



Cochlear implants: new developments and considerations for Chinese speakers

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Financial disclosure

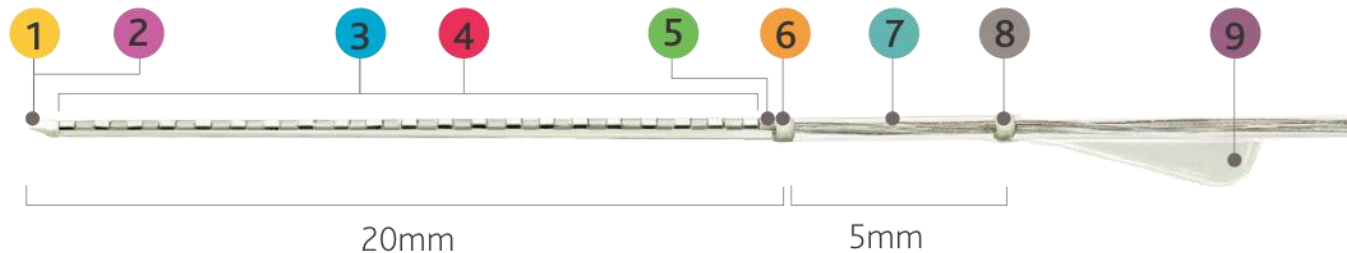
- Currently receiving research grants as PI from
 - Medel on VSB/ BB studies
 - Advanced Bionics on CI studies
- As Co-I in
 - Research projects associated with Signal processing with Cochlear Ltd
- CI surgeon performing devices from Medel/ Advanced Bionics and Cochlear Ltd

New Development

- Atraumatic insertion, allowing preservation of residual hearing
- Single-sided deafness/ Tinnitus management
- Bilateral cochlear implant

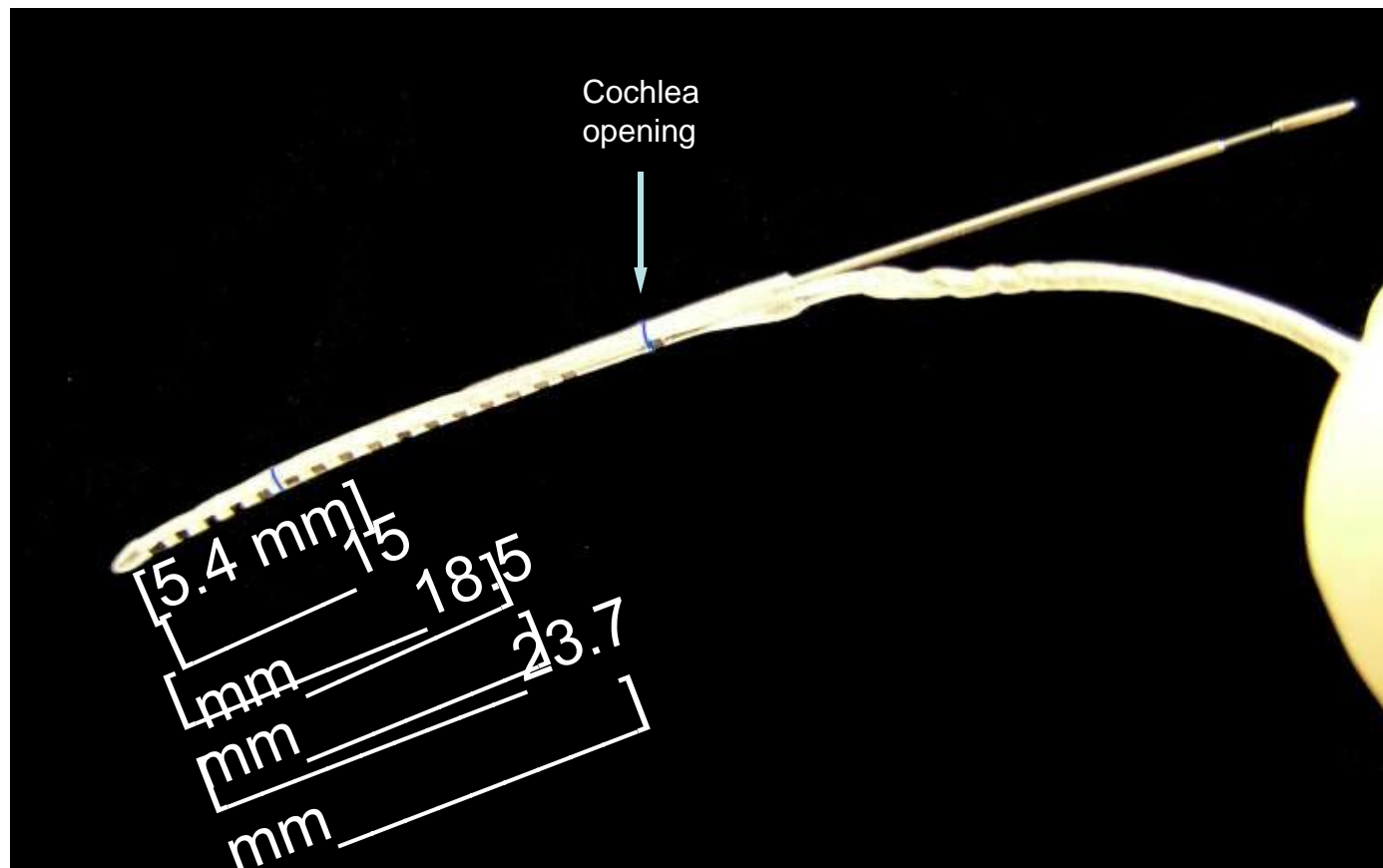
New Electrode Design

- Cochlear Nucleus CI 422
- Medel Soft series
 - Flex soft 31 versus 28
- Advanced Bionics HiFocus V

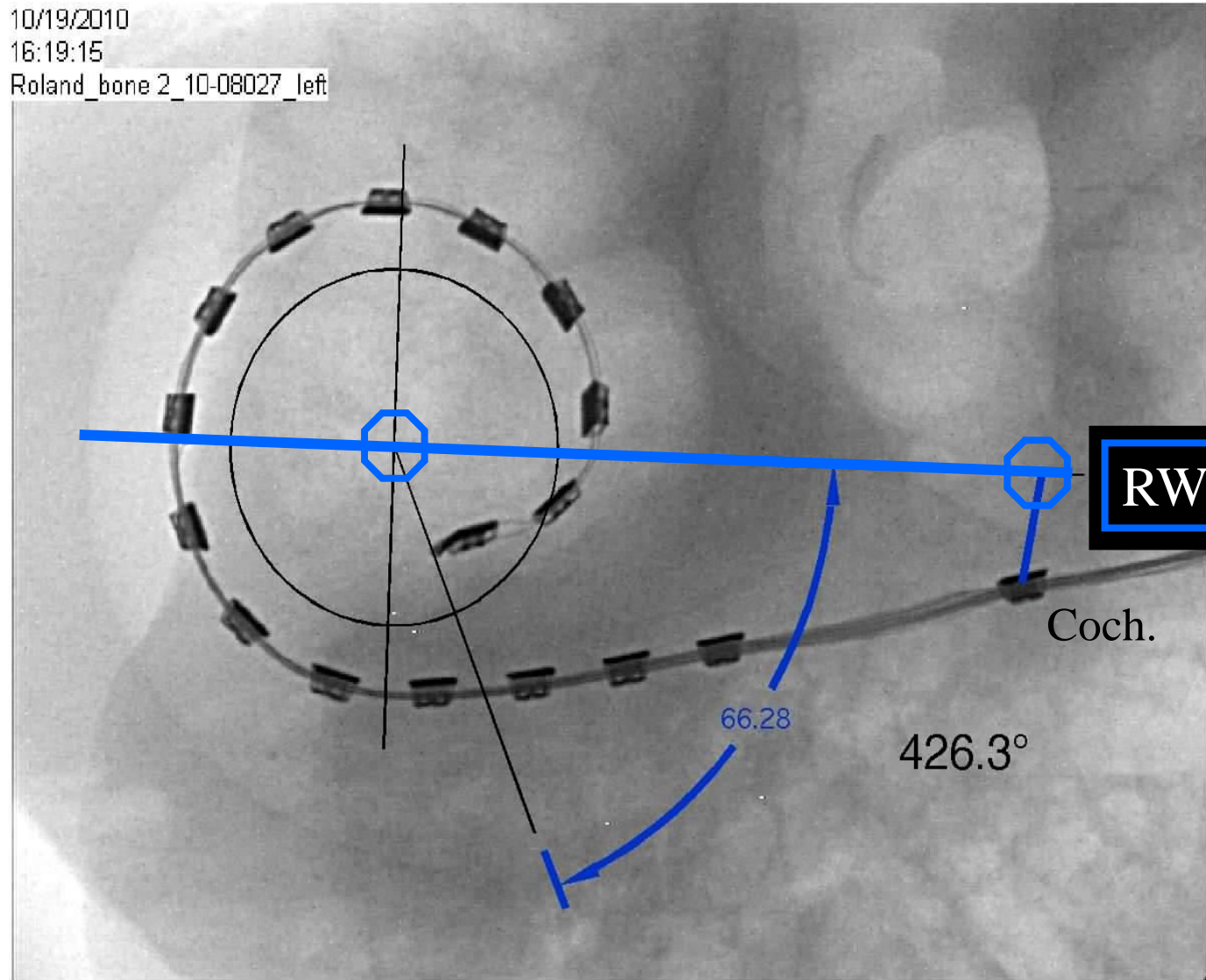




- Active electrode spread: 5.0 mm
- Proximal blue marker to distal tip of array: 18.5 mm
- Total array length, distal tip to jog: 23.7mm
- Diameter distal tip:0.5 mm
- Diameter proximal base at blue marker: 0.7 mm
- Cochleostomy size: 0.8 mm
- Lead length fantail to neck/jog of array: 84 mm



