

Cochlear Implants and Quality of Life: A Prospective Study

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Objective: To evaluate changes in quality of life, anxiety, and depression after cochlear implantation in adults.

Design: Twenty-seven postlingually deafened adults who had received a MED-EL Combi 40+ implant were investigated. One generic Health-Related Quality of Life measure, the SF-36, two disease-specific measures, the Patient Quality of Life Form (PQLF) and the Index Relative Questionnaire Form (IRQF) completed by a near relative to the patient, in addition to a domain specific measure, the Hopkins Symptom Check List 25 items (HSCL-25), were used in a prospective study. The subjects were investigated before surgery and 12 to 15 months after surgery.

Results: The scores were significantly better after surgery in four of six categories of the PQLF. In the IRQF, where a family member of the cochlear implant recipient was studied, the scores were significantly better in four of five categories. There was a significant improvement in the HSCL-25 scores after surgery. In the SF-36, only one of eight scales showed significant improvement.

Conclusions: Cochlear implants were associated with statistically significant improvement in quality of life in postlingually deafened adults. The improvements were largest in the categories concerning communication, feelings of being a burden, isolation, and relations to friends and family. The implants also improved the relatives' daily lives. There was a statistically significant reduction in degree of depression and anxiety. Reduction in anxiety and depression was associated with gain in quality of life.

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Cochlear implants give deaf and profoundly hearing-impaired persons improvement in the ability to participate more actively in a society where sound is the most important factor for communication. The audiological benefit, usually measured with sentence tests, environmental sounds, and monosyllables, is demonstrated by the enhancement in open-set word recognition after implantation (Fetterman & Domico, 2002; Hamzavi, Franz, Baumgartner, & Gstoettner, 2001; Valimaa & Sorri, 2001). The results are continuously improving with the introduc-

tion of new processor stimulating strategies (Clifton & Spelman, 2003; Kompis, Jenk, Vischer, Seifert, & Hausler, 2002; Skinner, 2003). In a recent report, the UK Cochlear Implant group found little difference in results between groups of candidates who scored zero with acoustic hearing aids before surgery and groups who scored up to 50% correct (UK Cochlear Implant Study Group, 2004a). One group did, however, have reduced effectiveness from implantation; those who benefited from acoustic hearing aids before surgery but who received implants in ears that had been profoundly deaf for more than 30 years. The same group presented a method for predicting outcome from implantation (UK Cochlear Implant Study Group, 2004c).

Clinical trials have traditionally focused on the direct effect of a treatment; in cochlear implant recipients, that means sound and speech perception. In recent years, there has been a tendency to focus also on the effect a treatment has on the patients' daily lives, when measuring benefit from different types of medical treatment (Fayers & Machin, 2000). The term health-related quality of life (HRQOL) has been introduced, and the focus on HRQOL as a method of measuring benefit from different types of medical treatment has increased. HRQOL measures are constructed to measure a more comprehensive outcome of medical interventions, with physical, social, and psychosocial domains. The term quality of life is rarely defined in published studies but often implicitly defined from a functionalistic perspective of society (Bowling, 2001). A working group under the World Health Organization, the World Health Organization Quality of Life group, has provided a definition of quality of life; "Quality of life is defined as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. It is a broad-ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, and their relationships to salient features of their environment" (WHO QOL Group, 1993).

General HRQOL measures, applicable for different patient populations and disease-specific HRQOL measures, aiming to be more clinically and socially significant in relation to specific conditions,

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have been developed (Bowling, 2001). A common recommendation is to include both generic and disease-specific measures in a study (Fletcher et al., 1992). In addition, there are domain-specific scales, measuring specific outcomes, for instance, depression and anxiety, which can be used as an evaluation of treatment outcomes (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974). Special instruments have also been developed to the overall valuation of health status expressed as a standardized figure between 0 (death) and 1 (perfect health). These instruments can be referred to as quantification of health status with fixed end points. They are often used together with cost to conduct cost utility analyses (Feeny, Furlong, Boyle, & Torrance, 1995; Rabin & de Charro, 2001; Sintonen, 2001).

The relationship between acquired deafness and psychological state has been subject to investigations in earlier and more recent reports. One study concluded that there was a relationship between hearing impairment and depression, but the relationship between hearing impairment and paranoia, abnormal personality profiles, and dementia was unclear (Jones & White, 1990). A review article showed that there was an association between acquired deafness and psychological disturbances (Thomas, 1981). The author found, however, little evidence to support the relationship between hearing loss and heightened suspiciousness or an increased likelihood of paranoid reactions.

