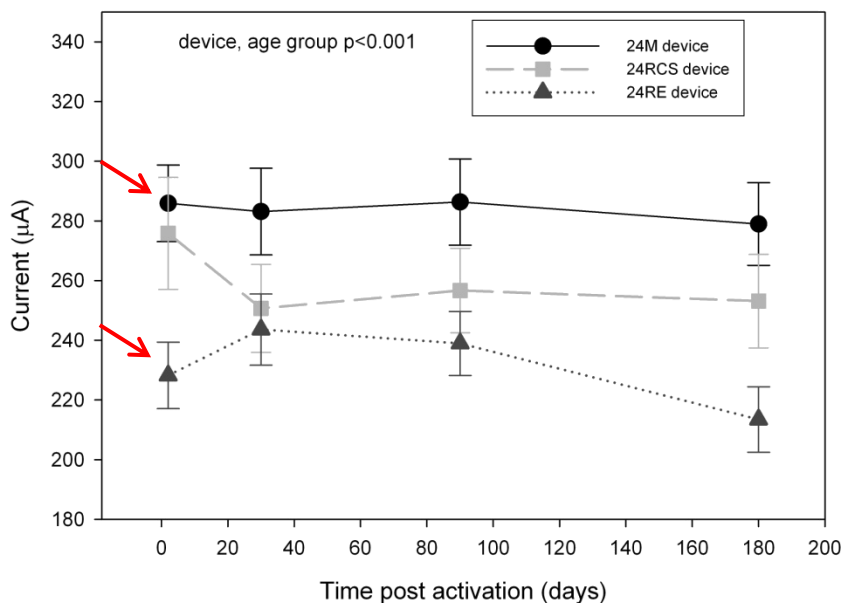


Ideal Cochlear Entry Point



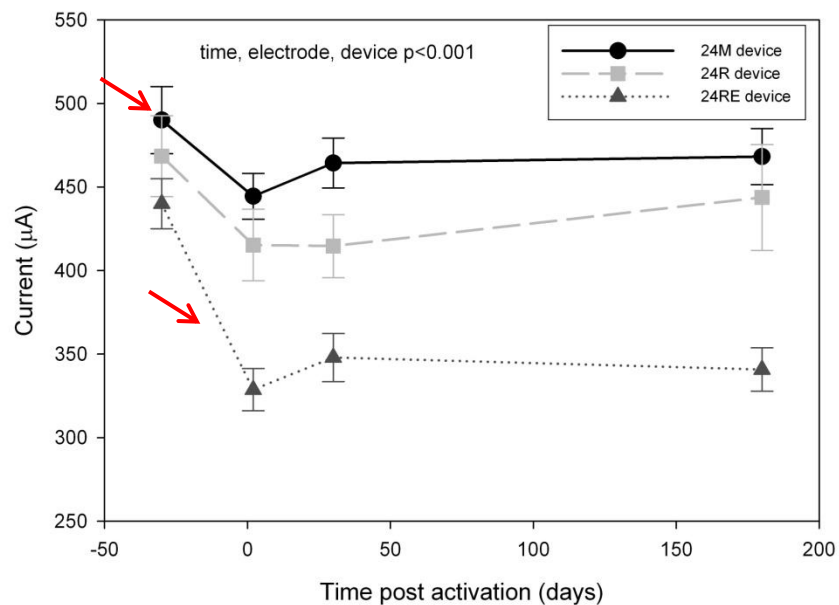
Improved Electrophysiologic Performance with Ideal Insertion

behavioural thresholds



	24M	24RCS	24RE
n(day2)	38	19	37
n(day30)	37	19	40
n(day90)	36	17	48
n(day180)	35	17	38