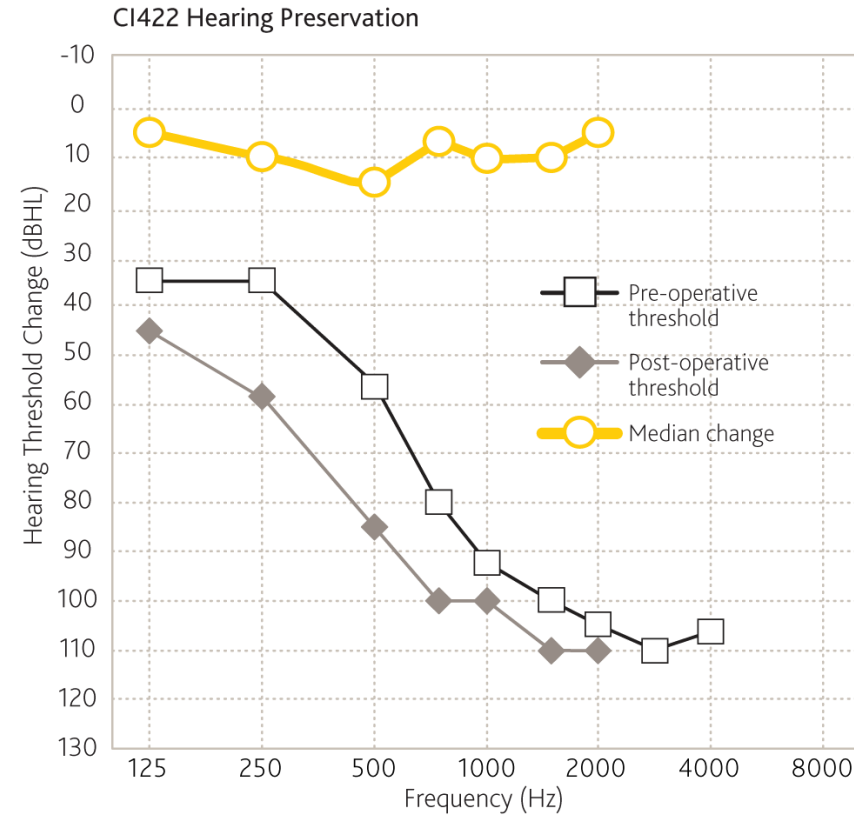
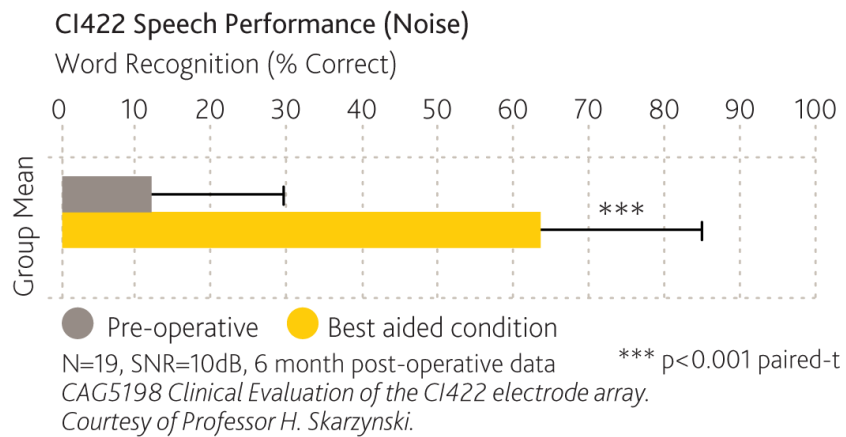
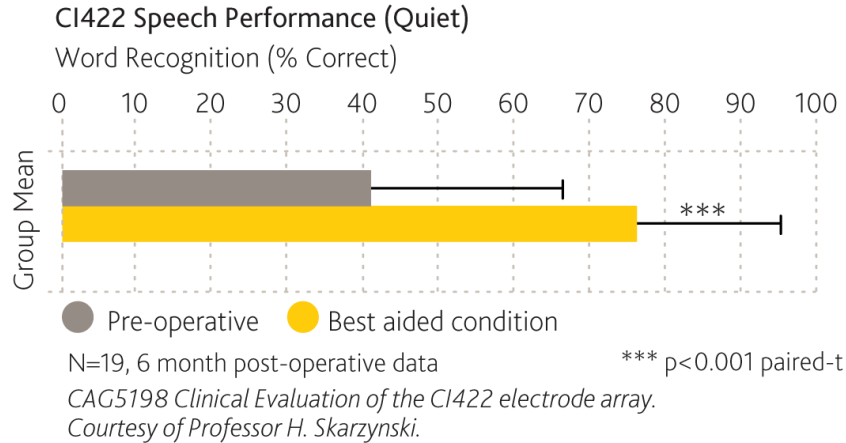
10/19/2010
16:19:15
Roland_bone 2_10-08027_left



Roland, Oct. 2010, 8027 Left Mid Scala Electrode Advanced Bionics

Slim half-band electrode

PROVEN OUTCOMES



N=19, 6 month post-operative data
CAG5198 Clinical Evaluation of the CI422 electrode array.
Courtesy of Professor H. Skarzynski.

Bilateral Cochlea Implant

- Bilateral Simultaneous or Sequential Cochlear Implant

Binaural cochlear implantation: Comparison of 3m/house and nucleus 22 devices with evidence of sensory integration††
Balkany et al 1988

Binaural Cochlear Implants Placed during the Same Operation
Gantz et al 2002

Evidence based review

The Laryngoscope
Lippincott Williams & Wilkins
© 2007 The American Laryngological,
Rhinological and Otological Society, Inc.

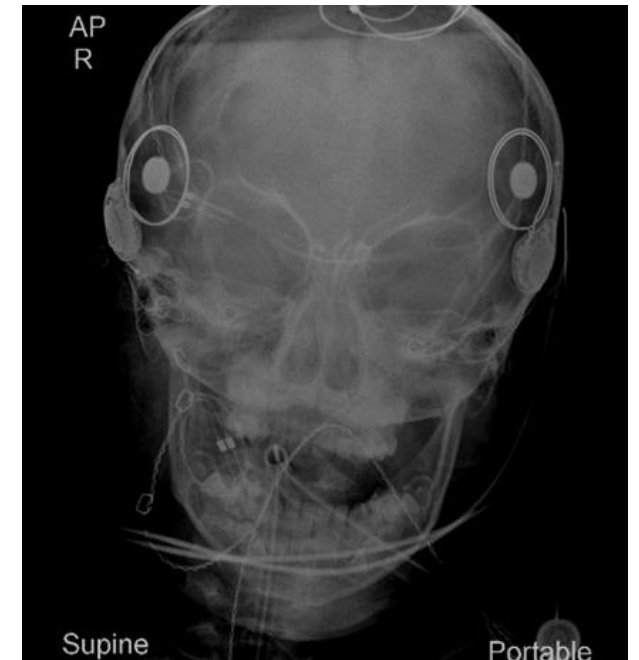
Bilateral Cochlear Implantation: An Evidence-Based Medicine Evaluation

John Murphy, MBBS, MRCS; Gerard O'Donoghue, MCh, FRCS



Bilateral surgeries- How I do it?

