Assessment of Auditory and Psychosocial Handicap Associated with Unilateral Hearing Loss Among Indian Patients

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Abstract In order to assess psychosocial and auditory handicap in Indian patients with unilateral sensorineural hearing loss (USNHL), a prospective study was conducted on 50 adults with USNHL in the ENT Outpatient clinic of a tertiary care centre. The hearing handicap inventory for adults (HHIA) as well as speech in noise and sound localization tests were administered to patients with USNHL. An equal number of age-matched, normal controls also underwent the speech and sound localization tests. The results showed that HHIA scores ranged from 0 to 60 (mean 20.7). Most patients (84.8 %) had either mild to moderate or no handicap. Emotional subscale scores were higher than social subscale scores ($p = 0.01$). When the effect of sociodemographic factors on HHIA scores was analysed, educated individuals were found to have higher social subscale scores ($p = 0.04$). Age, sex, side and duration of hearing loss, occupation and income did not affect HHIA scores. Speech in noise and sound localization were significantly poorer in cases compared to controls ($p < 0.001$). About 75 % of patients refused a rehabilitative device. We conclude that USNHL in Indian adults does not usually produce severe handicap. When present, the handicap is more emotional than social. USNHL significantly affects sound localization and speech in noise. Yet, affected patients seldom seek a rehabilitative device.

Keywords Unilateral sensorineural hearing loss · Audiometry · Speech tests · Sound localization

Introduction

The handicap experienced by adults with bilateral sensorineural hearing loss is well known, but the consequences of unilateral sensorineural hearing loss (USNHL) is often underestimated based on the assumption that a person with normal hearing in the contralateral ear is not likely to face a major handicap. Binaural hearing is vital for sound localization, speech discrimination in a background of noise, ability to identify common sounds and ease of listening. Studies by Newman et al. [1] and Chiossoine-Kerdel et al. [2] have shown that these essential functions are impaired in patients with USNHL. The effect of USNHL may be assessed by evaluation of self perceived handicap using an appropriately designed questionnaire as well as by objective assessment of sound localization and speech discrimination.

The Hearing Handicap Inventory for Adults (HHIA), designed by Newman et al. [3] in 1990 was a modification of the Hearing Handicap Inventory for the Elderly [4]. It is a 25 item self assessment scale, containing a 13 item emotional subscale and a 12 item social or situational subscale. The HHIA specifically addresses both the auditory as well as the non-auditory aspects of USNHL such as the emotional, functional and social handicap. It has also been shown to be a reliable tool for the evaluation of outcome after rehabilitation with hearing aids [5]. It is easy to administer and interpret and has good internal consistency and high test–retest reliability.

The HHIA has been administered to patients with both unilateral and bilateral hearing loss in some studies [1, 3, 6, 7]. However, some authors [6, 7] have found this questionnaire inadequate to study the handicap faced by those patients with USNHL. Specifically, these authors have designed questionnaires which include questions that test sound localization, speech discrimination in noise and

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general hearing in daily life situations. Previous studies have shown that patients with USNHL have difficulties in both speech discrimination in the presence of background noise [1, 6, 7] and sound localization [7–10] when assessed by specific tests.

In the present study we aimed to assess the auditory, psychosocial and communication handicap experienced by adult Indian patients with moderately severe to profound USNHL using the HHIA. We also measured auditory handicap using two auditory tests, viz., the speech in noise test and the sound localization test.

Materials and Methods

Fifty consecutive patients aged 14 years and above with USNHL who presented to the outpatient section of the Department of ENT between 2006 and 2009 were included in the study. All patients had normal auditory thresholds in the unaffected ear. The mean pure tone average of 0.5–2 kHz in the affected ear was greater than or equal to 60 db. Individuals with other co-morbidities that hamper communication such as laryngeal pathology, stroke, neuromuscular disorders, mental retardation etc. and very sick or bed-ridden patients were excluded from the study.

Sample Size Calculation

Sample size was calculated based on the results of a study performed by Welsh et al. [10] who found that the mean score on speech-in-noise test among normal individuals was 86 % and that among those with USNHL was 66 % (difference between the two groups being 20 %). Assuming a clinically significant difference to be 25 % with an α error of 5 % and power of 80 % the sample size was calculated to be 46 cases and 46 controls.

