

OTOLOGY

Noise-induced hearing loss and hearing aids requirement

Trauma acustico cronico e protesizzazione

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SUMMARY

Subjective disturbances, due to hearing loss, are auditory disability and handicap which can be evaluated with a questionnaire. The present study refers to a population of industrial workers affected by noise-induced hearing loss. Aim of the study is to identify the minimal level of hearing loss over which the patient felt changes in his quality of life, and the average auditory threshold at which the patient considered the application of a hearing aid useful or necessary. The sample comprised 180 males with noise-induced hearing loss. Each subject received a questionnaire designed for this study. Data show a correlation between disability, handicap and the degree of noise-induced hearing loss. The most relevant problems in noise-induced hearing loss are correlated with disability rather than handicap. 35 dB can be considered as the level above which these devices can be suggested to patients. Hearing aids can become a therapeutic instrument even in the presence of a low degree of hearing loss.

KEY WORDS: Hearing loss • Noise-induced hearing loss • Hearing aids • Auditory disability • Auditory handicap

RIASSUNTO

I disturbi soggettivi dovuti ad una perdita uditiva sono rappresentati dalla disability uditiva e dall'handicap uditivo: tali disturbi possono essere valutati mediante l'uso di questionari. Il nostro studio riguarda una popolazione di lavoratori dell'industria pesante affetti da trauma acustico cronico. Obiettivo dello studio era quello di identificare il minimo livello di perdita uditiva oltre il quale il paziente avverte cambiamenti nella sua qualità di vita; veniva inoltre ricercata la soglia media a cui i soggetti ritenevano utile o necessaria l'applicazione di una protesi acustica. Il campione in esame era composto da 180 uomini affetti da trauma acustico cronico, ed a ciascun paziente è stato somministrato un questionario appositamente redatto per lo studio. I dati ricavati mostrano una correlazione tra disability, handicap ed il grado di sordità; i problemi più rilevanti nel trauma acustico cronico sono correlati maggiormente con la disability che con l'handicap. 35 dB può essere considerato il livello di soglia media oltre il quale suggerire l'applicazione di un ausilio protesico. Le protesi acustiche possono pertanto diventare uno strumento terapeutico anche in presenza di una ipoacusia di grado medio-lieve.

PAROLE CHIAVE: *Ipoacusia • Trauma acustico cronico • Protesizzazione acustica • Disability uditiva • Handicap uditivo*

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Introduction

Subjective disturbances due to hearing loss have usually come under auditory disability and auditory handicap. In the 1980 WHO classification ¹, auditory disability refers to a lack of ability to perform activities in the manner and in the range considered normal, whereas auditory handicap refers to limitations of the individual's social role ². According to this classification, disability can include the auditory problems and the individual experiences following hearing impairment, whereas handicap can comprise the non-auditory problems that result from disability or auditory impairment ³.

A more recent WHO document ⁴ has considered health condition as related to impairment, limitation in activities and restrictions in participation. In this model, the state of health is determined by three dimensions: impairment related to

body function and structure, activities and participation and this model has a principal impact on rehabilitation ^{5,6}.

Auditory disability, due to hearing loss, can be evaluated by a questionnaire ⁷ and the international literature has demonstrated the validity of this instrument ⁸⁻¹².

The relationship between hearing loss, determined by means of pure tone audiometry (PTA), and auditory discomfort has been extensively debated: some studies revealed a direct relationship between hearing loss and disability ¹³ while others did not ¹⁴. At the same level of hearing impairment, this inequality can be justified either by different perception of disability in each single patient, or by the kind of questionnaire used.

Recently, scientific studies have identified a hearing loss level over which a hearing loss, measured by means of PTA, causes a disability or a handicap (25 dB) in the patient ^{15,16}. One of the most frequent causes of sensorineural hearing

deficit in adults, in industrial countries, is noise-induced hearing loss (NIHL) ^{17,18}. Usually, NIHL affects principally frequencies between 3 and 6 KHz, causing the missed perception of some sound signals (bell, telephone, etc.) and difficulties in verbal communication, above all in a noisy environment.

Aim of this study was to evaluate problems that affect subjects presenting NIHL focusing on the need to fit a hearing aid.

Materials and methods

The study sample comprised 180 males, mean age 45 years (range 25-65) affected by NIHL.

The study group included only subjects still working in a documented noisy environment and affected by bilateral sensorineural hearing loss, more evident at frequencies between 3 and 6 kHz. In order to exclude subjects affected by presbycusis, only patients presenting an audiometric threshold above the expected-for-age ISO 1999-1990 reported median values were enrolled in the study group. Inclusion criteria also took into account the absence of other possible causes of hearing loss. All subjects in whom we simply suspected extraprofessional hearing loss or a limited collaboration to PTA were excluded.

