

Choice of cochlear implant side in a paediatric population

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Abstract

Objective: To compare the effect of right- or left-sided cochlear implantation on listening skills in a paediatric population.

Methods: A retrospective analysis was conducted on the listening skills performance data of children who were operated on and followed up at the Çukurova University Department of Otorhinolaryngology between 2007 and 2011. Sixty-three patients were included in the study. Patients were evaluated using the Listening Progress Profile, the Meaningful Auditory Integration Scale and the littLEARS test.

Results: The mean age of the children was two years (range of one to five years). Twenty-nine patients were male and 34 were female. Twenty-eight patients were implanted in the right ear and 35 in the left ear. There were no statistically significant differences between right and left ear implantees in terms of listening skills performance.

Conclusion: This study indicates that the choice of cochlear implant side is not crucial for the development of listening skills.

Key words: Cochlear Implantation; Deafness; Auditory Localization

Introduction

Cochlear implants are generally accepted as being the most efficient technological implement for the treatment of those patients with severe to profound bilateral sensorineural hearing loss who do not have satisfactory results using conventional sound amplification devices. The benefit of cochlear implantation depends on: aetiology, duration of hearing impairment, cognition and language, the patient's degree of maturity, and the emotional condition of the patient.^{1,2} The choice of ear for cochlear implantation depends on the pre-operative functional status, hearing sensitivity and speech perception, and clinical and anatomical status of each ear.³

The choice of ear for implantation becomes more complex when residual hearing is similar in both ears and no anatomical restrictions are evident. Post-implantation hearing in the right or left ear may be related to the asymmetry of normal auditory function, hemispheric specialisation and laterality of the central auditory system. Although the auditory cortex receives sensory input from both ears, there is a large corpus of functional imaging, electrophysiological and behavioural data showing that this region is activated most strongly by stimulation of the contralateral ear.⁴ In addition, a large number of functional and structural brain imaging studies have highlighted the predominant role

of the left hemisphere in speech processing.^{5,6} Despite these cumulative data, the effect of side of cochlear implantation on behavioural performance in prelingually deafened children is not yet clear.

In this study, we investigated the effect of the side of cochlear implantation (right or left) on listening skills in a paediatric population.

Materials and methods

This study involved a retrospective analysis of the listening skills performance of children who were operated on and followed up at the Çukurova University Department of Otorhinolaryngology between 2007 and 2011.

Sixty-three patients were included in the study. Twenty-eight patients were implanted in the right ear and 35 in the left ear. All patients were operated on under general anaesthesia by the same surgeon, using the same technique. The speech processor was fitted one month after surgery.

The Listening Progress Profile, the Meaningful Auditory Integration Scale and the littLEARS[®] test were used for all patients in order to evaluate the development of listening skills. Patients were evaluated pre-operatively, and post-operatively at 1, 3, 6 and 12 months. Intergroup comparisons (between right and

left ear implantees) were performed; these were limited to right-handed patients only. The Statistical Package for the Social Sciences for PC version 13.0 software program was used for statistical analysis of data (SPSS Inc, Chicago, Illinois, USA).

Results

The mean age of the children at the time of operation was 2.16 years (range, 1–5 years). The mean age was 2.23 years in the right ear implantee group and 2.07 years in the left ear implantee group. Twenty-nine patients were male and 34 patients were female. Forty-five patients were implanted with Med-El devices, 17 were implanted with Cochlear Nucleus devices and 1 patient was implanted with an Advanced Bionics device. Twenty-eight patients were right ear implantees and 35 patients were left ear implantees. Demographic characteristics of the patients are shown in Tables I and II.

