Original Article

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DOI:
10.4103/jfcm.JFCM_142_15

Cochlear implants in children: A cross-sectional investigation on the influence of geographic location in Saudi Arabia

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Abstract:

INTRODUCTION: The role of the family in detecting a child's hearing difficulty and the age at which an implantation is done have been identified as strong predictors of the outcomes of pediatric cochlear implantation. In the absence of screening programs for hearing loss in Saudi neonates, the family's role is of paramount importance. The aim of this study was to investigate the influence of geographic location on the course of identification, examination, and cochlear implantation in children in Saudi Arabia.

MATERIALS AND METHODS: Pediatric patients who had received either unilateral or bilateral cochlear implantation at King Abdulaziz University Hospital in Riyadh, Saudi Arabia, between January 1, 2012, and December 31, 2014, were surveyed.

RESULTS: A total of 156 pediatric patients have had a cochlear implant between January 1, 2012, and December 31, 2014. The one-way analysis of variance test to compare the means of the independent sample groups in various geographic zones showed that with a hundred percent access to primary health care, the geographic location of the population had an influence on the detection of hearing loss but not on the cochlear implantation.

CONCLUSION: This study found that the geographic location of the population has an influence on the time of detection of hearing loss in children but not on the time of cochlear implantation. Raising parental awareness of the importance of early detection of hearing loss is necessary. Further research is also required to define the role of factors such as the income and the educational level of parents on the early detection of neonatal hearing loss.

Keywords:

Children, cochlear implant, Saudi Arabia

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Introduction

Problems pertaining to hearing diminish a child's ability to learn, and hearing-impaired (HI) children have little self-confidence because of inadequate language and communication skills, especially in their perceived social acceptance by peers, parental attention, physical appearance, and overall self-esteem.[1] Speech comprehension and production in children is a multistage process: in the first stage, the child has a closed-set words by which he/she recognizes and produces a finite number of words that are in his/her set of options presented by situational questions. This is usually affected by hearing. A more advanced stage consists of an open set of words, whereby a child recognizes and produces an infinite number of words prompted by situational cues. Finally, full speech comprehension and production is achieved when the child understands and uses words by herself/himself without any external cues. Studies have shown that the

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How to cite this article: Al-Sayed AA, AlSanosi A. Cochlear implants in children: A cross-sectional investigation on the influence of geographic location in Saudi Arabia. J Fam Community Med 2017;24:118-21.

cochlear implant provides a significant improvement in auditory discrimination and speech production skills with a limited open-set word and sentence recognition.[2]

Research evidence shows that severe to profoundly HI children should have implants as early as possible to develop speech perception skills and speech comprehension at a later stage.[3-5] The provision of cochlear implant early during the critical stage of a child's language development has shown superior audiological and linguistic performance.[6] Evidence from research favors sequential bilateral implantation over unilateral implantation with a 37% observed advantage for speech recognition, especially in those children who had their second implant before the age of 6 years.[7,8]

Technically, children with an unaided four-frequency pure tone audiometry (PTA) of 80 dB HL or less in both the ears are candidates for bilateral cochlear implantation. Since it is tricky to measure a four-frequency PTA in young children, recent observational studies recommend a two-frequency PTA, which can easily measure 85 dB HL or less in both ears as the criterion for bilateral implant in children.[9]

A cochlear implant device supplies electrical stimulation directly to the auditory nerve circumventing the damaged hair cells in the cochlea, providing a perceived sensation of hearing.[10] Thus, a cochlear implant does not restore normal hearing but provides a sensory neuronal stimulation for sound vibration, resulting in sound perception and subsequent motor neuronal reaction.[11]

Extensive auditory, speech, educational, and psychological testing are performed before and after implantation.[2] There has been an increase in cochlear implants in children in the recent years, particularly, in those implanted within the first year of life.[12]

