

# Cochlear implants in deaf children

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## ABSTRACT

**Objective:** This investigation was aimed to determine the current status of sensorineural hearing loss in children from the provinces of the Kingdom Saudi Arabia and to report on those with severe to profound hearing loss who are in need of cochlear implant.

**Methods:** A comprehensive survey of 9540 Saudi children was carried out from September 1997 through to May 2000. The subjects were randomly selected from the 4 main provinces of the country. The main objective was to screen these children for hearing impairment. A survey team included an ear, nose and throat specialist, a nurse, a social worker and an audiologist. A questionnaire was completed; clinical examination and audiological assessment was performed. Those confirmed and in doubt cases were referred for further audiological and clinical assessment including computerized tomography scan and auditory brain stem response.

**Results:** The over all prevalence of hearing impairment was 13% (1241 out of 9540). Those with sensorineural hearing loss was 142 (1.5%) and those with severe to profound (76-100 decibels loss) was 68 (0.7%) 7 of them suffered from unilateral while 135 suffered from bilateral sensorineural hearing loss.

**Conclusion:** The prevalence rate of severe to profound sensorineural hearing loss is high in our country compared to developed countries. Cochlear implant is a useful procedure for those with severe and profound sensorineural hearing loss but hearing aids must be tried first. There is definitely a requirement for additional hearing and speech centers to be available, which, are at least accessible in the big cities in each province.

**Keywords:** Sensorineural hearing loss prevalence, cochlear implant.

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Cochlear implant started recently in the Kingdom Saudi Arabia (KSA) and considerable interest and enthusiasm has been put into this matter. The prevalence of childhood hearing impairment varies in children from different populations. Studies on the epidemiology and etiology of hearing impairment in KSA showed that sensorineural hearing impairment was 2.6% (1996).<sup>1</sup> Considering this high prevalence of hearing impairment, this investigation aimed to determine the current status of sensorineural hearing loss (SNHL) in children from the different provinces of the KSA and report on those with severe to profound SNHL who are in need of cochlear implant. The north western region was included with the western province.

**Methods.** A comprehensive random sample survey of 9540 Saudi children below the age of 15 years was carried out during the period September 1997 through to May 2000. The subjects were randomly selected thus enabling adequate and representative covering of all socioeconomic and demographic groups of the Saudi population from the 4 main provinces of the country. The main objective was to screen these children and those parents or guardians who came with them for hearing impairment, with special emphasis on the prevalence of SNHL. There were 4 survey teams, each included an otorhinolaryngologist, an audiologist, a nurse and social worker. In each province, different cities and villages were chosen, and the health centers in that

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region were randomly selected, the population registered was called to bring their children for hearing screening. The response was 69%. A questionnaire modified from the World Health Organization (WHO)<sup>2</sup> Prevention of Deafness and Hearing Impairment (PD/HI) was used which included the name, age, birth, weight, sex, parent relationship, family history of deafness complaint of hearing, speech problems and immunization history. Included were sheets to record the ear, nose and throat (ENT) clinical findings, hearing evaluation, diagnosis of hearing impairment and action needed for management, for example medical, surgical, hearing aid or special education, or both. Each child was assigned a code number and that code number designated the questionnaires. After taking history, the ENT specialist clinically examined each child; the ears were examined, cleaned from wax if any and the hearing evaluation was carried out. The audiologists evaluated the hearing using free sound, pure tone screening audiometer and tympanometry (acoustic emission was not available at the time of screening). Those children who failed the screening test or if in doubt, were referred to the main hospital in the area where full audiological assessment took place including auditory brain stem response (ABR) depending upon the mental age and cooperation of the child.