- Simultaneous surgeries not much difference from unilateral
- The differences:
 - Drape the whole head
 - Test the first side before starting the second side
 - No monopolar diathermy on the second side (also true for sequential CI)



Question: sequential when to do

- US multicenter study Roberts 2007
- 3 age groups 3-5/5-8/>8
- Young children achieved better in speech perception in second ear
- Second ear not as good as the first side for age >5

Recommendation: sequential better to do before age of 5

Conclusion

- Bilateral cochlear implant offers additional advantage to unilateral implant in terms of speech understanding and directional hearing
- Simultaneous implant is preferred
- Surgery does not carry a higher risk

Question: Children younger than 12 months (James and Papsin)



Fig. 3. Axial computed tomography scan through the temporal bone at the level of the round window niche (arrow) from an 11 month old. The cross sectional area of the mastoid bone on this scan is 180 mm². Thirty-four percent of the mastoid contains marrow (white outline), and 32% is pneumatized (black outline).

Increase in size of the mastoid bone with age

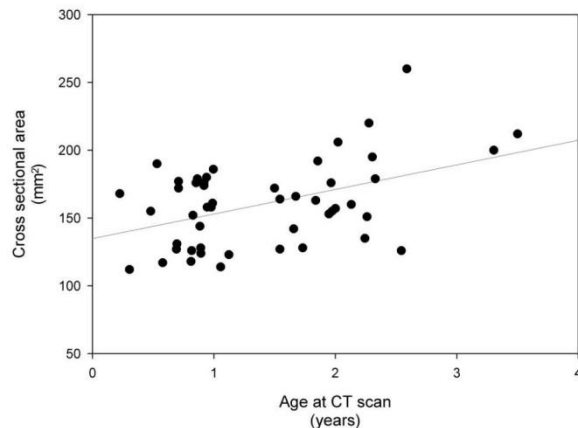


Fig. 2. Increase in size of the mastoid bone with age, as determined by measurement of the cross sectional area of the bone on an axial computed tomography scan at the level of the round window niche (linear regression SigmaPlot software).

Change in composition of mastoid bone with age

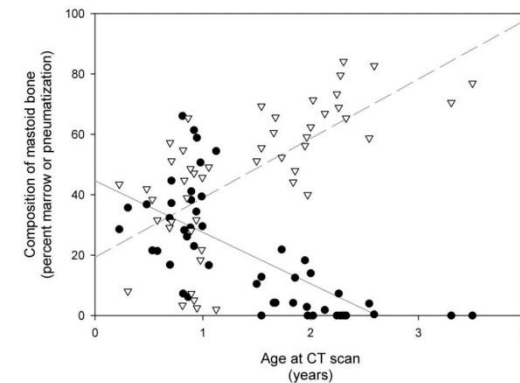
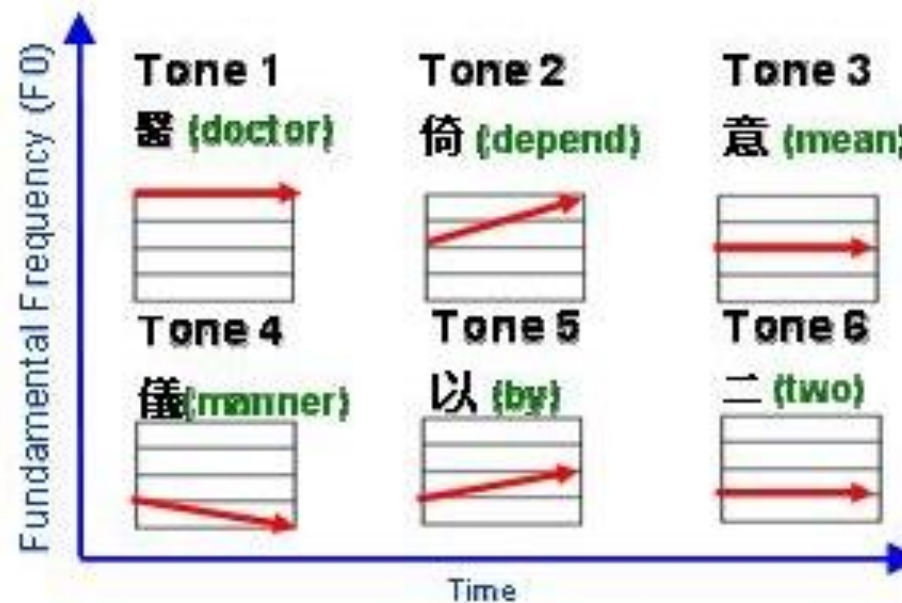
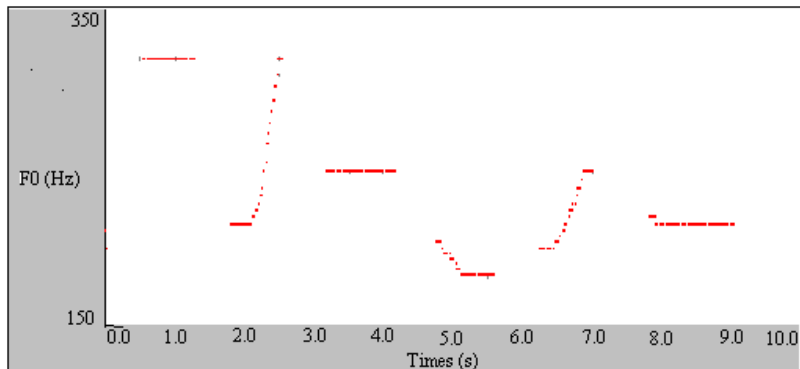


Fig. 4. Change in composition of the mastoid bone with age (linear regression SigmaPlot software). Percentage of the mastoid comprised of marrow (●); percentage of the mastoid comprised of pneumatized bone (▼). Measurements made on an axial computed tomography scan at the level of the round window niche.



The Six Cantonese Tones

- Design of materials and test
- Tests of Word and Tone recognition



Outline

- Outcomes on Mandarin
 - Literature review
 - Tones/ word recognition and others
- Outcomes on Cantonese
 - 5 year data on Prince of Wales Hospital
 - Tone production / word recognition

Outcomes on Mandarin Tone Perception

	N	Mean age at implantation (yr)	Mean duration of implant use (yr)	Mean percentage correct	Chance level
Wu & Yang, 2003	16	5.8	1 2	73.1 79.2	25%
Peng et al., 2004	30	9;3	3;7	72.9	50%
Cao et al., 2004	53 3	1 to >17	No information	69	?
Huang et al., 2005	26	3.5	1.2 to 3.5	54.8	25%
Wang et al., 2007	29	Young gp: 2.2 Old gp: 6.5	Young gp: 4.5 Old gp: 4.1	72.1 57.3	33.3%

Outcomes on Mandarin Tone Production

	N	Mean age at implantation (yr)	Mean duration of implant use (yr)	Outcomes
Xu et al., 2004	4	4 to 9	1 to 5	Acoustic analysis: Tones produced tended to be flat; Tone intelligibility: 0.25 to 8.5 out of a 10-pt rating scale
Peng et al., 2004	30	9;3	3;7	53% correct
Han et al., 2007	14	1.16 to 7.09	0.3 to 2.6	48.4% correct

Outcomes on Mandarin Open-set Word Recognition

	N	Mean age at implantation (yr)	Mean duration of implant use (yr)	Outcomes
Cao et al., 2000	25	8.3	<0.5 to 2	~40%
Cao et al., 2004	533	1 to >17	No information	44%

Outcomes on Mandarin Open-set Word Recognition

	N	Mean age at implantation (yr)	Mean duration of implant use (yr)	Outcomes
Cao et al., 2000	25	8.3	<0.5 to 2	~40%
Cao et al., 2004	533	1 to >17	No information	44%
Wang et al., 2007	29	Young gp: 2.2 Old gp: 6.5	Young gp: 4.5 Old gp: 4.1	Young gp: 80% Old gp: 60.4%

Long term outcomes on Cantonese

- Speech outcomes
 - Open-set word recognition
 - Cantonese tone production
- To examine the effect of
 - implant experience
 - age at implantation

Subjects

- 45 prelingually deaf children
- 20 females and 25 males
- Using CI for 5 year
- Implanted at age from 1;04 to 14;09 (mean = 5;05)

Study design

- Open-set word recognition
- Tone production
- Expressed as percentage correct
- Tested at 6 time intervals from pre-operation to five-year post-surgery

Data Analyses

- Linear regression
 - DV: Tone production scores
Word recognition scores
 - IV: Age at implantation (Age)
Duration of implant use (Time)



Results – Linear regression

	Word recognition	Tone Production
Variables	P-value	p-value
Time	0.000	0.000
Age at implantation	0.807	0.027
Interaction	0.003	0.044

Data Analyses

- Linear regression, age by age
- Implanted at <2, 2, 3, 4, 5, 6, 7, 8, 9, >=10
 - DV: Tone production scores
Word recognition scores
 - IV: Duration of implant use (Time)

Linear regression – age by age

- Parameter estimates
 - The estimated increase on tone production/word recognition scores in relation to one unit increase in time
 - Example
 - $-3.5 = 3.5$ score decrease with 1 more year of implant use
 - $6.5 = 6.5$ scores increase with 1 more year of implant use