Recent studies have identified the role of the family and the age of implant as strong predictors of the outcome of pediatric cochlear implantation.[13] Therefore, delays in cochlear implantation should be lessened to have better implant outcomes. Studies to evaluate the influence of the introduction of newborn hearing screening programs on the age at which children have cochlear implantation have shown a significant decline in the age at implantation and a simultaneous increase in the number of children getting implants within the first year of life.[12]

In the absence of such screening programs for hearing loss in Saudi neonates, the child's family is the first to detect the child's hearing difficulty. The problem is subsequently reported to a primary healthcare provider or local ENT specialist, who in turn refers them to the Regional Health Council, which in turn directs the family to a specialized center for cochlear implantation. Consequently, the geographic factors have much influence on the efficiency of this sequential process of identification, examination, and cochlear implantation. The geographic factors include the urban, semi-urban, or rural domicile.

This research, the first such an investigation, aimed to determine the influence of geographic factors on the course of identification, examination, and cochlear implantation in children in Saudi Arabia. It is hoped that this research will aid the decisions that guide the implementation of the hearing screening program of the newborn.

Materials and Methods

This cross-sectional study included a total of 156 pediatric patients who had received either unilateral or bilateral cochlear implantation at King Abdulaziz University Hospital (KAUH) in Riyadh, Saudi Arabia, between January 1, 2012, and December 31, 2014. The study included children between 3 and 144 months of age with hearing impairment caused by defects in the inner ear and related sensory structures, specifically, defective hair cells in the cochlea (sensorineural hearing loss [SNHL]), and have had either a unilateral or bilateral cochlear implant. Children <3 moths of age were not included since due to safety, cochlear implants were not routinely performed at this age. Children older than 12 years were also excluded as they did not normally have an implantation done at our center.

Data was abstracted by retrospective chart review of these 156 cases. The information obtained included the age at which hearing impairment was first observed by the family, age at which hearing impairment (SNHL) was first diagnosed at a primary healthcare facility, age at which hearing impairment (SNHL) was evaluated by extensive audiologic examination at KAUH, and the age at which the cochlear implant was performed.

Data on the patient's geographic location comprised the parents' region of residence. The data on residence were assigned to one of the five major regions of Saudi Arabia, namely, central, southern, northern, western, and eastern regions. Ethical approval by the Research and Statistics Committee at KAUH and informed consent from the patient's parents were obtained.

Statistical analysis was accomplished using SAS version 9.4 (SAS Institute, North Carolina, USA). Data were presented in the form of mean scores and standard deviations for continuous variables, and frequencies and percentage for categorical variables, with 95% confidence intervals. A one-way analysis of variance (ANOVA) was performed to compare the means of the independent sample groups.

Results

Of the total 156 cases, 58.3% were females and 41.6% males. The mean age in months at which hearing impairment was first observed was 7.0 (±11.3); the mean age at which hearing impairment (SNHL) was first diagnosed was 7.0 (±11.3); the mean age at which hearing impairment (SNHL) was medically evaluated for implant was 22.0 (±15.4); and the mean age at which cochlear implant was performed was 45.09 (±21.3) [Table 1].

Table 2 shows the mean age of children (±SD) by region. The mean age at which the cochlear implant was performed was 44.76 (±1.99) months for the central region, 45.29 (±1.85) for the southern region, 44.79 (±1.52) for the northern region, 45.16 (±2.08) for the western region, and 45.43 (±1.12) for the eastern region. Data on the parental access to primary health care showed that there was 100% access in all the five regions of the country [Table 3].