Each subject filled in a questionnaire, specifically designed for this study (App. I) which comprised 15 items exploring everyday situations, common to all subjects and aimed to analyse problems related to hearing loss. These items were classified as emotional (items 3, 7, 8, 12, 13, 15) and social (items 1, 2, 4, 5, 6, 9, 10, 11, 14). Moreover, the questionnaire presented 10 items designed in order to evaluate the cooperation of the subjects to the test and divided into extra-auditory effects of hearing loss (1, 3, 5, 7, 9) and effects that are not expected to be related to hearing loss (2, 4, 6, 8, 10) (App. II). Finally, the questionnaire presented 5 items aimed at exploring the degree of knowledge of hearing aids as well as the need to obtain help from this device.

The items were extremely simple and direct, and the language was simple. The examiners asked the questions by reading the text, while speaking slowly but in a loud voice. The question was repeated only once, so that if the subject did not understand on the second attempt, he was excluded from the study. The possible answers were: never, rarely, at times, often, always; they were classified as 1 to 5, respectively.

PTA was carried out in a sound proof chamber, at least 16 hours after the last exposure to noise, and at a frequency ranging between 250 and 8000 Hz. The PTA threshold was referred to the average threshold at 0.5-1-2-3-4 KHz, range of frequencies that, in our previous investigations, best correlated with auditory disability (AD) and auditory handicap (AH) ¹⁵.

Results

The mean PTA threshold in the 180 subjects in this study was 30.25 dB (standard deviation (SD) \pm 5.21 dB, range 15.50-62.50 dB).

Answers to the 15 items exploring emotional and social effects of hearing loss are reported in Table I. From these results, it can be seen that major subjective disturbances, due to hearing loss, concern questions nos. 1, 2, 8, 9 and 14 (1 – watching TV and listening to the radio; 2 – understanding whispering voices; 8 – need to take a particular position; 9 – in public clubs; 14 – asking people to repeat something) with a percentage higher than 50% if “at times”, “often” and “always” answers are considered, while the events which seem to cause fewer disturbances, in our study sample, are feeling limited or insecure (question no. 12); communication problems during shopping (question no. 11 – 73%) and troubles at the cinema (question no. 10 – 72%).

The degree of social and emotional effects due to hearing loss, evaluated on the basis of the score, was correlated to hearing loss (Table II).

Only the last group (> 35 dB) showed a relevant difference in

Table I. Answers to items exploring social and emotional effects due to hearing loss in 180 subjects in the study group (* emotional, ** social effects).

Items	Never (%)	Rarely (%)	At times (%)	Often (%)	Always (%)
1) Watching TV, listening to radio**	32 (18)	20 (11)	64 (36)	34 (20)	30 (17)
2) Understanding whispering voices**	12 (7)	22 (12)	54 (30)	52 (29)	38 (21)
3) Family conversations*	78 (43)	50 (28)	38 (21)	10 (6)	2 (1)
4) Following church ceremonies**	96 (63)	16 (10)	32 (21)	8 (5)	0
5) Listening to car radio**	84 (49)	22 (13)	42 (24)	20 (12)	4 (2)
6) Visiting friends, family members**	64 (36)	32 (18)	50 (28)	28 (16)	6 (3)
7) Limited in your own life*	104 (58)	20 (11)	46 (26)	8 (4)	2 (1)
8) Take particular position*	76 (42)	8 (4)	46 (25)	36 (20)	14 (8)
9) In public clubs, barman or waiter**	52 (29)	12 (7)	74 (41)	26 (14)	4 (2)
10) At the cinema**	106 (59)	22 (12)	36 (20)	12 (7)	0
11) During shopping**	92 (51)	40 (22)	32 (18)	16 (9)	4 (2)
12) Feeling limited and insecure*	110 (62)	30 (17)	28 (15)	8 (4)	4 (2)
13) Different hearing between the 2 ears*	106 (59)	16 (9)	38 (21)	16 (9)	2 (1)
14) Ask people to repeat**	18 (10)	18 (10)	82 (45)	50 (28)	12 (7)
15) Not understanding*	108 (60)	30 (7)	30 (17)	10 (6)	2 (1)

Table II. Mean score obtained in questionnaire in relationship to hearing loss of social (A) and emotional (B). Differences are significant at Bonferroni's test ($p < 0.001$).