Pre-operatively, the average score for the Listening Progress Profile test was 2.1 in the right ear implantee group and 2.2 in the left ear implantee group. Twelve months post-operatively, the score was 40.3 in the right ear implantee group and 39.8 in the left ear implantee group. The average pre-operative score for the Meaningful Auditory Integration Scale test was 4.8 in the right ear implantee group and 4.9 in the left ear implantee group. Twelve months post-operatively, the score was 37.2 in the right ear implantee group and 36.9 in the left ear implantee group. The average pre-operative score for the littleEARS test was 2.7 in the right ear implantee group and 2.1 in the left ear implantee group. Twelve months post-operatively, this score was 32.3 in the right ear implantee group and 31.2 in the left ear implantee group (Table III). There were no statistically significant

Device	Ear		Total
	Right	Left	
Advanced Bionics			
– <i>n</i>	0	1	1
– % with device	0	100.0	100.0
– % overall	0	2.9	1.6
Med-El			
– <i>n</i>	21	24	45
– % with device	46.7	53.3	100.0
– % overall	75.0	68.6	71.4
Cochlear Nucleus: CI24 (CA)			
– <i>n</i>	7	0	7
– % with device	100.0	0	100.0
– % overall	25.0	0	11.1
Cochlear Nucleus: CI512 with Contour			
– <i>n</i>	0	10	10
– % with device	0	100.0	100.0
– % overall	0	28.6	15.9
Total (<i>n</i> (%))	28 (44.4)	35 (55.6)	63 (100.0)

TABLE II
AGE OF PATIENTS

Ear	Age at test (y)	Age at operation (y)
Right		
– Mean	5.25	2.07
– SD	1.506	0.940
– Median	5.00	2.00
– Min	3	1
– Max	10	5
Left		
– Mean	5.57	2.23
– SD	1.170	0.731
– Median	5.00	2.00
– Min	4	1
– Max	9	4
Total		
– Mean	5.43	2.16
– SD	1.329	0.827
– Median	5.00	2.00
– Min	3	1
– Max	10	5

Y = years; SD = standard deviation

differences between the two groups in terms of the development of listening skills (Figure 1).

Discussion

In normal hearing subjects, functional magnetic resonance imaging data indicate greater contralateral (rather than ipsilateral) cortical activation in response to monaural stimulation with tones,⁷ noise⁴ and syllables.⁸ Cortical auditory evoked potential data also support the asymmetrical activation of auditory pathways, characterised by shorter latencies and higher amplitudes for contralateral versus ipsilateral click stimulation.^{9,10} In addition, many functional and structural brain imaging studies have confirmed the dominant role of the left hemisphere in speech processing.

- **Choice of ear for cochlear implantation depends on pre-operative functional status, hearing sensitivity and speech perception, and clinical and anatomical status of each ear**
- **The effect of implantation side on behavioural performance in prelingually deaf children is unclear**
- **In this study, there was no significant difference between right and left ear implantees in listening skills development**

Asymmetric brain organisation was already evident in 4-day-old neonates presented with dichotic speech stimuli,¹¹ and in 3-month-old patients who listened to speech and speech-like stimuli.¹² The results of a study by Henkin *et al.* showed that children with prelingual hearing loss with right cochlear implants did better than children with left cochlear implants.¹³ In that study, the right cochlear implant advantage was independent of age at implantation and was evident in