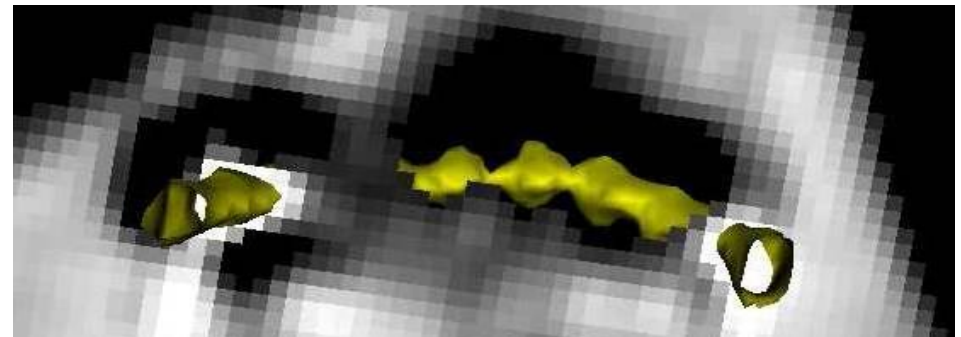
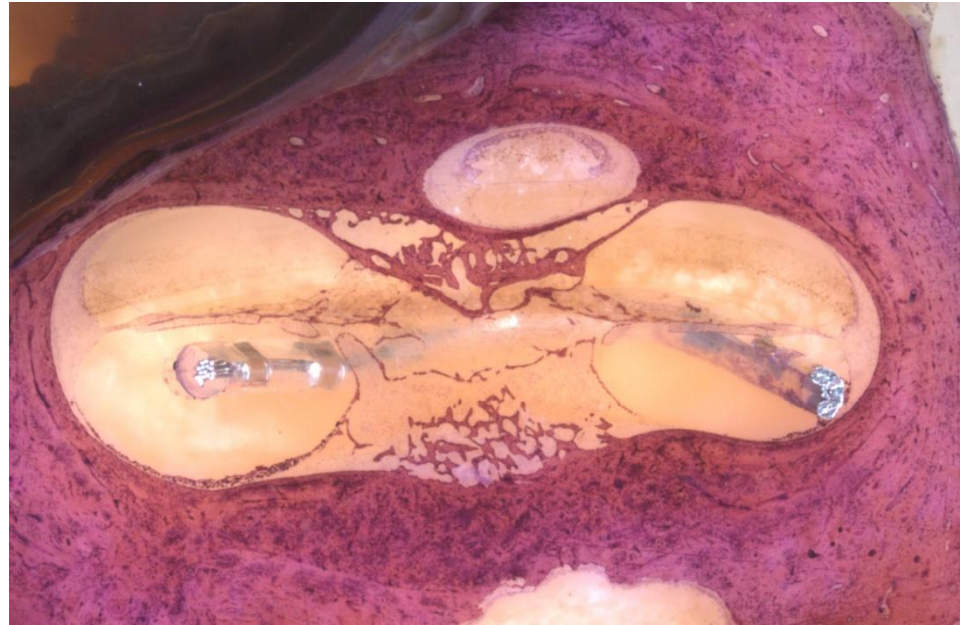
Ecap over time



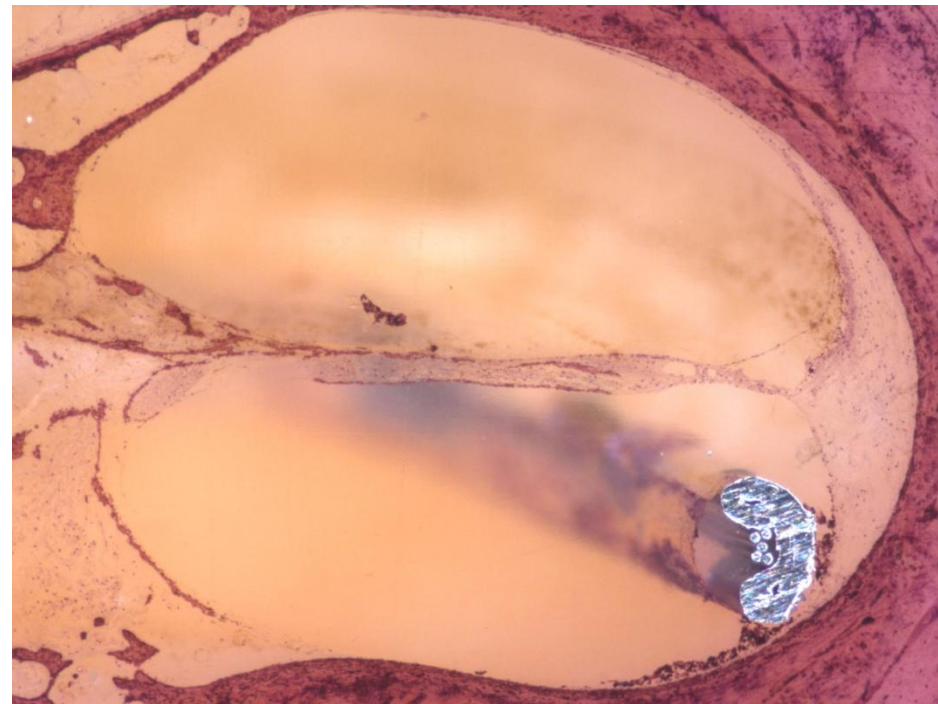
	24M	24RCS	24RE
n(OR)	37	18	55
n(day2)	34	18	52
n(day30)	30	14	37
n(day180)	27	9	30