Linear regression – Word Recognition

Age	Parameter estimate	p-value
<2	14.59	0.00
2	14.70	0.00
3	7.51	0.11
4	7.99	0.03
5	6.37	0.39
6	9.74	0.00
7	10.51	0.03
8	2.64	0.15
9	-4.48	0.38
>=10	4.41	0.24

Linear regression – Word Recognition

Age	Parameter estimate	p-value
<2	14.59	0.00
2	14.70	0.00
3	7.51	0.11
4	7.99	0.03
5	6.37	0.39
6	9.74	0.00
7	10.51	0.03
8	2.64	0.15
9	-4.48	0.38
>=10	4.41	0.24

Discussion

- Different magnitude of improvement for children implanted at various ages

Implanted before 8 years old

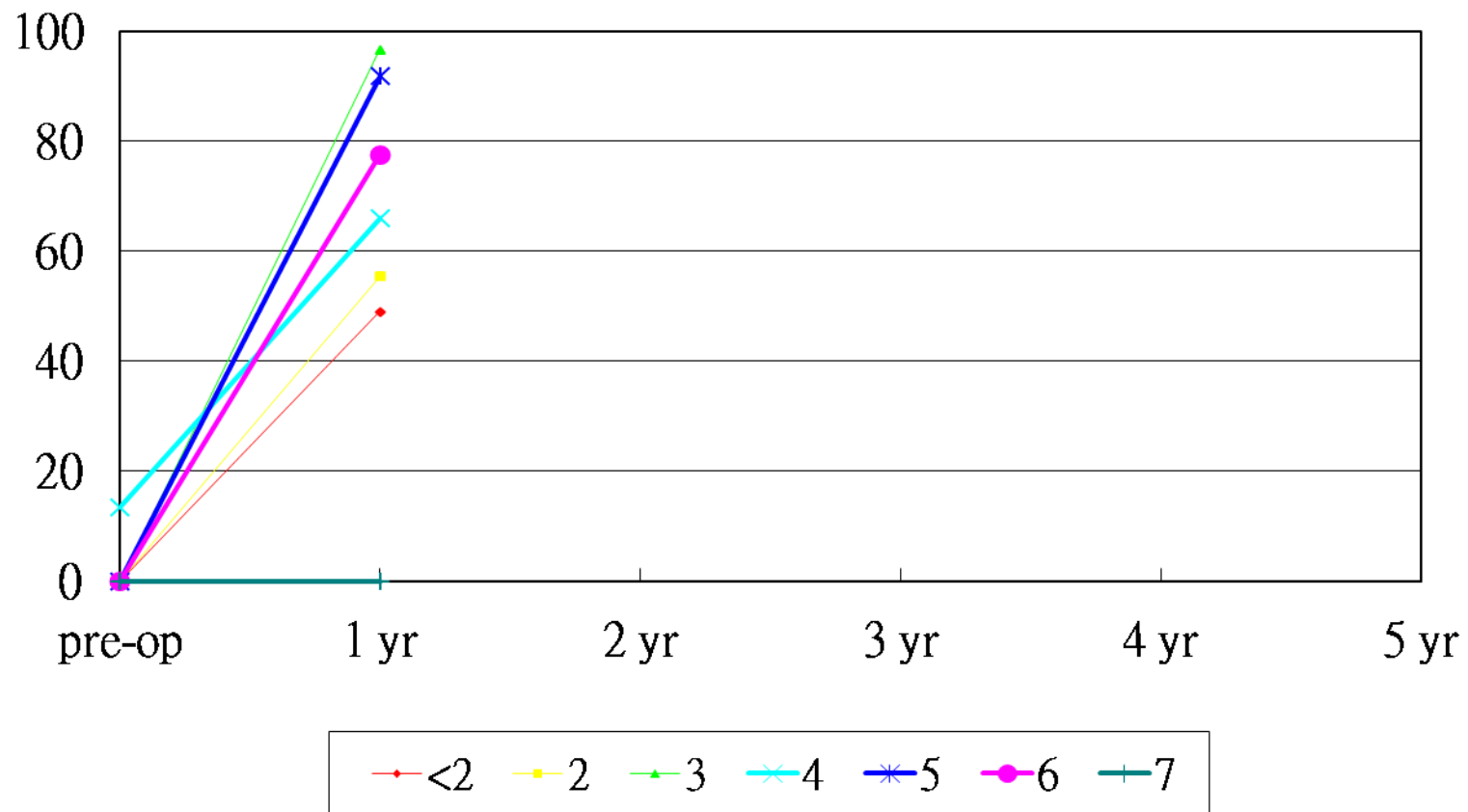
- Coefficient estimates =
 - <2: 14.59
 - 2;00 – 2;11: 14.70
 - 3;00 – 3;11: 7.51
 - 4;00 – 4;11: 7.99
 - 5;00 – 5;11: 6.37
 - 6;00 – 6;11: 9.74
 - 7;00 – 7;11: 10.51