Table 1: Mean age of the child at which hearing impairment was first observed, diagnosed, medically evaluated, and mean age at cochlear implant

Mean age (in months)	Mean±SD
Mean age at which hearing impairment was first observed	07.0±1.3
Mean age at which hearing impairment (SNHL) was first diagnosed	07.0±1.3
Mean age at which hearing impairment (SNHL) was medically evaluated	22.0±1.4
Mean age at which cochlear implant was performed	45.09±1.3

SD = Standard deviation, SNHL = Sensorineural hearing loss

Table 2: Mean age of the child (±SD) at cochlear implant by region

Region	*N* (%)	Mean age (in months) at cochlear implant Mean±SD
Central	66 (42.3)	44.76±1.99
Southern	38 (24.3)	45.29±1.85
Northern	27 (17.3)	44.79±1.52
Western	15 (9.6)	45.16±2.08
Eastern	10 (6.4)	45.43±1.12

SD = Standard deviation

Table 3: Parental access to primary health care

Region	*N* (%)	Percentile access available
Central	66 (42.3)	100
Southern	38 (24.3)	100
Northern	27 (17.3)	100
Western	15 (9.6)	100
Eastern	10 (6.4)	100

Discussion

ANOVA test was performed to compare the means of the independent sample groups in the five geographic zones. The one-way ANOVA test in the five geographic zones shows two different outcomes. ANOVA for the geographic distribution of mean age at which hearing loss was first observed had a p-value= <0.0001 for the F-test which indicates that there was a significant difference in the age at which hearing loss was first observed in the five geographic regions and that the geographic, regional location had an influence on the age at which the hearing loss is first observed in children in Saudi Arabia [Table 4]. However, ANOVA for the geographic distribution of the mean age of cochlear implant a p-value = 0.5557 for the F-test which indicate that there was no significant difference in the age at which cochlear implant is done in the five different geographic locations and that the geographic, regional location had no influence on the age at which cochlear implantation is done in children in Saudi Arabia [Table 5]. It seems, therefore, that although there is a time difference (in months) among the various geographic regions in Saudi Arabia in the detection of hearing impairment in children, there is no such time difference (in months) for cochlear implants. This could be the result of such factors as parents' education and level of income. Since the data on accessibility to primary health care were 100% in all the geographic zones, parental access to primary care had little significance in the analysis of the data.

Besides, the overall mean age of cochlear implantation in Saudi Arabia is 45.7 (±21.3) as compared to a mean of 21.5 months in the United States.[14,15] This seems to indicate an excessive waste of time between the time of observation of the impairment by the family and the time of implantation of the device, which severely holds back the child's learning and language acquisition. Thus, there is a need to address urgently these issues in a population that has excellent access to primary health care. The introduction of newborn hearing screening programs that would enable them to have an implant within their first year of life and educational programs that would inform parents on the significance of an early implant and consequences of a delay should effectively address the issue of delayed implantation.

Conclusion

The entire population of the country has easy access to primary health care, geographic location of domicile has a definite influence on the time of detection of hearing loss in children, but not on the time of cochlear implantation. There is an urgent need for the introduction of newborn hearing screening programs in Saudi Arabia together with educational programs for parents on the importance of an early cochlear implantation.

Financial support and sponsorship

Support and funding were provided by King Abdullah Ear Specialist Center (KAESC), and the Department of Otorhinolaryngology – Head and Neck Surgery, College of Medicine, King Saud University, Riyadh, Saudi Arabia.

Table 4: Analysis of variance for the geographic distribution of the sample and mean age at which hearing loss was first observed

Group	*n* (count)	Mean	SD	SE	
Group 1	66	7.76	1.3	0.16	
Group 2	38	6.24	1.12	0.1817	
Group 3	27	7	1.08	0.2078	
Group 4	15	6.1	1	0.2582	
Group 5	10	7.9	1.12	0.3542	
ANOVA table					
Source of variation	**Sum of squares**	**df**	**Mean square**	***F*-statistics**	p^a
Between groups	78.5155	4	19.6289	13.9889	<0.0001
Within groups	211.879	151	1.40317		
Total	290.394	155			
	χ^2	**df**	p^a		
Test for equality of variance	2.5586	4	0.6341		

P value significant when <0.05, [a]0.05. SD = Standard deviation, SE = Standard error, ANOVA = Analysis of variance

Table 5: Analysis of variance for the geographic distribution of the sample and mean age at cochlear implant