Some authors have investigated change in psychosocial state after cochlear implant operation. In one report, a significant reduction in depression between the pre-operative and the 9-month postoperative stages was found, but not between the pre-operative and 18-month postoperative stages (Summerfield & Marshall, 1995a). They used a scale from zero to 12 and a series of 8 cartoon faces best indicating the patients' mood, to measure degree of depression. A majority of the patients fell into the normal to mildly depressed range, both before and after cochlear implantation. Improvement in quality of life 9 and 18 months after surgery was found, measured by the Quality of Life questionnaire, prospectively. They also used the Glasgow Benefit Inventory retrospectively and found significant benefit 9 and 18 months after implantation. The Glasgow Benefit Inventory is a measure developed to investigate benefit from otorhinolaryngological interventions and is not a health status measure (Robinson, Gatehouse, & Browning, 1996). In a prospective study, psychological change up to 54 months after cochlear implantation was investigated (Knutson et al., 1998). The authors found no significant differences with the Beck Depression Inventory between pre-implant and the follow-up scores. They did,

however, find significant differences in the Minnesota Multiphasic Personality Inventory, "Social Introversion" and "Paranoia" scales. In the "Depression" scale, differences were significant only at the 9- and 18-month follow-up scores. Another prospective study found significant improvement in quality of life in a group of 7 of 9 adult cochlear implant recipients. Two patients, who had surgical complications or debilitating chronic injuries, did not show the same benefit (Harris, Anderson, & Novak, 1995). Three different disease-specific inventories, the Patient Quality of Life Form (PQLF), the Index Relative Questionnaire Form (IRQF), and the Performance Inventory for Profound and Severe Loss Answer Form were used in a prospective report (Maillet, Tyler, & Jordan, 1995). Significant improvement in all three questionnaires 24 months after surgery was found. In another study, a disease-specific HRQOL instrument, the Nijmegen Cochlear Implant Questionnaire was described (Hinderink, Krabbe, & van Den Broek, 2000). The Nijmegen Cochlear Implant Questionnaire was used together with a generic HRQOL measure, the SF-36 and a multi-attribute health classifications system, the Health Utility Index-2, in a retrospective study (Krabbe, Hinderink, & van den Broek, 2000). The authors found statistically significant improvements in all 6 domains of the disease-specific instrument and in 5 of 8 of the domains of the SF-36. They also compared candidates on a waiting list for cochlear implant with the operated cochlear implant recipients; the differences were statistically significant only in 2 of 8 domains of the SF-36. A generic HRQOL measure, the Nottingham Health Profile was used in a study with 34 adult cochlear implant recipients who were compared with indexes of the age-matched average Finnish population (Karinen, Sorri, Valimaa, Huttunen, & Lopponen, 2001). The authors concluded that the Nottingham Health Profile probably was not very sensitive for measuring changes in quality of life caused by changes in senses and that specific quality-of-life measures for those with impairment in the sensory system are needed. In a recent retrospective report, Francis et al. found that 65.9% of postlingually and 50% of prelingually deafened cochlear implant recipients above 50 years reported that their quality of life was much better 1 year after cochlear implant operation (Francis, Chee, Yeagle, Cheng, & Niparko, 2002).

Open-ended questionnaires and qualitative methods have also been used in evaluating quality of life in cochlear implant recipients. In a study among better-performing cochlear implant recipients, advantages from cochlear implants were reported most frequently on psychological, lifestyle, and social effects in addition to speech perception and environ-

mental sound perception (Tyler & Kelsay, 1990). "Social connectedness" and "enhanced ability to communicate" were described as the major outcomes of the interviews in a qualitative study (Hogan, 1997). In an investigation of cochlear implant candidates by an open-ended questionnaire, 45% of the complaints came in the "psychosocial" category (Zhao, Stephens, Sim, & Meredith, 1997).

Several reports have been published concerning cost-effectiveness among adult cochlear implant recipients (Carter & Hailey, 1999; Evans, Seeger, & Lehnhardt, 1995; Francis et al., 2002; Harris et al., 1995; Palmer, Niparko, Wyatt, Rothman, & de Lissovoy, 1999; Wyatt, Niparko, Rothman, & de Lissovoy, 1996). In a meta-analysis, reasonable cost-utility ratios were found; the treatment is cost-effective compared with health interventions commonly covered by third-party payers in the United States (Cheng & Niparko, 1999). In a recent report by the UK Cochlear Implant Study Group, the cost-effectiveness was found reasonable in a majority of the patients, including those above 70 years of age. Relaxations of the criteria for cochlear implant in terms of operating patients with less profound hearing losses led to reduction in cost-effectiveness (UK Cochlear Implant Study Group, 2004b).