The type of hearing impairment was determined by pure tone average based on the air conduction threshold at 500Hz, 1000Hz and 2000Hz using (acoustic) and bone conduction of 500 to 4,000 Hz. The standard technique was employed for masking air and bone conduction. Brain stem auditory evoked potential waves were elicited by click stimuli generated by a 100 millisecond square wave electrical pulse through earphones. Three electrodes were placed at 3 points on the head, for example left

and right mastoid on both ear lobes, and at the central zone. Recordings were made routinely between the vertex and the ipsilateral ear. Impedance audiometry using (Autotymp Grason Stadler Incorporation 37) in the form of tympanograms, acoustic threshold, and acoustic reflex decay was performed. The last one is mainly carried out to help differentiate between cochlear and retrocochlear disorders. Those children with otorrhea, were treated, swabs for culture and sensitivity were taken and treatment was completed after swab results, hearing assessment was performed following treatment.

**Results.** Among the total children screened, 142 were identified to suffer from SNHL. In this paper we will report on the cases of SNHL of severe to profound only. Seven children with unilateral SNHL of the severe type following mumps, 135 children suffered from bilateral disease, of these 36 had severe SNHL and 32 with profound deafness (25.8%), according to the previously described audiological assessment. The number of children with mild to moderate SNHL was 67 and they could benefit from hearing aids. Those with severe to profound hearing loss constitute 47.9% (68 children) of all cases of SNHL, and 0.7% of the total children surveyed. Those with mental retardation, 5 in number, were excluded together with 3 cases of congenital absence of the inner ear. Details of the subjects characteristics are shown in **Table 1** and the various causes of SNHL are shown in **Table 2**.

**Discussion.** The high prevalence of hearing impairment (HI) in this study was mainly due to otitis media (acute and chronic suppurative and otitis media with effusion) these are fortunately

**Table 1** - Details of subjects with respect to sex, age category, hearing impairment percentage and residence.

Subjects		Male (%)		Female (%)		Total (%)	
<b>Total subject</b>							
N	<b>Hearing impairment (%)</b>	4189 (43.9)	13.84 -	5351 (56.1)	12.76 -	9540 (100)	- (13)
<b>Age Category</b>							
Up to 4 years	13.5	1108 (53.9)		946 (46.1)		2054 (22)	
> 4-8 years	14.7	1749 (51)		1682 (49)		3431 (36)	
> 8-12 years	11	1251 (34.6)		2364 (65.4)		3615 (37)	
>12 years	13.6	81 (18.4)		359 (81.6)		440 (5)	
<b>Province</b>							
Central	9.7	2067 (54.4)		1733 (45.6)		3800 (40)	
Eastern	9.9	330 (51)		317 (49)		647 (7)	
Southern	20.7	360 (34.8)		675 (65)		1035 (11)	
Western	14.7	1432 (35.3)		2626 (64.7)		4058 (42)	
N - number							

**Table 2** - Causes of sensorineural hearing loss among 9540 Saudi children.

Cause	N	Proportional Prevalence (%)	Overall Prevalence (%)
Hereditary	52	36.6	0.6
Renal Tubular acidosis (RTA)	2	1.4	0
Retenitis Pegmentosa	2	1.4	0
Prematurity + Low birth weight (LBW)	8	5.6	0.1
Jaundice	4	2.8	0
Meningitis	5	3.5	0.1
Mumps	7	4.9	0.1
Measles	3	2.1	0
Rubella	2	1.4	0
Toxoplasmosis	2	1.4	0
Sickle cell disease	1	0.7	0.1
Fever of unknown etiology	4	2.8	0
Head injury	4	2.8	0
Unknown cause	46	32.4	0.5
<b>Total</b>	<b>142</b>	<b>100</b>	<b>1.5</b>
N - number			

preventable diseases. The prevalence of HI was significantly higher in male children as compared to female children. Earlier studies reported that male children may have a higher incidence of some of the risk factors associated with hearing impairment, Zakzouk 1997,<sup>3</sup> Ferberviart 1996,<sup>4</sup> From et al 1993.<sup>5</sup> Lee et al 1997<sup>6</sup> reported greater risk of bilateral hearing loss in children living in crowded housing conditions as well as those parents with a reported low educational attainment. The hearing impairment was found to be significantly higher in children whose parents were first cousins or relatives, or both. Darin et al, 1997,<sup>7</sup> reported that in 33% of the hearing impaired children, the causative factor was heredity. In our study, heredity factors were responsible for 36.6%.