Administration of HHIA

After obtaining informed consent, the HHIA was administered to all subjects with USNHL. The answers to 4 additional questions (Table 1) were also noted to obtain further information about the degree of handicap as well as the patient's perception regarding the need for any intervention.

Administration of Speech Tests

A total of 45 of the 50 subjects who had undergone HHIA testing were administered the speech-in-noise test and sound localization test. An equal number of age and sex matched controls with normal hearing in both ears were selected and pure tone audiometry, speech-in-noise and

Table 1 Additional 4 questions asked during interview of subjects with unilateral hearing loss

1. What made you seek medical advice for your hearing problem?
2. Are you willing to use a hearing aid to improve your hearing?
3. How much will you be willing to spend to find a remedy for your hearing problem?
4. What changes have you made in your life style due to the hearing problem?

sound localization tests were performed in these individuals as well.

The speech tests were administered in a sound-proof testing room as follows:

1. **Speech-In-Noise (SIN) test:**
Twenty phonetically balanced (PB) words from the PB list (in a language best understood by the subject which could be Hindi, Tamil, Malayalam, Telugu, Bengali or English), were presented via 2 speakers at 65 dB in 3 individual noise conditions using a Signal-to-Noise Ratio (SNR) of +10 dB with the signal remaining at the standard setting of 65 dB. The speech material used for the tests was a standardized set for each of the languages mentioned. Three SIN conditions were chosen, viz.

SIN I—Speech to hearing ear and noise to impaired ear.

SIN II—Speech to impaired ear and noise to hearing ear.

SIN III—Speech and noise simultaneously to both ears.

The subjects were seated with their backs to the speakers which were located one meter from the centre of the head at an angle of 135 degrees from the front of the patient in the horizontal plane. The result was expressed as a percentage of correctly identified words in each of the 3 conditions.

2. **Sound localization test:**
Pure tones were randomly delivered via 2 speakers to the hearing and impaired ear. The subject, was seated such that the speakers were located one meter from the centre of the head at an angle of 135 degrees from the front of the patient in the horizontal plane. The subject was asked to identify the side of origin of the sound. Pure tones centered around 1 kHz were presented at 90 dB for 2 s. Randomized presentations of the sound of 10 per speaker were presented. The result was expressed as a percentage of correct responses for each side.

Institutional Review Board

The study design was scrutinized and approved by the Institutional Review Board and Ethics Committee of Christian Medical College, Vellore.

Results and Analysis

Sociodemographic Profile

The socio-demographic profile of the cases is shown in Table 2. The age range of the cases was from 14 to 62 years. A little less than two-thirds of the cases were males. Exactly 50 % of the cases had unilateral hearing loss of more than 5 year's duration at presentation.

HHIA Scores

The HHIA scores in the cases ranged from 0 to 60, the mean score being 20.7. On classifying HHIA scores into no handicap (0–16), mild to moderate handicap (18–42) and severe handicap (>42) categories as described by Newman et al. [3], 54.4 % showed no handicap, 30.4 % showed mild to moderate handicap and 15.2 % showed a severe handicap. Analyzing the questions in the inventory it was found that the questions pertaining to poor hearing in noise, acceptance of the presence of a handicap and feeling of depression or of being upset received the highest scores. At least 50 % of patients expressed some handicap while in a

noisy environment. Over half the subjects admitted that they felt both handicapped and upset or depressed due to their hearing loss.

There was no influence of age, sex, education, occupation, income, side of hearing loss and duration of hearing loss on the total HHIA scores (Table 3). However, the mean emotional subscale score was significantly greater than the mean social subscale score ($p = 0.01$). Analysis of the mean emotional and social subscale scores with respect to age, sex, type of occupation, level of education, income, side of hearing loss and duration of hearing loss (Table 4), showed that the better educated (graduate/postgraduate) subjects had a significantly higher social subscale score than the less educated subjects (school/diploma) ($p = 0.04$).