Implanted at or above 8 years old

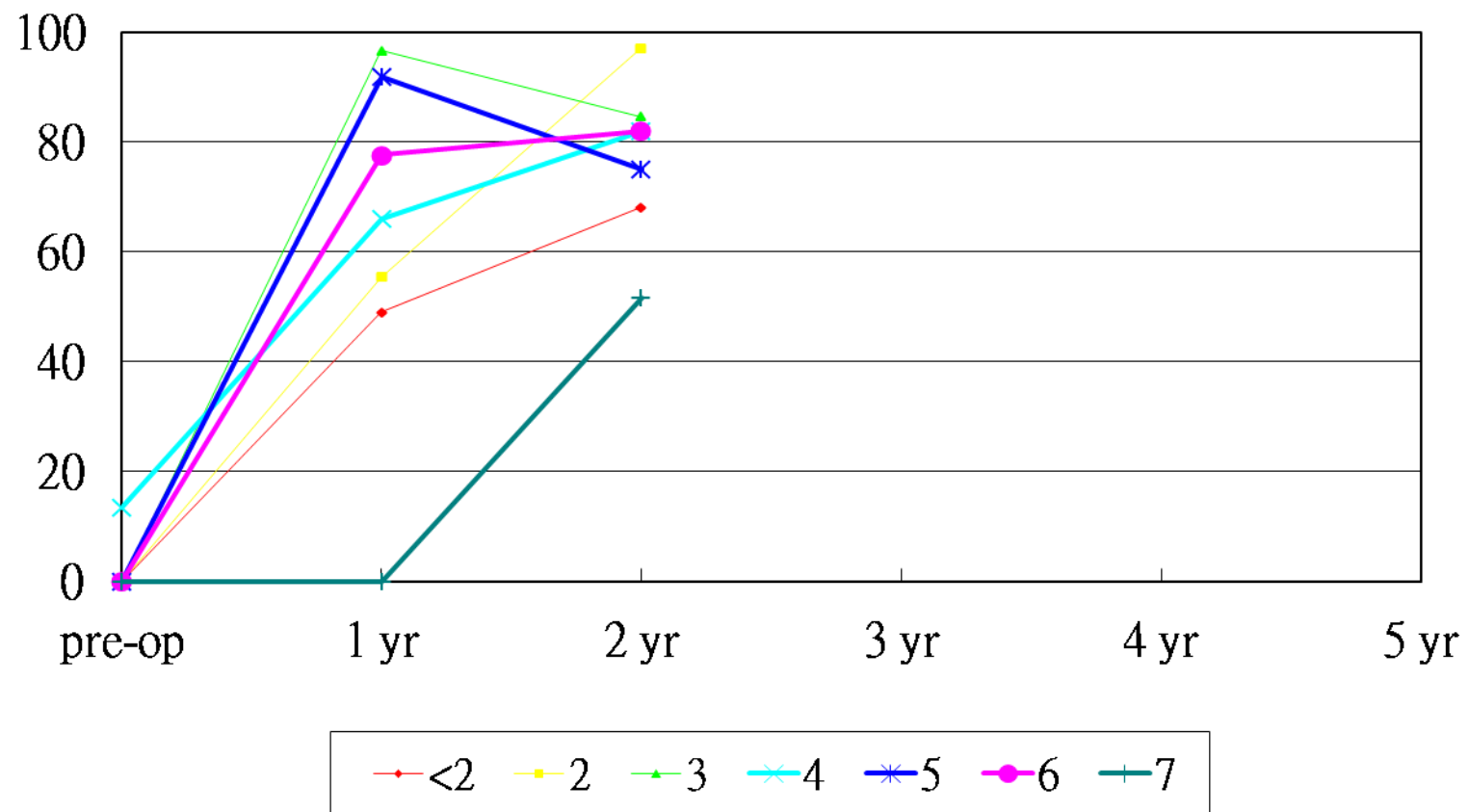
- Coefficient estimates =

– 8:00 – 8;11:	2.64
– 9:00 – 9;11:	-4.48
– \geq 10:00:	4.41
- P-values all >0.05

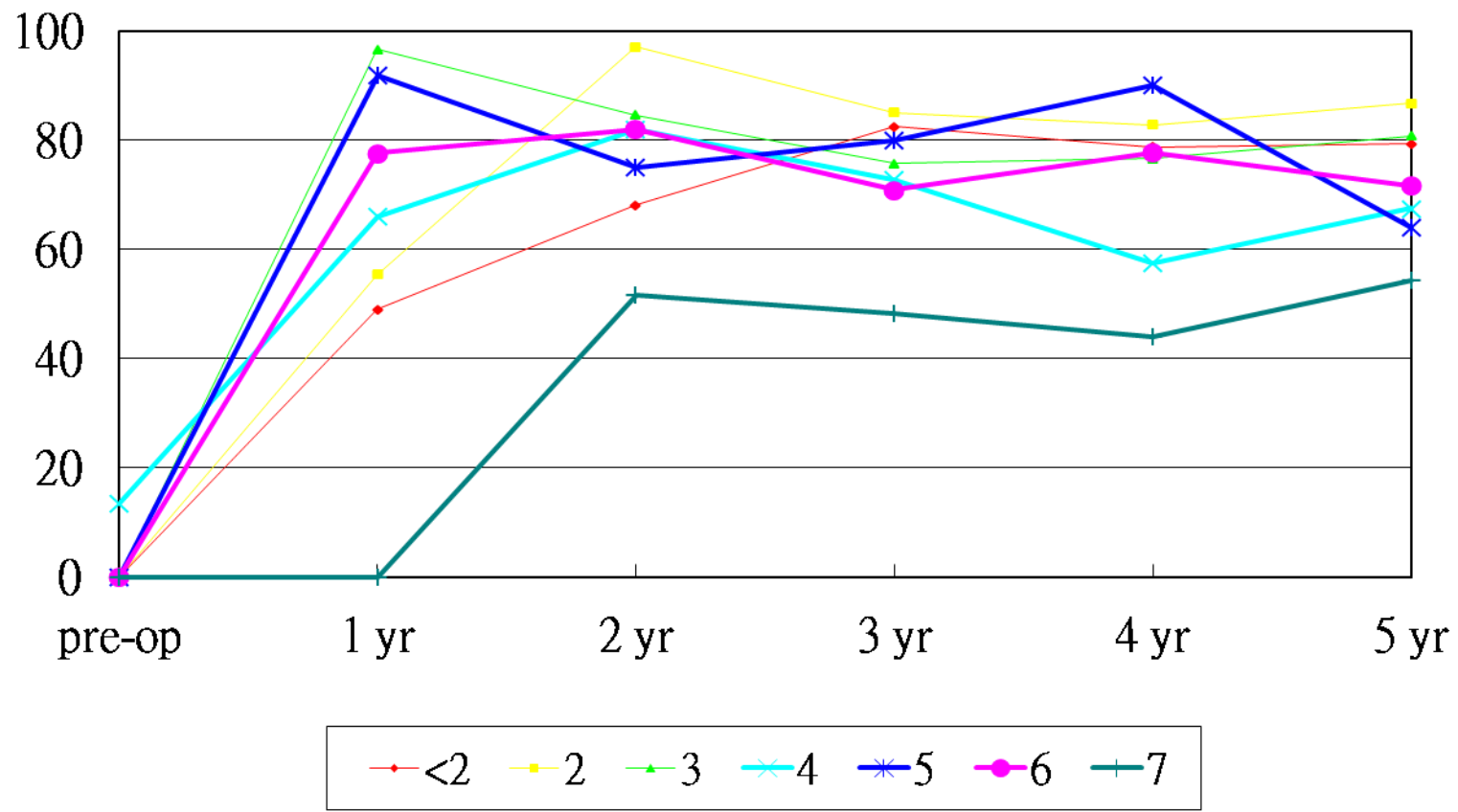
Word Recognition



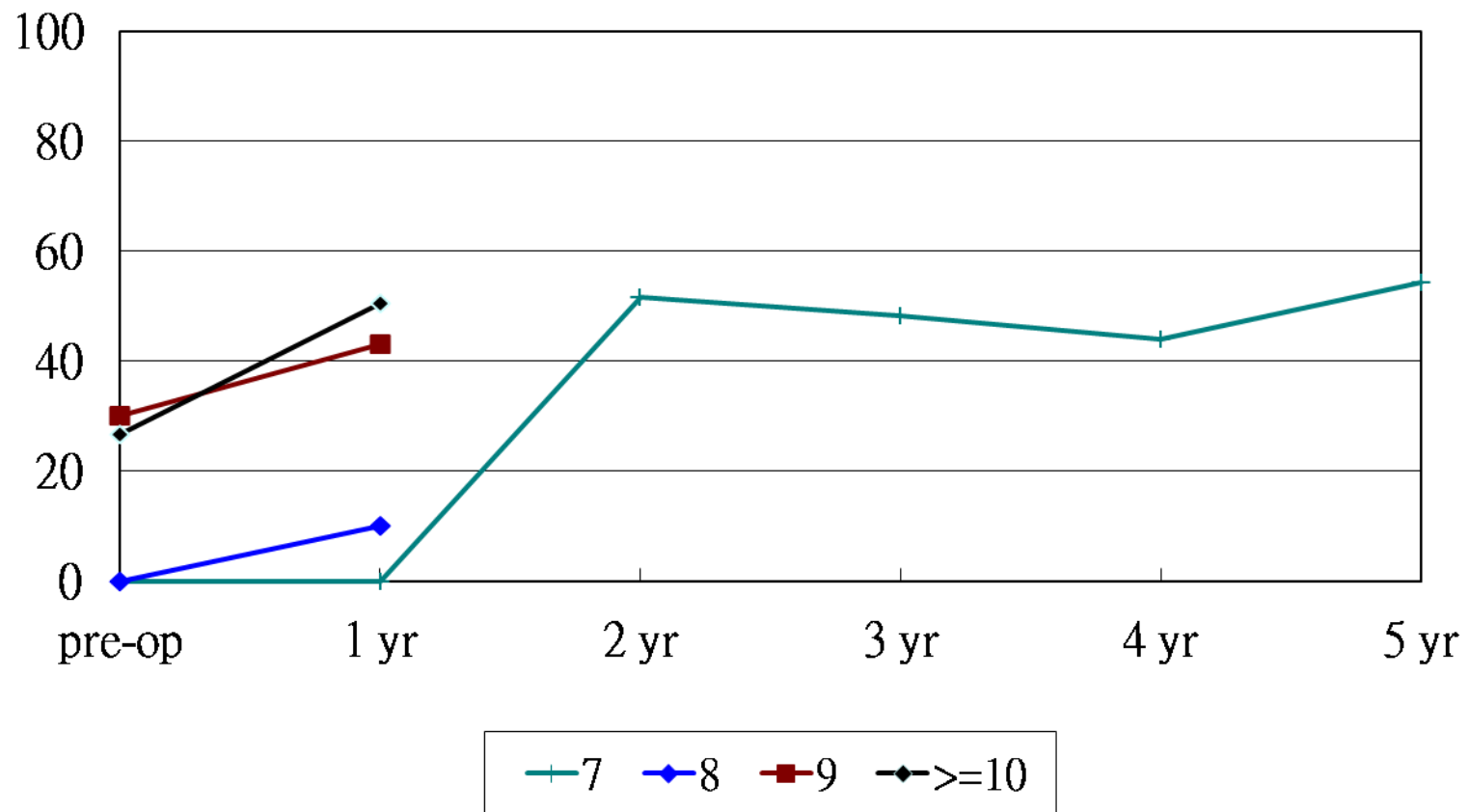
Word Recognition



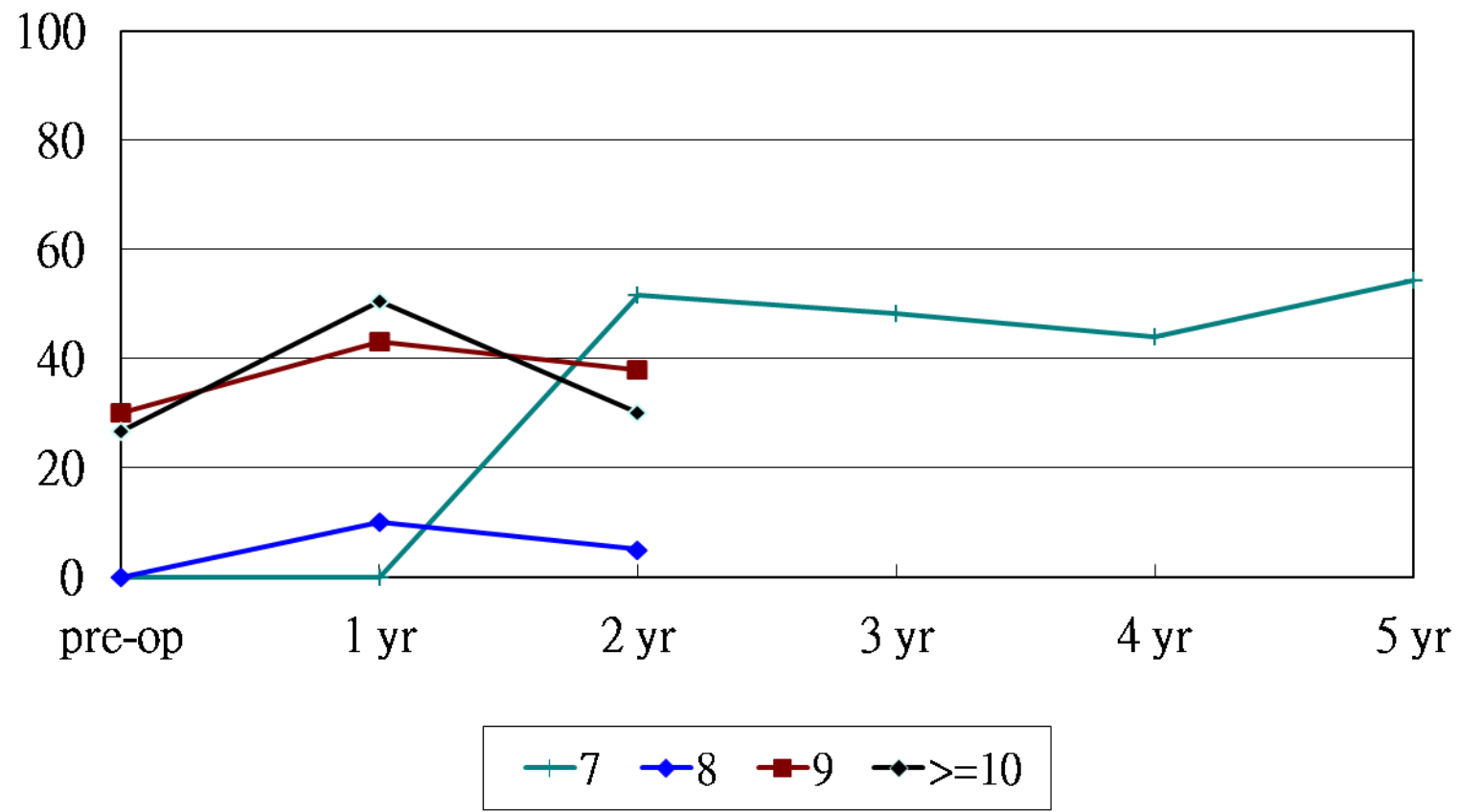