The results from the literature show that cochlear implants have a positive impact on quality of life among profoundly deaf adults. When reading the existing literature, we found that many of the previous studies had weaknesses related to instruments and study designs. Some reports had very limited number of patients, others were retrospective, and few reports had included generic, disease-specific, and domain-specific instruments. A variety of different methods had been used to measure quality of life. We knew from the existing literature that improvement in hearing and communication by cochlear implantation improved the quality of life to deaf adults. We wanted to get more detailed information about which aspects of the patients' lives the improvements were most pronounced. Based on previous studies, we expected to find associations between quality-of-life changes and improvement in psychological state (Knutson et al., 1998; Summerfield & Marshall, 1995a). We therefore decided to perform a prospective study in which disease-specific, generic, and domain-specific inventories were included.

METHODS

Twenty-nine postlingually deafened adult cochlear implant candidates were asked to participate in a prospective study concerning change in quality of life after cochlear implantation. A questionnaire

TABLE 1. Causes of deafness

Causes	<i>n</i>	%
Unknown/progressive	14	52
Hereditary	4	15
Otosclerosis	3	11
Meningitis	2	7
Meniere disease	2	7
Trauma	1	4
Rubella	1	4

n = 27.

was sent to the patients by mail, completed at home, and returned by mail. Data were obtained before surgery and 12 to 15 months after surgery. Twenty-seven of 29 (93%) responded. All had received a MED-El Combi 40+ implant. There were 15 women and 12 men; mean age was 57.6 years (SD, 14.5; range, 28 to 82 years). Mean duration of deafness before surgery was 8.5 years (SD, 10.3; range, 0 to 37 years). Causes of deafness are shown in Table 1.

Three different instruments were used; the first consists of two different parts.

The PQLF and the IRQF were both developed at the House Ear Institute, Los Angeles. The PQLF is a disease-specific HRQOL instrument, containing 43 questions concerning the patients' coping with their hearing loss, adaptation to the implant, and emotional alterations since implantation (Crary, Wexler, Berliner, & Miller, 1982; Wexler, Miller, Berliner, & Crary, 1982). The last 5 questions, dealing with adaptation to the implant, were not included in this study; they are not appropriate in a pre-postparadigm (Maillet et al., 1995). The subjects were asked to mark the most appropriate answer, using a scale from 1 to 5, where a low score may represent either a positive or negative response, depending on the question. For scoring management, the most positive response received the higher score. The questionnaire has been validated, showed reasonable reliability, and was divided into subcategories by factor analysis (Mo, Harris, & Lindbæk, 2004). Examples of questions in the different subcategories are given in Table 2. A near relative of the patient completed the IRQF. It contains 31 questions regarding the relative's experience with the patient as hearing impaired, the effect of the handicap on their daily activities, and the patient's adaptation to the implant (Crary et al., 1982; Wexler et al., 1982). The last 8 questions were dealing with the patient's adaptation to the implant and were not used in this study (Maillet et al., 1995). Again, a scale from 1 to 5 was used to answer the questions, and for scoring management the most positive result received the highest score. The questionnaire has been validated, showed reasonable reliability, and

TABLE 2. Examples of items in subcategories of the PQLF and the IRQF

	Example of item
PQLF category	
Relations to close individuals	How would you evaluate the quality of the relationship with the individual closest to you?
How communication and hearing affects life	How difficult is it for you to communicate?
Work	How satisfying is your employment?
Hobbies	To what extent are you involved in hobbies and/or recreational activities?
Isolation and relation to friends	How isolated do you feel as a result of deafness?
Feelings of being a burden and belonging	How much of a burden do you feel you are to your family and the individual closest to you?
IRQF category	
Feelings for patient	How comfortable are you when with the patient at home?
How hearing loss affects life	How often do you feel upset due to the patient's deafness?
Communication	How frustrating do you find communicating with the patient?
Hobbies and activities	About how many social situations do you and the patient attend per month?
Safety and welfare	To what degree are you concerned about the safety and welfare of the patient because of his/her deafness?

has been divided into subcategories by factor analysis (Mo et al., 2004). Examples of questions in the different subcategories are given in Table 2.

The Short Form 36 (SF-36) is a generic HRQOL instrument. There are eight domains, focusing on different HRQOL aspects, except for one domain that is an overall evaluation of HRQOL. The responses to the questions on each scale were summed according to the manual to provide 8 scores between 0 and 100, where a higher score means a better result. The SF-36 has been used in a variety of conditions and has been validated and reliability tested (Ware, Snow, & Kosinski, 2000).