Speech in Noise Test Results

The results of the speech in noise test in cases when compared with that of controls showed a significantly poorer performance among cases only in the setting where speech is presented on the side of the affected ear and noise is

Table 2 Socio-demographic data of patients with USNHL ($n = 50$)

Socio-demographic variable	Number	%
Age(years)		
<20	12	24
21–40	20	40
>40	18	36
Sex		
Males	32	64
Females	18	36
Occupation		
With frequent socialization	27	54
Without frequent socialization	23	46
Income (1 = INR 100000 per annum)		
<1	31	62
1–4	13	26
>4	6	12
Education		
School/diploma	28	56
Degree/post graduate	22	44
Side of hearing loss		
Right	28	56
Left	22	44
Duration of hearing loss (years)		
<1	12	24
1–5	13	26
>5	25	50

Table 3 Effect of sociodemographic variables, side and duration of hearing loss on total HHIA scores

Sociodemographic variable	Total HHIA scores			
	Mean	SD	Range	p
Age				
≤20	19.00	16.525	0–58	0.992
21–40	20.10	17.788	2–60	
>40	19.89	17.710	0–58	
Sex				
Male	21.75	17.537	2–60	0.134
Female	16.22	16.217	0–50	
Occupation				
Frequent socialization	22.44	18.822	0–60	0.238
Infrequent socialization	16.61	14.653	0–50	
Income (INR 100000 per annum)				
<1	20.32	17.566	0–60	0.535
1–4	20.46	16.292	2–58	
>4	15.33	18.875	0–48	
Education				
School/diploma	16.43	15.447	0–60	0.167
Degree/postgraduate	24.00	18.527	2–58	
Side				
Right	17.55	16.515	0–58	0.368
Left	21.5	17.677	2–60	
Duration(years)				
<1	19.50	13.541	4–46	0.797
1–5	19.85	15.394	2–50	
>5	19.84	19.891	0–60	

Table 4 Effect of sociodemographic variables, side and duration of hearing loss on emotional and social subscale scores

Socio-demographic variable	Emotional scale score (±SD)	<i>p</i>	Social scale score (±SD)	<i>p</i>
Age (years)				
<20	13.67 (11.34)		5.33 (5.48)	
21–40	11.40 (11.91)		8.60 (7.29)	
>40	10.33 (9.61)	.669	9.56 (8.88)	.316
Age (years)				
≤20	13.67 (11.34)		5.33 (5.48)	
>20	10.89 (10.75)	.373	9.05 (7.98)	.129
Age (years)				
≤40	12.25 (11.57)		7.37 (6.77)	
>40	10.33 (9.61)	.647	9.56 (8.88)	.493
Age (years)				
21–40	11.40 (11.91)		8.60 (7.29)	
≤20 or >40	11.67 (10.28)	.742	7.87 (7.88)	.515
Sex				
Male	12.56 (11.03)		9.12 (7.92)	
Female	9.78 (10.58)	.272	6.44 (6.81)	.208
Occupation				
Frequent socialization	13.41 (12.18)		9.04 (8.01)	
Infrequent socialization	9.39 (8.10)	.281	7.13 (7.08)	.365
Income (INR 100000 per annum)				
<1	12.39 (10.75)		7.87 (7.88)	
1–4	10.92 (10.70)		9.54 (7.17)	
>4	8.67 (13.00)	.458	6.67 (7.66)	.298
Education				
School/diploma	10.29 (10.38)		6.14 (6.18)	
Degree/postgraduate	13.18 (11.44)	.387	10.73 (8.52)	.037*
Side				
Right	9.45 (10.33)		8.00 (7.88)	
Left	13.21 (11.13)	.181	8.29 (7.48)	.744
Duration(years)				
<1	10.33 (8.90)		9.00 (7.21)	
1–5	12.00 (9.73)		7.85 (6.95)	
>5	11.92 (12.47)	.922	7.92 (8.30)	.692

* Significant

presented on the side of the normal hearing ear ($p = 0.000$) (Table 5). In the other situations, there was no significant difference between the performance of the cases and controls. Statistical analysis to ascertain the effect of age, sex, side of hearing loss and duration of hearing loss on the speech-in-noise test showed no significant difference between groups (Table 6).