Word Recognition



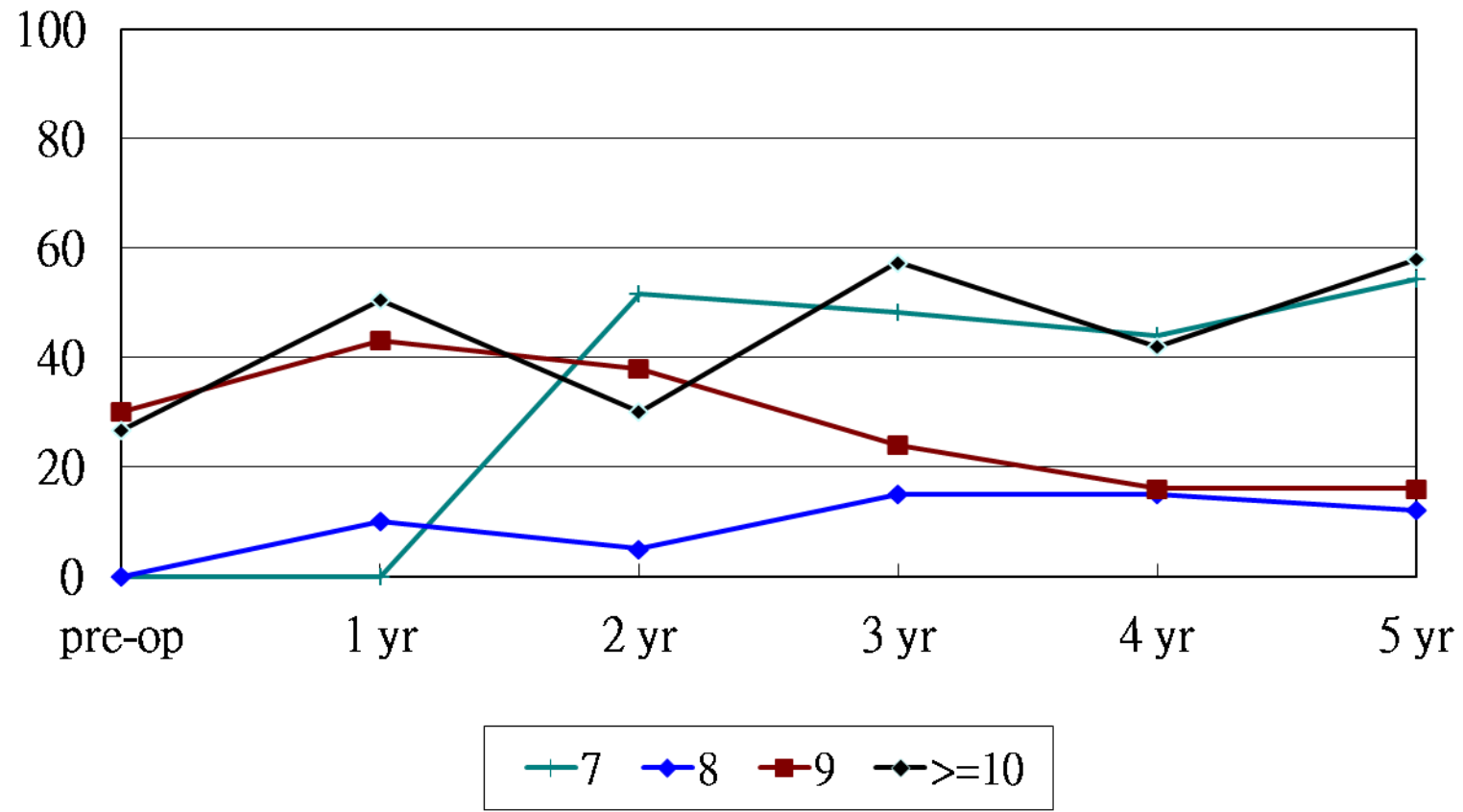
Word Recognition



Word Recognition



Word Recognition



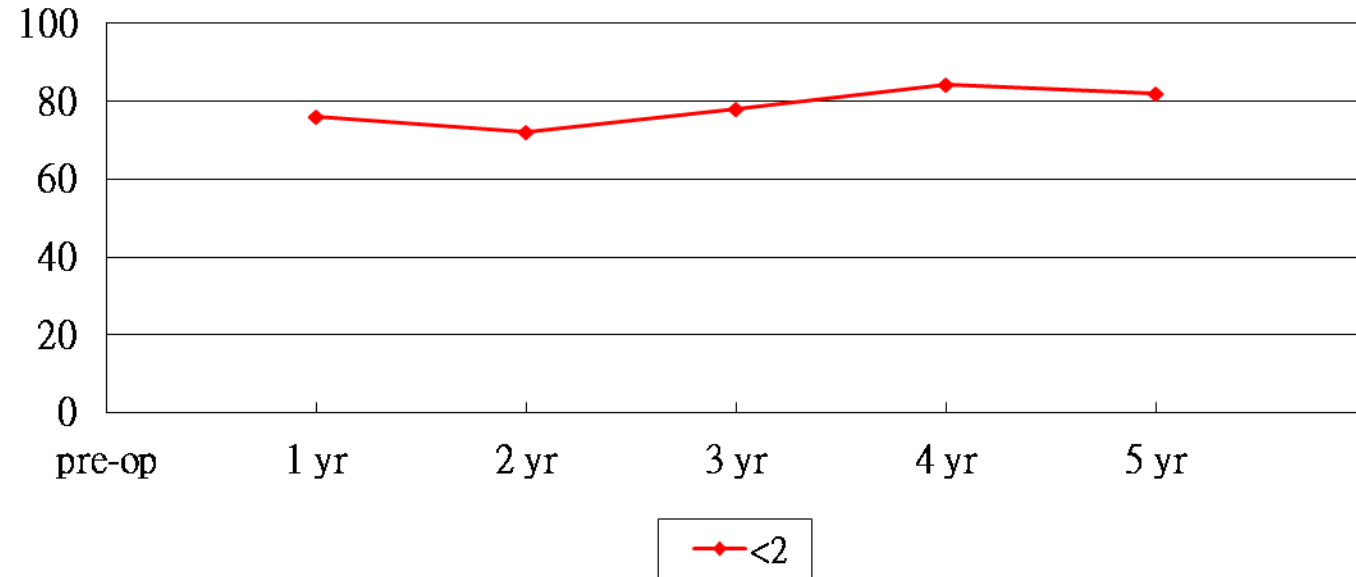
Linear regression – Tone production

Age	Parameter estimate	p-value
<2	2.50	0.42
2	7.38	0.02
3	9.05	0.00
4	3.50	0.25
5	4.78	0.25
6	4.74	0.02
7	3.02	0.01
8	2.41	0.03
9	-0.14	0.93
>=10	2.76	0.00