TABLE III
LISTENING SKILLS DEVELOPMENT DATA

Test	Ear	Pre-op	3 mth post-op	6 mth post-op	12 mth post-op
LIP	Right				
	– Mean ± SD	2.1 ± 0.94	23 ± 7.1	35 ± 5.9	40.3 ± 2.4
	– Median	2	22	35.5	42
	– Range	1–5	12–42	23–42	32–42
	Left				
	– Mean ± SD	2.2 ± 0.73	23.5 ± 9	34.2 ± 6.3	39.8 ± 3.3
	– Median	2	23	34	42
	– Range	1–4	0–42	21–42	30–42
	Total				
	– Mean ± SD	2.1 ± 0.83	23.3 ± 8.2	34.5 ± 6.1	40.1 ± 2.9
	– Median	2	22	34.5	40.1
	– Range	1–5	0–42	21–42	30–42
MAIS	Right				
	– Mean ± SD	4.8 ± 5.2	21.7 ± 7	30.4 ± 7.5	37.2 ± 2.6
	– Median	4	21	30	38
	– Range	0–29	10–38	0–39	32–40
	Left				
	– Mean ± SD	4.9 ± 3.9	23.5 ± 6.2	32 ± 4.2	36.9 ± 3.1
	– Median	4	26	32	38
	– Range	0–19	5–34	24–40	24–40
	Total				
	– Mean ± SD	4.9 ± 4.5	22.7 ± 6.6	31.3 ± 5.9	37.1 ± 2.9
	– Median	4.9	22.7	31.3	37.1
	– Range	0–29	5–38	0–40	24–40
littlEARS	Right				
	– Mean ± SD	2.7 ± 5.9	15.7 ± 5.4	26.2 ± 5.7	32.3 ± 3.8
	– Median	1.5	16	26.5	34.5
	– Range	0–32	4–25	16–35	20–35
	Left				
	– Mean ± SD	2.1 ± 3.1	15.8 ± 7.1	24.1 ± 6.4	31.2 ± 4.1
	– Median	1	16	26	32
	– Range	0–17	0–27	9–35	20–35
	Total				
	– Mean ± SD	2.3 ± 4.5	15.7 ± 6.4	25 ± 6.2	31.7 ± 3.9
	– Median	2.3	15.7	25	31.7
	– Range	0–32	0–27	9–35	20–35

Pre-op = pre-operation; mth = months; post-op = post-operation; LIP = Listening Progress Profile; SD = standard deviation; MAIS = Meaningful Auditory Integration Scale

children implanted when younger than 24 months. The overall difference in performance between right and left cochlear implant users was small but significant for both words and phonemes, and was consistent at the

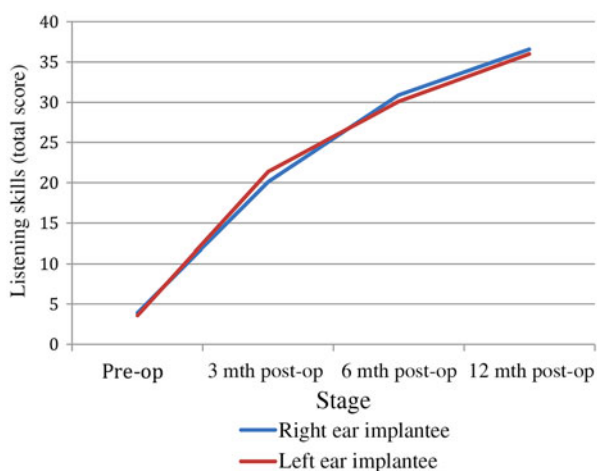


FIG. 1

Total scores for listening skills development, for right and left ear implantees. Pre-op = pre-operation; mth = months; post-op = post-operation

two time intervals tested. Cerebral dominance did not have a significant effect on performance, and the right cochlear implant advantage was maintained when analysis was restricted to right-handed children.¹³ Chen *et al.* found no significant difference in hearing performance between the worse ear and better ear groups; choosing the worse ear for implantation did not appear to have a negative impact on performance outcome.¹⁴ In another study, there were no differences between left ear and right ear implantees in terms of improvement on speech recognition tests.¹⁵ Different studies have shown that left hemisphere dominance for speech occurs in 95–98 per cent of right-handed people and in 70–80 per cent of left-handed people.¹⁶

In the present study, we found no statistically significant difference in listening skills development between right ear and left ear implantees within the confines of the performance tests used.

In conclusion, despite the fact that functional imaging studies have shown an advantage of the right ear in non-cochlear implant patients, performance tests in the current study showed no difference between right ear and left ear implantees. This

implies that the choice of cochlear implant side is not crucial for the development of listening skills.

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