Sound Localization Test Results

Individuals with USNHL were found to have a wide variation in ability to localize the source of sound (0–100 %)

Table 5 Speech in noise (SIN) cases versus controls

	SIN I (mean) (±SD)	SIN II (mean) (±SD)	SIN III (mean) (±SD)
Cases ($n = 45$)	96.78 (6.56)	79.00 (25.44)	91.89 (9.67)
Controls ($n = 45$)	96.74 (4.37)	96.63 (4.09)	93.59 (8.00)
<i>p</i>	.974	.000*	.364

* Significant

Table 6 Effect of sociodemographic variables, side and duration of hearing loss on speech in noise test (SIN) results in cases

Sociodemographic variable	SINI	SINII	SINIII
Age(years)			
<20	94.50	83.00	91.00
21–40	96.94	75.56	91.67
>40	97.94	80.29	92.65
<i>p</i>	.429	.742	.909
Sex			
Males	96.55	78.79	93.28
Females	97.19	79.38	89.38
<i>p</i>	.760	.942	.199
Side			
Right	97.00	78.00	91.25
Left	96.60	79.80	92.40
<i>p</i>	.842	.817	.697
Duration(years)			
<1	94.17	75.83	92.92
1–5	97.73	77.27	93.18
>5	97.73	81.59	90.68
<i>p</i>	.282	.800	.723
Income (INR 100000 per annum)			
<1 lakh	95.93	78.70	92.96
1–4 lakh	98.33	83.75	88.75
>4 lakh	97.50	70.83	93.33
<i>p</i>	.561	.605	.430
Education			
School/diploma	96.40	83.40	91.00
Degree/postgraduate	97.25	73.50	93.00
<i>p</i>	.672	.198	.497
Occupation			
Frequent socialization	96.36	79.77	90.68
Infrequent socialization	97.17	78.26	93.04
<i>p</i>	.685	.845	.419

with a mean score of 7.21 % (SD = 23.02). However, there was a significant difference in sound localization ability between patients with USNHL and normals (mean 99.57 %; range 90–100; SD 1.77) ($p = 0.000$).

Response to Queries Regarding Hearing Rehabilitation

All patients were explained in detail regarding the various options available currently for rehabilitation. When asked if a hearing aid or other visible fitted device would be an acceptable option for hearing rehabilitation, 72 % of the cases expressed the opinion that they would not be willing to accept this and could manage their affairs quite well without any further treatment for their problem. Most patients (82 %) had made no changes in their lifestyle on account of the handicap.

It appeared that many patients presented to the ENT department for assessment and advice on management options, particularly when associated symptoms like tinnitus and vertigo were present (30 %) but were not willing to proceed with the options presented for reducing the hearing handicap. As many of these patients were simultaneously being evaluated for the various causes of US-NHL (including vestibular schwannoma), they were happy to accept the results of a thorough evaluation and not seek specific rehabilitative measures including the use of a CROS hearing aid or bone anchored hearing aid (BAHA). Among those who were willing to consider auditory rehabilitation, the cost of the hearing device was often a limiting factor.

Discussion

In the present study, as in other previous studies [1], a wide range of scores was obtained both for the total as well as the emotional and social/situational subscales of the HHIA showing that the problem is the same in the Indian population. This result reflects the great variability in the perceived handicap of individuals with unilateral hearing deficits. Overall, it appears that the handicap experienced is mild to moderate and tolerable in everyday situations. The effect of age, sex, side, duration, income and occupation appear to be negligible.

The process of adaptation to USNHL appears to be good in that self perceived handicap is unaffected by the duration of hearing loss in most studies. Chiossoine-Kerdel et al. [2] studying patients with sudden unilateral SNHL, found no correlation between the duration of hearing loss and HHIA scores, although the authors mention that a sudden SNHL might be expected to generate higher HHIA scores than one of insidious onset. In a study of the functional impairment due to unilateral deafness on 55 individuals, Welsh et al. [10] found that contrary to the common belief that neural plasticity can reduce the impact of noise on hearing there was no improvement with time. Colleti et al. [6] studying adults who had unilateral hearing loss from childhood administered a questionnaire which covered a

range of areas (psychosocial, auditory disability, employment, hobbies etc.) and found no difference in the handicap experienced between these adults and a group of age and sex matched controls. In the present study, too, we found no correlation between the HHIA scores and the duration of hearing loss.