Linear regression – Tone production

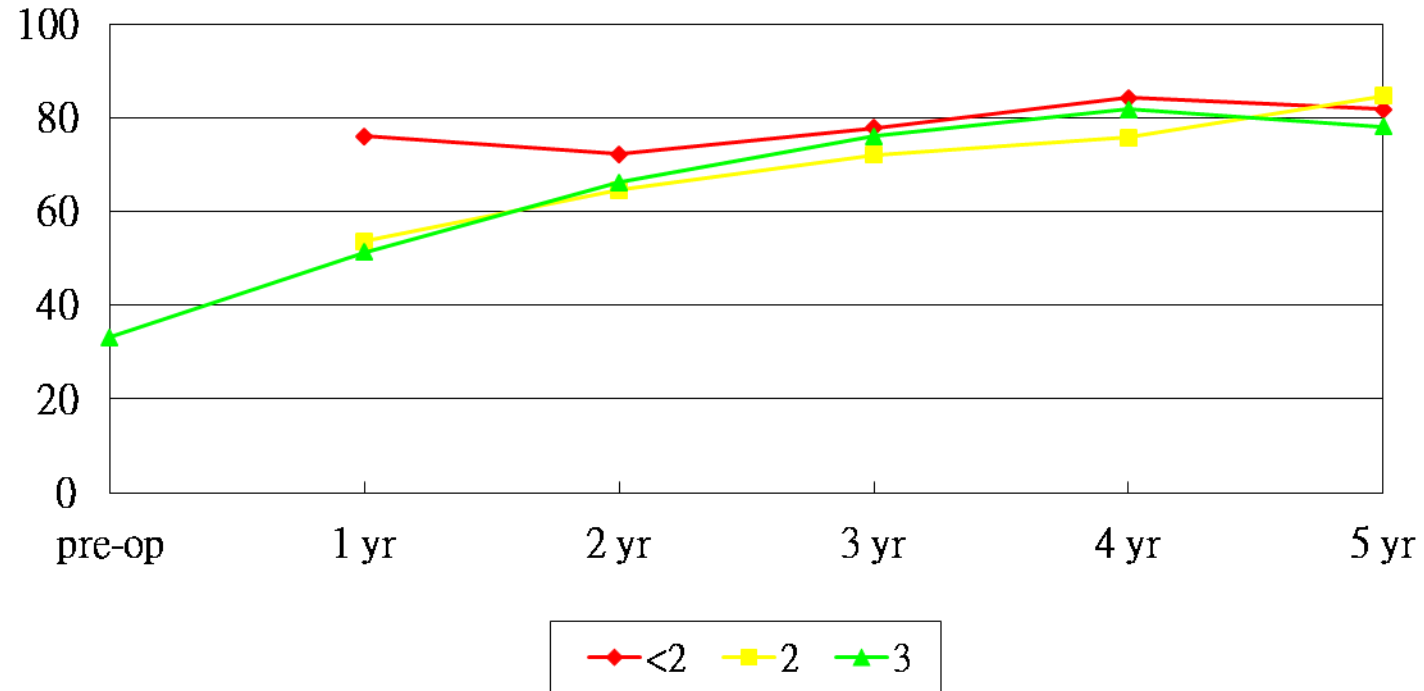
Age	Parameter estimate	p-value
<2	2.50	0.42
2	7.38	0.02
3	9.05	0.00
4	3.50	0.25
5	4.78	0.25
6	4.74	0.02
7	3.02	0.01
8	2.41	0.03
9	-0.14	0.93
>=10	2.76	0.00

Linear regression – age by age



- Up to 75% accuracy within one year of implant use
- Maintained throughout 5 years

