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Ear selection and pediatric cochlear implants: A preliminary examination of speech production outcomes

Peter Flipsen Jr.*

Department of Communication Sciences and Disorders, and Education of the Deaf, Idaho State University, 921 S. 8th Avenue Mail Stop 8116, Pocatello, ID 83209-8116, United States

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Summary

Objective: The goal of the current study was to examine whether ear selection (left versus right) for cochlear implantation results in significant differences in speech production outcomes.
Methods: Ten children with right-ear implants were compared to five children with left-ear implants on intelligibility of speech produced in single words, sentences, and conversation as well as on accuracy of speech sounds produced during administration of a single word articulation test and in conversational speech.
Results: The children with right-ear implants performed significantly better than those with left-ear implants but only on the single word tasks. No significant differences were observed at the sentence or conversational speech levels.
Conclusion: Findings are discussed relative to the possibility that the obtained ear of implantation differences (if real) may disappear over time. Such a conclusion is quite tentative however given the small sample size in the current study. Such a limitation may also explain why no differences were obtained for the connected speech measures. Further study of ear selection outcomes is clearly indicated.

1. Introduction

Despite recent trends toward bilateral implantation and some early evidence of the relative benefits of two implants [1], many pediatric candidates for cochlear implants continue to receive only a single implant. A question that has received only limited attention is whether the ear selected for implantation (i.e., right ear versus left ear) makes any difference to the development of speech and language. In cases where both ears are viable candidates for implantation, such information clearly has the potential to influence the choice. In cases where there are

* Tel.: +1 208 282 4403; fax: +1 208 282 4571.
E-mail address: flippete@isu.edu.

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known constraints against using a particular ear, information about outcomes has the potential to inform patients, parents, surgeons, rehabilitation professionals and educators about expectations following implantation.

A number of perspectives are usually considered when making ear selection decisions. From a medical perspective surgeons are always concerned about possible structural impediments to electrode insertion such as cochlear ossification or congenital malformations of the cochlea. They are also concerned about relative infection risks such as cases in which the patient has an active case of OM in one ear or the other. From an audiological perspective there are questions about dealing with unequal hearing thresholds; implant teams appear to vary in their preference for implanting either the better-hearing or worse-hearing ear. In addition, documentation of auditory neuropathy in one ear or the other may influence ear selection. Then there is the speech and language perspective which is particularly relevant for pediatric cochlear implantation. All other factors being equal, a strong preference to provide maximum stimulation of the language-dominant hemisphere likely motivates recommendations for implantation in the contralateral ear. With very young children, identifying the language dominant hemisphere is problematic, however, because speech and language have yet to emerge making dominance very difficult to ascertain. Typically handedness, usually evident (though not firmly established) before the first birthday, is used as a proxy for language dominance; such an approach is clearly not fool-proof however, particularly for left-handed patients [2]. A potentially higher incidence of left-handedness among hearing-impaired individuals [3] only serves to amplify the problem. A final but somewhat lesser perspective on ear selection is maximizing manipulation of the device itself by the patient which may be facilitated by implantation on the side of the dominant hand [4].

Studies to date have tended to indicate few if any differences relative to ear selection; the focus of the few studies that have been conducted has however largely been on adults and has only included responses to speech or other auditory input (i.e., there has been little or no study of children and/or speech production). Although studies of adults reflect the impact of the modified auditory input from cochlear implants to both a mature neurological system and a mature language system, comparing findings from such studies with studies of children (such as the current one) may eventually allow us to isolate the impact of development from the impact of that modified input. Examining the existing adult studies, Morris et al. [5] reported no significant differences in speech recognition performance between 38 adult patients with left-ear implants against 63 adult patients with right ear implants at 1 year post-implant. The findings were the same even when the analysis was limited to only the 67 right-handed patients. Roman et al. [6] reported no significant difference between adults with left-ear implants ($n = 4$) and those with right-ear implants ($n = 3$) on consonant discrimination thresholds. Analysis of auditory evoked potential responses by the same participants indicated similar overall response shapes, but significantly slower response latencies in those with left-ear implants. In a related study Roman et al. [7] examined auditory evoked responses to tone bursts and reported no significant difference in latency or amplitude of N_1/P_2 peaks between adults with left-ear ($n = 4$) and right-ear implants ($n = 3$). Deguine et al. [4] examined ear selection outcomes relative to handedness and reported no significant difference in open set word and sentence discrimination performance in 76 patients (including an unspecified number of children) regardless of whether the implant was ipsilateral or contralateral to reported handedness. Overall studies to date appear to show no significant differences relative to ear selection.

Studies of individuals with normal hearing in one ear but significant hearing loss in the other (i.e., those with significant unilateral losses) may be relevant here. This is the case because assuming a child meets the typical implantation criteria (i.e., a severe-profound bilateral hearing loss), when they receive a single cochlear implant it effectively transforms them into someone with near-normal hearing in the implanted ear but a continuing severe or profound hearing loss in the other ear. Thus, their situation is very similar to someone with a unilateral hearing loss. Of course the analogy is not a perfect one in at least two respects. First, a cochlear implant provides electric hearing rather than acoustic hearing and thus the auditory input into the ''good'' ear is not quite the same as the input which our auditory systems normally deal with. And second, children born with unilateral losses have the immediate benefit of normal hearing in their good ear, rather than the delay of at least 1 year usually experienced by those who receive a unilateral cochlear implant. These differences only argue however for even greater potential differences for children using a single cochlear implant. A recent review of studies of unilateral hearing loss [8] indicated mixed findings, but the author noted that up to 35% of children with significant unilateral hearing loss may need to repeat a grade in school, and up to