The HHIA as a tool for assessing self perceived handicap in patients with unilateral hearing loss may be inadequate in that it contains very few questions specific for this disorder. In studies in which HHIA was administered to adults with unilateral hearing loss, the authors have found the need to ask additional questions in order to bring out the true nature of the handicap [2, 6, 7]. Relying on the HHIA (which was essentially designed to assess hearing handicap in bilateral hearing loss) for patients with US-NHL will result in underestimation of the effect of the hearing loss on the individual.

Some authors have found that the degree of hearing handicap in USNHL is dependent on the side affected. Jensen et al. [9, 11] found that right sided unilateral deafness in children produced greater handicap than left sided deafness. They also found that right sided deafness was associated with poorer academic performance at school. They suggest that auditory deprivation of the left hemisphere may play a role. Similar findings were noted by others [12, 13]. Kimura [13] have suggested that the fact that the left cerebral hemisphere mediates speech and the right hemisphere mediates non-speech sounds might account for this phenomenon. In our study, the side affected did not influence the HHIA scores to any great degree, however.

The greater degree of handicap experienced by more educated individuals in the social domain in this study (Table 4) suggests that such individuals who have more demanding occupations where interaction with a large number of individuals occurs quite frequently in the course of their work are more affected than others. These would include those employed in banks, teaching institutions and businesses. Further, well educated individuals may presumably be more exposed to a number of multimedia devices including telephones and mobile phones and audiological equipment that demand binaural hearing for the best hearing experience.

In the present study, sound localization in the horizontal plane was uniformly affected in all patients compared to controls. Speech-in-noise with speech given on the affected side and noise on the good side resulted in significantly poorer scores among the cases compared to controls ($p = 0.000$). This finding is consistent with the results of others [6, 9–12, 14]. However, the large standard deviation in the responses in this testing condition (Table 5) suggests great inter-subject variability. Similar findings have been noted by others, albeit using other modes of testing [14].

The significantly higher emotional subscale scores in this population emphasize the need for integration of counseling and psychotherapy in the rehabilitation of these patients. Improvement in the patient's emotional status may positively affect the social aspects of the individual. A good assessment of the individual's degree of handicap will enable the surgeon to adequately counsel the patient regarding the outcomes one may expect from the treatment modalities offered like CROS hearing aids or bone-anchored hearing aids. In the present study, however, less than 25 % agreed to consider the use of a rehabilitative device. This may, in some measure, be related to the cost of these devices, as neither the government nor private insurance covers the cost of these devices currently.

Conclusion

In conclusion, USNHL among Indian patients produces mild to moderate psychosocial handicap using HHIA in about a third of patients and no handicap in a little over half the patients. Further study is required to ascertain the possible limitations of the HHIA in assessing handicap in this group of patients. Sound localization and speech in noise are significantly affected in these patients, however. Despite this, most patients do not choose to go in for any kind of rehabilitative device and present to the physician to be reassured that there is nothing sinister about their problem.

Key Messages

- Moderately severe to profound USNHL in Indian patients produces a mild to moderate psychosocial handicap in about 1/3 of patients based on the HHIA; in a little over 50 % of patients, there is no handicap
- Sound localization and speech discrimination in noise are significantly impaired in USNHL compared to normals, however
- Emotional subscale scores are higher than social subscale scores on HHIA; well educated individuals have comparatively greater handicap in the social domain
- The age, sex, side affected, duration of hearing loss, annual income or occupation have no significant effect on the HHIA
- The HHIA in its present form may be inadequate to assess the handicap due to USNHL completely; questions assessing speech in noise and sound localization should be added

- Most patients present for evaluation to be reassured that there is no sinister cause for the problem rather than for rehabilitation

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Conflict of interest The authors declare that they have no conflict of interest.

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