Our study showed that the overall prevalence of SNHL was 1.5%. The prevalence of severe >76 decibels (dB) in the better ear or profound deafness where there was no response at 95-100dB was 0.7% of the total children screened. These figures are higher than those previously reported from Riyadh 0.4% (1996) and other studies. Davidson et al 1988<sup>8</sup>

reviewed 10 studies from 14 countries and found a prevalence range of 0.56 to 2.3/1000 for hearing loss greater than 40dB bilaterally in the western world. They also found that prevalence for the less developed countries tended to be slightly higher, with figures between 2 and 4.2/1000. Regional variations of SNHL prevalence are expected due to the effect of environment and the level of medical care. In this study the prevalence rate was found to be higher in the southern and western provinces where family intermarriage is more practiced as well as the health services delivery system being less, especially in the rural areas. There are several prenatal, perinatal and post natal risk factors that play an important role in the pathogenesis of hearing impairment. One of the major causes was found to be the hereditary factor A large number of children from the southern province were from mothers who did not attend antenatal care clinic and therefore had abnormal pregnancy for example, toxemia, infection difficult labor. Also incomplete vaccinations were noticed in a large number of children from the southern and western provinces. The most common postnatal factor was meningitis accounting for 4.8% of the severe SNHL and 18.8% of the profound hearing loss in our study.

Thomas 1992<sup>9</sup> observed that bacterial meningitis was associated with SNHL, learning difficulties and delayed speech. Fortnum and Davis 1993<sup>10</sup> suggested that bacterial meningitis was the single most important cause of acquired sensorineural hearing impairment in the children. Zakzouk and El-Sayed 1992<sup>11</sup> studied 68 children with bacterial meningitis in Riyadh, KSA. They found that 24 had developed bilateral SNHL (32.3%). Six with unilateral SNHL 8.8%.

In a previous epidemiological study in Riyadh, Zakzouk (1997)<sup>12</sup> reported that meningitis formed 3% of the total hearing impaired children with SNHL. According to the Saudi Ministry of Health report<sup>13</sup> 45% of the population of the KSA are children, with the assumption that the KSA population is 16 million, 7,200,000 are children. With simple calculations, this means that we have 93,600 children with SNHL. For example 26% (24,155) children with severe to profound SNHL. Some of them need cochlear implants. Children with severe to profound SNHL, should be fitted with hearing aids for at least 6 months with speech training. Flanagan et al 1996<sup>14</sup> determined the acceptance and effectiveness of hearing aids in the management of children with persistent hearing loss. They observed that 98% of the children noticed a definite improvement in their hearing whilst using the aids. If children do not benefit from the hearing aid, they will be assessed for cochlear implant. The use of recent advancement in diagnosis and intervention techniques such as cochlear implantation would be helpful to improve the hearing status and rehabilitation of hearing impaired children, Makhdom et al 1997.<sup>15</sup> To be a

good candidate for this implant he or she should be medically, radiologically and audiological fit with psychological and social stability. Also a hearing and speech center with well trained personnel must be available. A multielectrode cochlear implant can dramatically restore or make these children have reasonably useful hearing, provided that it is inserted in the cochlea satisfactorily.

A report by Al-Shaikh et al 2000,<sup>16</sup> regarding cochlear implant in post linguallly deafened patients in KSA, concluded that patients with postmeningitic total hearing loss do not represent excellent candidates for cochlear implants. They recommended that a selection of patients with residual hearing and shorter duration of deafness with the use of modern imaging technique gave a better result in their cases.

In conclusion, the prevalence rate of severe to profound SNHL is high in our country compared to developed countries. Some areas in our country need more environmental and medical care. Health education, immunization, especially with mumps, measles and meningitis vaccines that is now compulsory should be stressed upon. Cochlear implant is a useful procedure for those with severe and profound SNHL, but hearing aids must be tried first. There is a need for more hearing and speech centers to be available for those in need of them, at least in the big cities in each province. Training of personnel to cope with this task is needed as well as parents, education and public awareness.

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