Intracochlear Electrode Behaviour

- experimental insertions
 - high resolution CT
 - Cone Beam CT
 - resin impregnation and section



Electrode “Flipped Orientation”



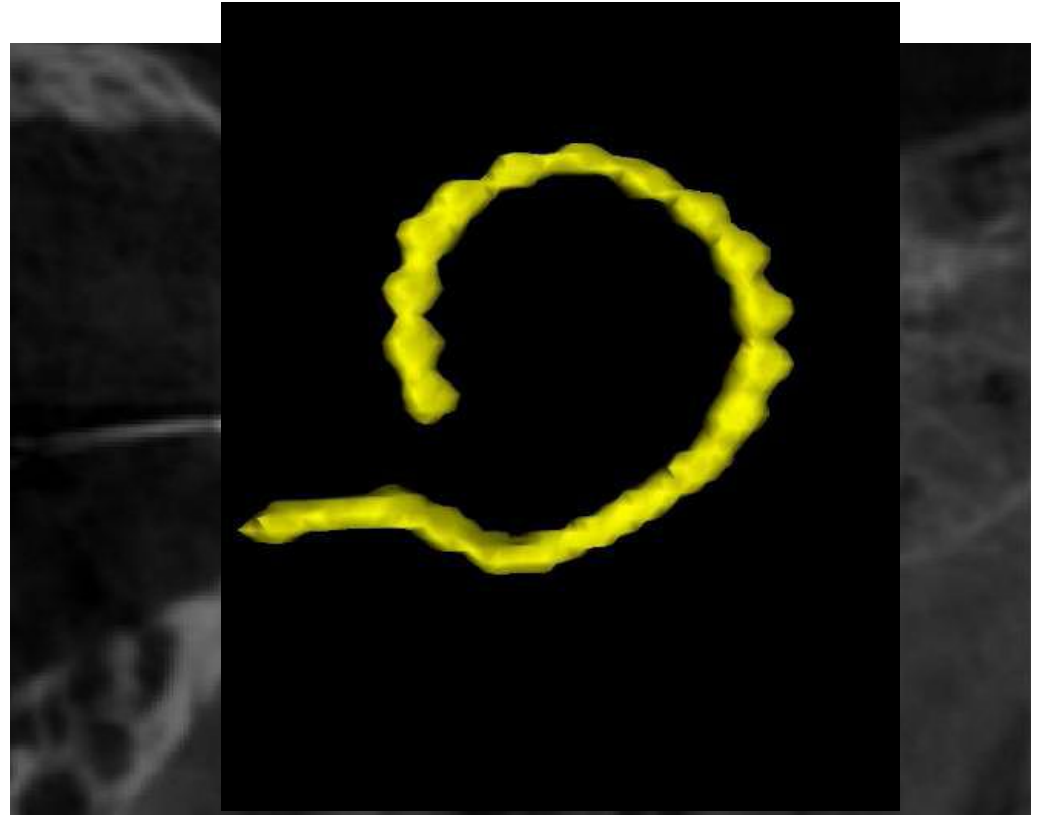
Actually Flipping



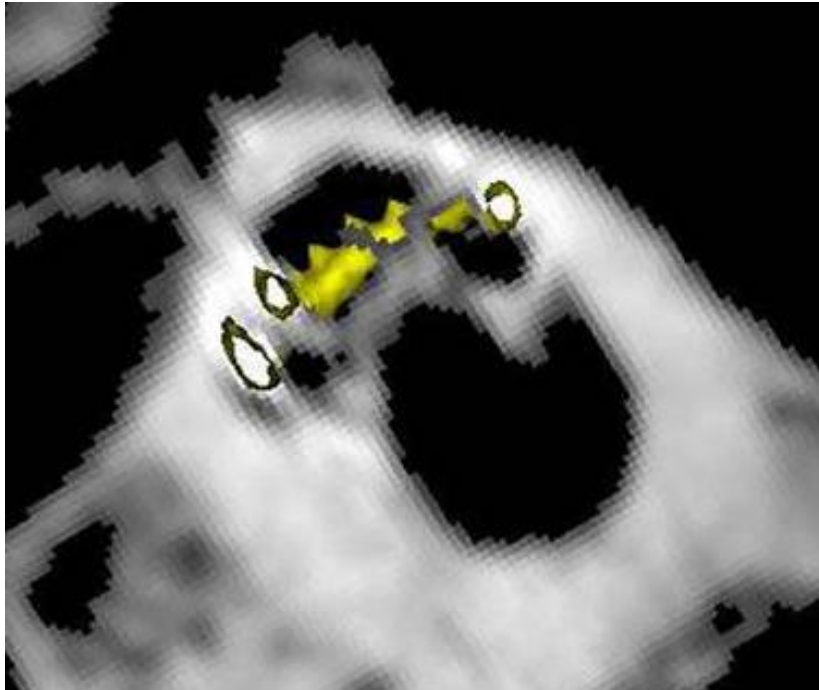
Deteccion, Diagnostico Y Tratamiento Precoz de la Sordera en la Infancia, Madrid – May 28, 2011