(A) Hearing threshold	No. patients	Score (SD)
< 20 dB	13 patients	2.1 (0.3)
21-25 dB	27 patients	2.1 (0.5)
26-30 dB	58 patients	2.3 (0.4)
31-35 dB	51 patients	2.5 (0.5)
> 35 dB	31 patients	3.0 (0.7)
(B) Hearing threshold	No. patients	Score (SD)
< 20 dB	13 patients	1.7 (0.4)
21-25 dB	27 patients	1.5 (0.5)
26-30 dB	58 patients	1.9 (0.4)
31-35 dB	51 patients	2.0 (0.5)
> 35 dB	31 patients	2.3 (0.6)

score, compared with the other four groups. This difference was statistically significant at Bonferroni's test ($p < 0.001$). Answers to the items referring to extra-auditory effects of hearing loss and to effects that cannot be attributed to hearing loss are reported in Table III. In this case, a large number of subjects did not report these symptoms (58-91% of cases).

The rate of subjects that answered "never" was higher for the items that did not explore extra-auditory effects (items 2, 6, 8, 9, 10), 86% vs. 73%. In this case, the degree of the problem was not related to the hearing threshold.

All 180 subjects examined (100%) reported having knowledge of the existence of hearing aids and of these 174 (97%) were convinced that these devices could be helpful in the presence of hearing loss. However, only 8 subjects (4%) wear one or had tried to use one before; 4 of them had a hearing threshold between 20 and 25 dB and 4 had a threshold above 35 dB.

Overall, 24 subjects (13%) stated that a hearing aid could be useful in their case; in these subjects, the PTA threshold was 35 (SD 9). On the contrary, 150 patients (84%) answered that hearing aids would not be necessary, while 6 (3%) were in doubt. Mean threshold of subjects that considered

Table IV. Answers to items referring to the idea of possible advantage in wearing hearing aid in relation to hearing threshold. ANOVA test showed significant threshold difference between subjects with or without hearing aid need ($p < 0.05$).

Hearing threshold	Yes (%)	No (%)	Uncertain (%)
< 20 dB	0	18 (100)	0
21-25 dB	4 (9)	44 (91)	0
26-30 dB	4 (11)	34 (89)	0
31-35 dB	4 (14)	22 (79)	2 (7)
> 35 dB	12 (25)	32 (67)	4 (8)
	24	150	6

a hearing aid useful in their condition was 29 dB¹⁰. The ANOVA test was used to check the association between two variables: the threshold difference between subjects with or without subjective need of a hearing aid is significant ($p < 0.05$). These results are reported in Table IV where data are related to hearing threshold.

Considering the characteristics of a hearing aid required by patients, 136 (76%) thought that the principal must be the positive effect on hearing, 36 (20%) the reliance of the device, 4 (2%) the aesthetic factor and 4 (2%) the price.

Discussion

The principal aim of the study was to determine the relationship existing between hearing loss and the need to wear a hearing aid in the presence of noise-induced hearing loss by means of a questionnaire. However, in order to establish the problems affecting the subjects and to assess their adequate collaboration to the test, we also evaluated the problem referred.

In the first part of the study, we evaluated the problems related to disability and handicap^{2,7,8}. Analysis of the data, in accordance with previous reports^{9,15,19}, clearly shows a correlation between severity of disability and handicap and the degree of hearing loss due to acoustic trauma^{13,15}. However, we found a relatively high rate of cases that did not report any symptoms, thus demonstrating that acoustic trauma does not necessarily determine subjective hearing loss^{9,15}.

Table III. Answers referring to extra-auditory items (*) and to effects not due to hearing loss (**) obtained in the 180 subjects examined.

Items	Never (%)	Rarely (%)	At times (%)	Often (%)	Always (%)
1) Headache	104 (58)	16 (9)	42 (23)	18 (10)	0
2) Itch**	142 (79)	12 (7)	18 (10)	8 (4)	0
3) Insomnia*	124 (69)	16 (9)	24 (13)	14 (8)	2 (1)
4) Visual disorders**	136 (76)	12 (7)	28 (15)	4 (2)	0
5) Palpitation*	148 (83)	2 (1)	24 (13)	6 (3)	0
6) Walking difficulties**	164 (91)	8 (5)	2 (1)	4 (2)	2 (1)
7) Hypertension *	146 (81)	6 (3)	8 (5)	2 (1)	18 (10)
8) Voice modification**	154 (87)	4 (2)	8 (4)	8 (4)	6 (3)
9) Digestive problems*	158 (88)	6 (3)	10 (6)	6 (3)	0
10) Urinary stimulus**	154 (86)	8 (4)	4 (2)	14 (8)	0

The most common problems reported were difficulty in understanding a soft voice and asking to repeat, while the problems least reported were social limitations and discomfort with other people. These conclusions fully agree with those of previous reports^{2 10 14 15} and demonstrate that the most relevant problems in NIHL are correlated with disability rather than handicap. This can become one of the worst problems, among those we have considered, since it significantly changes a person's way of life.

The high rate of subjects not reporting extra-auditory effects and, above all, of subjects not reporting effects uncorrelated to hearing loss, demonstrates the reliability of the data obtained with this questionnaire.