Group	*n* (count)	Mean	SD	SE	
Group 1	66	44.76	1.99	0.245	
Group 2	38	45.29	1.85	0.3001	
Group 3	27	44.79	1.52	0.2925	
Group 4	15	45.16	2.08	0.5371	
Group 5	10	45.43	1.12	0.3542	
ANOVA table					
Source of variation	**Sum of squares**	**df**	**Mean square**	***F*-statistics**	p^a
Between groups	10.329	4	2.58226	0.755706	0.5557
Within groups	515.969	151	3.41701		
Total	526.298	155			
	χ^2	**df**	p^a		
Test for equality of variance	6.11248	4	0.1909		

P value significant when <0.05, [a]0.05. SD = Standard deviation, SE = Standard error, ANOVA = Analysis of variance

Conflicts of interest

There are no conflicts of interest.

References

1. Theunissen SC, Rieffe C, Netten AP, Briaire JJ, Soede W, Kouwenberg M, *et al.* Self-esteem in hearing-impaired children: The influence of communication, education, and audiological characteristics. PLoS One 2014;9:e94521.
2. Kveton J, Balkany TJ. Status of cochlear implantation in children. American Academy of Otolaryngology-Head and Neck Surgery Subcommittee on cochlear implants. J Pediatr 1991;118:1-7.
3. Tobey EA, Thal D, Niparko JK, Eisenberg LS, Quittner AL, Wang NY; CDaCI Investigative Team. Influence of implantation age on school-age language performance in pediatric cochlear implant users. Int J Audiol 2013;52:219-29.
4. Anderson I, Weichbold V, D'Haese PS, Szuchnik J, Quevedo MS, Martin J, *et al.* Cochlear implantation in children under the age of two – What do the outcomes show us? Int J Pediatr Otorhinolaryngol 2004;68:425-31.
5. Nikolopoulos TP, O'Donoghue GM, Archbold S. Age at implantation: Its importance in pediatric cochlear implantation. Laryngoscope 1999;109:595-9.
6. AlSanosi A, Hassan SM. The effect of age at cochlear implantation outcomes in Saudi children. Int J Pediatr Otorhinolaryngol 2014;78:272-6.
7. Scherf F, van Deun L, van Wieringen A, Wouters J, Desloovere C, Dhooge I, *et al.* Hearing benefits of second-side cochlear implantation in two groups of children. Int J Pediatr Otorhinolaryngol 2007;71:1855-63.
8. Steffens T, Lesinski-Schiedat A, Strutz J, Aschendorff A, Klenzner T, Rühl S, *et al.* The benefits of sequential bilateral cochlear implantation for hearing-impaired children. Acta Otolaryngol 2008;128:164-76.
9. Lovett RE, Vickers DA, Summerfield AQ. Bilateral cochlear implantation for hearing-impaired children: Criterion of candidacy derived from an observational study. Ear Hear 2015;36:14-23.
10. Kral A, Hartmann R, Tillein J, Heid S, Klinke R. Hearing after congenital deafness: Central auditory plasticity and sensory deprivation. Cereb Cortex 2002;12:797-807.
11. Andrew Dillon. Cochlear Implants for Children and Adults with Severe to Profound Deafness. NICE Technology Appraisal Guidance [TA166]; 2009. Available from: http://www.nice.org.uk/guidance/ta166. [Last accessed 2017 Mar].
12. Lammers MJ, Jansen TT, Grolman W, Lenarz T, Versnel H, van Zanten GA, *et al.* The influence of newborn hearing screening on the age at cochlear implantation in children. Laryngoscope 2015;125:985-90.
13. Black J, Hickson L, Black B, Khan A. Paediatric cochlear implantation: Adverse prognostic factors and trends from a review of 174 cases. Cochlear Implants Int 2014;15:62-77.
14. Maisoun AM, Zakzouk SM. Hearing screening of neonates at risk. Saudi Med J 2003;24:55-7.
15. American Academy of Pediatrics, Joint Committee on Infant Hearing. Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. Pediatrics 2007;120:898-921.