Round Window Insertion

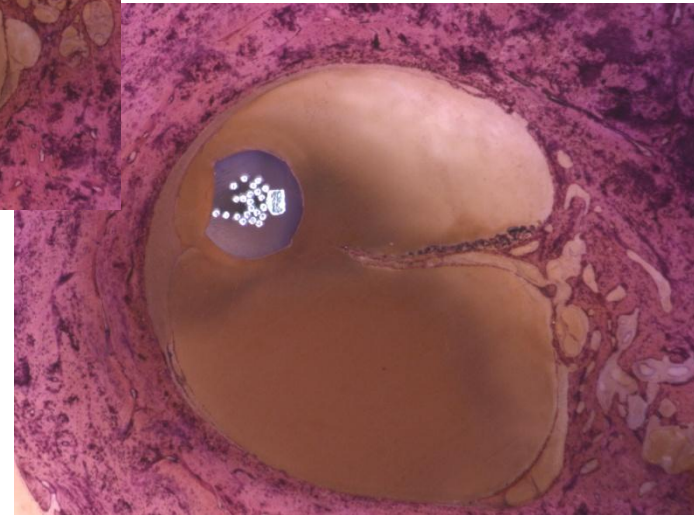
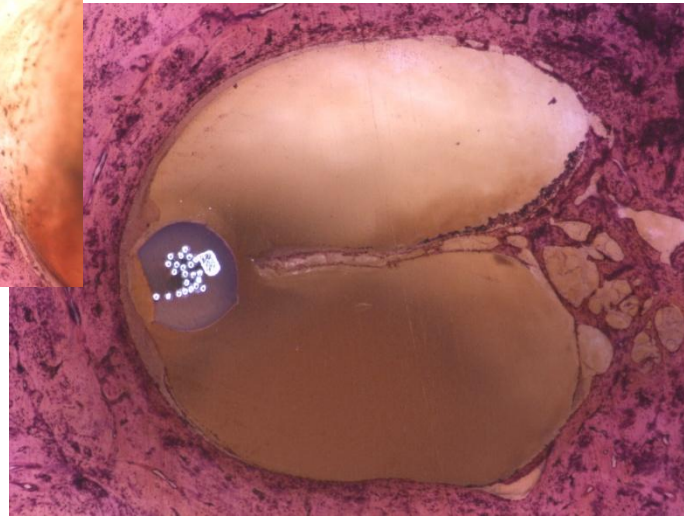
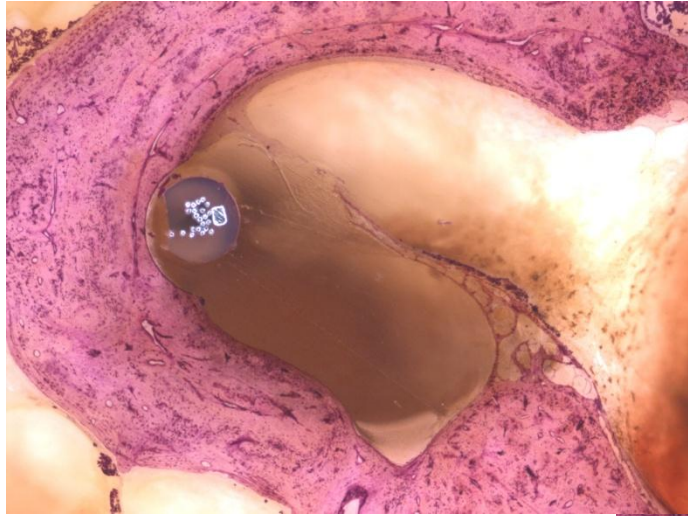
- kink in basal coil
- impact at replant?



Scala Implanted



Basilar Membrane Perforation



Has The Moth Been Found?

- device design for infants should allow receiver stimulator:
 - to be **positioned** to allow maximal “freeroll”
 - to be **“fixed”** enough to resist incidental force
 - retentive capacity of the periosteum adequate
 - **atraumatic** electrode insertion into cochlea
 - in scala tympani throughout insertion