The second part of the questionnaire was dedicated to the relationship existing between NIHL and hearing aids. Knowledge of the existence of these devices is universal, in our sample, and almost all patients were convinced that they could be helpful, in general, in the presence of hearing loss, however the rate of subjects that have tried these devices is extremely low, 4%, and, surprisingly,

not strictly correlated with the degree of hearing loss. The degree of hearing loss is significantly higher in subjects who think that a hearing aid could be helpful. However, only 13% of the subjects examined, in this study, stated that the hearing aids could be helpful in his case, the large majority of whom had a hearing threshold below 35 dB. Therefore, this value can be considered as the level above which these devices can be suggested to patients.

Interestingly, the principal characteristic of a hearing aid, required by subjects, seems to be its efficacy while other factors, such as the aesthetic aspect or the cost, are far less relevant in their judgement.

In conclusion, the results obtained in this study suggest that hearing aids can become a therapeutic instrument even in the presence of a relatively low degree of NIHL and this is facilitated by the application of digital devices, that allow better frequencial selectivity to be obtained, which is necessary in acoustic trauma typically characterized by high frequency hearing loss²⁰.

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APPENDICES

App. 1. Questionnaire

1. In noisy environments, for hearing difficulties, happens to you?					
	1 Never	2 Rarely	3 Sometimes	4 Often	5 Always
1) Problems in watching TV or listening to radio	1	2	3	4	5
2) Problems in understanding whispered voices	1	2	3	4	5
3) Feel left out of family conversations	1	2	3	4	5
4) Problems in following church ceremonies	1	2	3	4	5
5) Problems in listening to the car radio	1	2	3	4	5
6) Hearing problems when visiting friends, family or neighbours	1	2	3	4	5
7) Feel limited in your own life	1	2	3	4	5
8) Need to find particular positions for good hearing	1	2	3	4	5
9) In public clubs, problems with barmen or waiters	1	2	3	4	5
10) At the cinema, difficulty in following film dialogues	1	2	3	4	5
11) Communication problems when shopping	1	2	3	4	5
12) Feel limited or insecure	1	2	3	4	5
13) Problems due to different hearing level between the 2 ears	1	2	3	4	5
14) Need to ask people to repeat themselves during conversation	1	2	3	4	5
15) Misunderstandings with family or friends	1	2	3	4	5
2. Which kind of physical disorder, caused by hearing loss, do you have?					
	1 Never	2 Rarely	3 Sometimes	4 Often	5 Always
1) Cephalalgia (headaches)	1	2	3	4	5
2) Itch	1	2	3	4	5
3) Insomnia	1	2	3	4	5
4) Visual disorders	1	2	3	4	5
5) Palpitation	1	2	3	4	5
6) Walking difficulties	1	2	3	4	5
7) Hypertension	1	2	3	4	5
8) Voice modification	1	2	3	4	5
9) Digestive disorders	1	2	3	4	5
10) Urinary stimulus	1	2	3	4	5
3. Do you know about the existence of acoustic devices?					
1) Yes					
2) No					
4. If yes, do you think they can help you to improve hearing?					
1) Yes					
2) No					
5. If yes, have you already tried to use one?					
1) Yes					
2) No					
6. Do you believe that an acoustic device is useful for you?					
1) Yes					

(cont.)

(Appendix cont.)

- 2) No, because
- 3) I don't know, because

7. If yes, which factors would you take into consideration if you had to use it?

Place in order of importance the following characteristics, from 1 = most important, to 5 = least important.

- 1) Hearing well
- 2) Device dependability
- 3) Aesthetic
- 4) Price
- 5) Reputation of producer

App. 2. Items e subscales

Question 1

Emotional effects (Scale E)

3. To feel left out of family conversations
7. To feel limited in your own life
8. Need to find particular positions for good hearing
12. To feel limited or insecure
13. Problems due to different hearing level between the 2 ears
15. To have misunderstandings with family or friends

Social effects (Scale S)

1. Problems watching TV or listening to radio
2. Problems in understanding whispered voices
4. Problems in following church ceremonies
5. Problems in listening to the car radio
6. Hearing problems when visiting friends, family or neighbours
9. In public clubs, problems with barmen or waiters
10. At the cinema, difficulty in following film dialogues
11. Communication problems when shopping
14. To ask people to repeat themselves during conversation

Question 2

Noise-induced extrauditory effects (Scale ER)

1. Cephalalgia (headache)
5. Palpitation
7. Hypertension
9. Digestive disorders
3. Insomnia

Not noise-induced extrauditory effects (Scale ENR-LIE)

2. Itch
4. Visual disorders
6. Walking difficulties
8. Voice modification
10. Urinary stimulus