Implanted at 2 to 3;11 years old

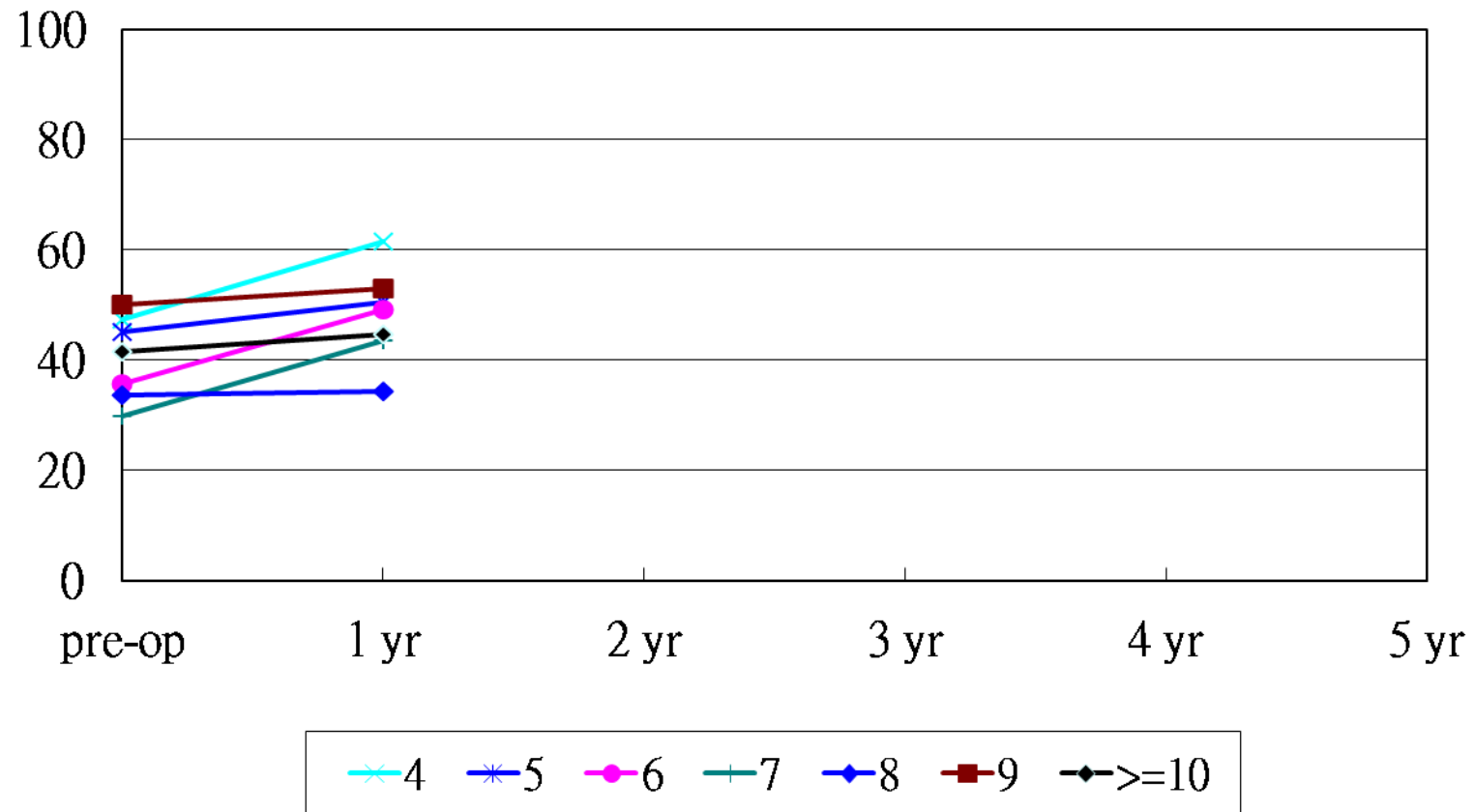


- Relatively lower scores in the first year
- Steadily improved

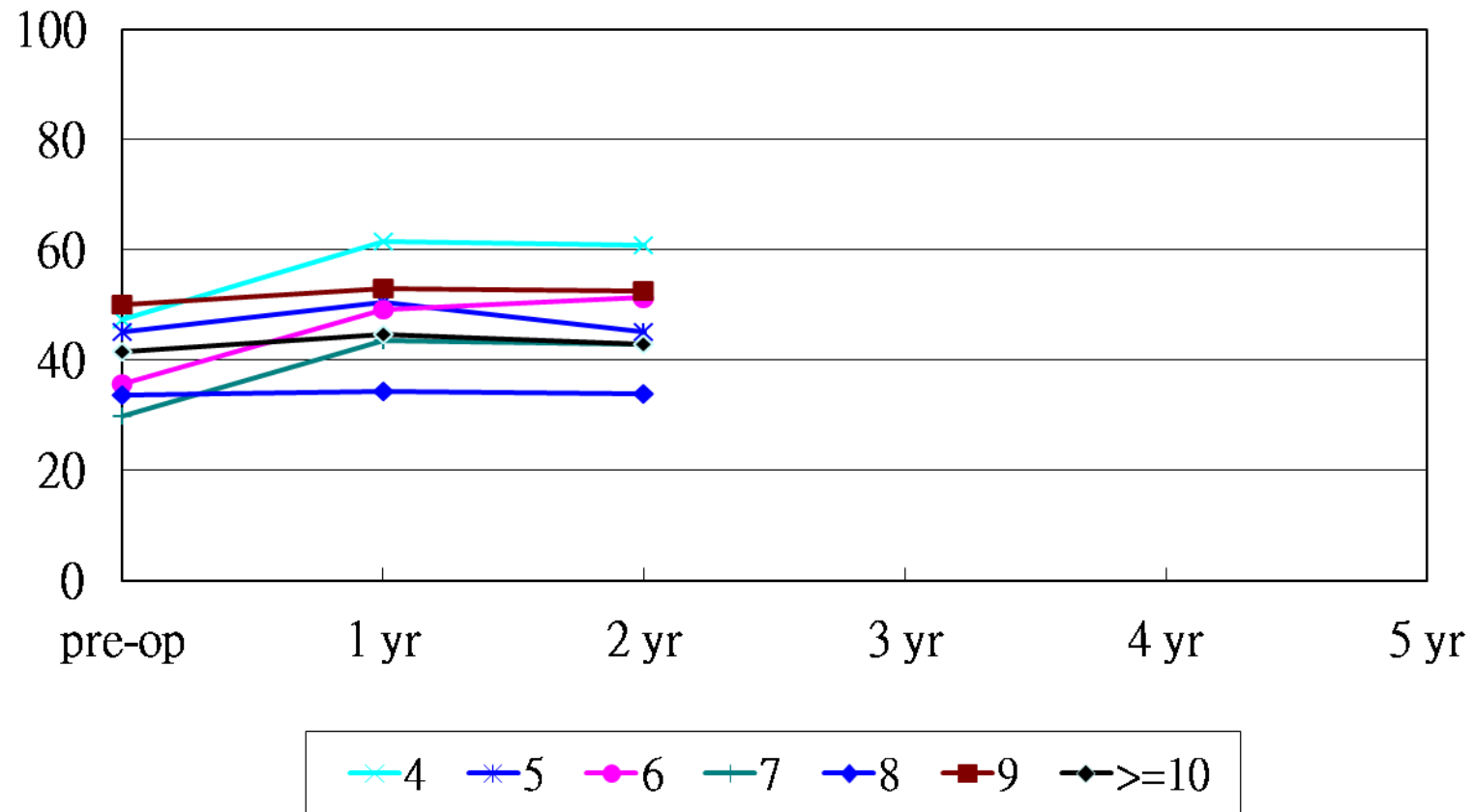
Implanted at > 4 years old

- Coefficient estimates ranged from -0.14 to 4.78
- Extent of improvement dropped markedly

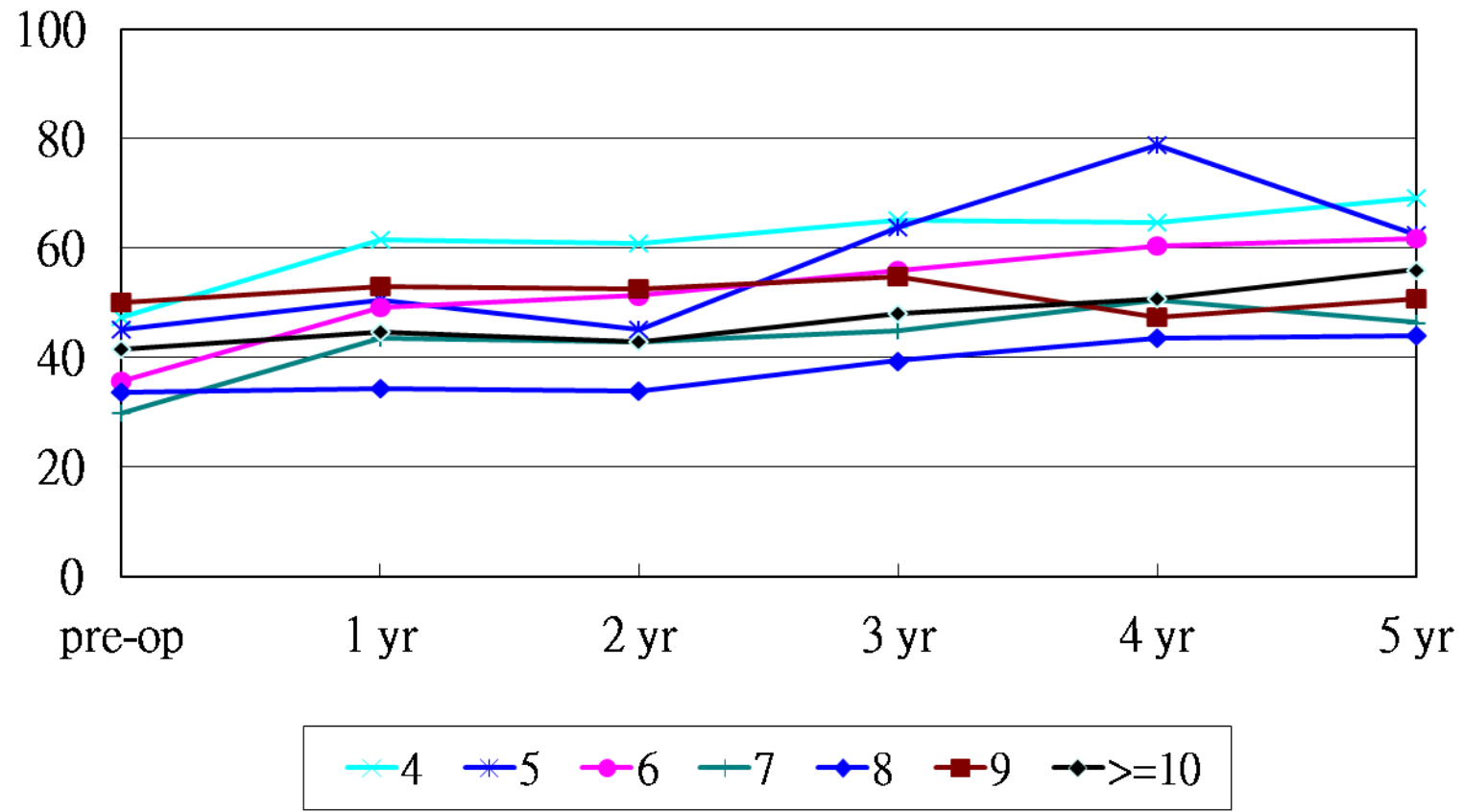
Linear regression – age by age



Linear regression – age by age



Linear regression – age by age



Conclusion

- Children implanted at various ages showed improvements both in word recognition and tone production over time
- Children implanted younger than 4 achieved the highest scores over time
- The magnitude of improvement becomes smaller with increasing age of implantation

Conclusion

- Critical implanted age for word recognition
 - Below aged 7
 - Achieved >70% after 2 yrs
 - Aged 7 or above
 - Achieved 12-58% after 5 yrs

Summary

- Critical implanted age for acquiring tone
 - Before two
 - achieved 76% accuracy after 1 year
 - From 2 to 3;11
 - achieved >72% accuracy after 3 years
 - Older than 4
 - only achieved 44-69% after 5 years

Age of implantation	Tone production	CI duration (yrs)	Word recognition	CI duration (yrs)
<2	😊😊😊	1	😊😊😊	2
2	😊😊😊	3	😊😊😊	2
3	😊😊😊	3	😊😊😊	2
4	😊	5	😊😊😊	2
5	😊	5	😊😊😊	2
6	😊	5	😊😊😊	2
7	😊	5	😊😊	2
8	😊	5	😊	5
9	😊	5	😊	5
>=10	😊	5	😊	5

What next?

- **A low-cost device?**
- Durability, safety and efficacy/ Company survival
- **A custom device?**
- Beating existing device
- Awaiting innovation
- **Future device**
- hardware: small, durable, flexible, custom designed electrodes, waterproof, noise reduction, total implantability



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