The Hopkins Symptom Check List (HSCL) as presented by Derogatis et al. (1974) had been developed over many years. It is a self-report, psychological inventory with 58 items, scoring on 5 underlying dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, anxiety, and depression. The HSCL-25 has been developed from the original HSCL and has shown high agreement with physicians' rating of emotional distress and has been considered a good indicator of emotional distress (Winokur, Winokur, Rickels, & Cox, 1984). The HSCL-25 contains 25 questions concerning the presence and intensity of depression and anxiety symptoms over the previous week (Sandanger et al., 1998). The scores were counted on a scale from 1 (not bothered) to 4 (extremely bothered). To be counted as a valid HSCL-25 score, at least 13 out of 25 items had to be completed. It has been used in a variety of populations, including the Norwegian, and has been validated and reliability tested. A score >1.75 has been defined as a "psychiatric case"; a score above 1.75 has been used as a screening procedure to identify persons with mental health problems but is not a diagnostic tool (Sandanger, Nygard, Ingebrigtsen, Sorensen, & Dalgard, 1999). The HSCL-25 scores were divided into anxiety and depression item subgroups (Winokur et al., 1984).

The statistical package SPSS 11.0 was used for data analysis. The differences were considered statistically significant at a value of $p < 0.05$. The comparison between the pre- and postoperative data was performed using paired samples *t*-tests. We also performed a nonparametric test (Wilcoxon), and the results were comparable. Bonferroni corrections were used. A linear regression analysis was performed to find factors contributing to change in PQLF score. Postoperative PQLF score was used as the dependent variable, and the analysis was corrected for the corresponding preoperative score. Sex, age, duration of deafness, postoperative speech perception score, and difference between pre- and postoperative HSCL-25 score were used as independent variables.

Speech perception scores among the users of cochlear implants had been obtained using Iowa sentences adapted to Norwegian (Teig, Lindeman, Tvete, Hanche-Olsen, & Rasmussen, 1993). The tests were administered under quiet conditions at 65 dBA SPL presentation levels. The responses were calculated as the percentage of correct words in sentences. Informed consent was obtained from the participants, and the Regional Ethical Committee approved the study.

We considered the differences clinically relevant when statistically significant, due to the relatively small number of patients.

RESULTS

In the PQLF, the differences were statistically significant, with Bonferroni correction in all categories except "hobbies" and "work" (Table 3). The improvement was largest in the category "how communication and hearing affects life," where 25 patients improved and 2 scored worse after surgery. The improvement in the category "feelings of being a burden and belonging" was also large; 21 patients

TABLE 3. Mean PQLF score before and after surgery

	Preop mean (SD)	Postop mean (SD)	Diff mean (SD)	<i>p</i> value
Relations to close individuals	4.06 (0.70)	4.35 (0.67)	0.29 (0.44)	0.01*
How communication and hearing affects life	2.60 (0.67)	3.53 (0.60)	0.93 (0.64)	0.01*
Work	3.00 (1.02)	3.60 (0.78)	0.58 (1.14)	NS* (0,08)
Hobbies	2.44 (0.73)	2.58 (0.75)	0.14 (0.66)	NS*
Isolation and relation to friends	2.72 (0.66)	3.32 (0.58)	0.60 (0.64)	0.01*
Feelings of being a burden and belonging	2.95 (0.83)	3.82 (0.69)	0.87 (0.90)	0.01*
Total	2.94 (0.54)	3.56 (0.44)	0.62 (0.47)	<0.01

p value: Paired-samples *t* test; 38 items, *n* = 27.

* With Bonferroni correction.

improved, 3 were unchanged, and 3 worse. In the category "isolation and relation to friends," the difference was moderate. Twenty-two improved, 1 was unchanged, and 4 scored worse after surgery. In the category "relations to close individuals," the difference was smaller but still statistically significant. Sixteen patients improved after surgery, 4 were unchanged, and 7 scored worse. In the categories "work" and "hobbies," the differences were not statistically significant; 18 and 13 improved, 5 were unchanged in both categories, and 4 and 9 became worse after surgery.

The scores in the IRQF showed statistically significant differences with Bonferroni correction in all the categories except "safety and welfare" (Table 4). Three "index relatives" did not complete this questionnaire. In the 4 categories with statistically significant changes, from 14 to 18 relatives scored better in the categories after surgery; between 2 and 7 scored worse.

In the SF-36 there was a statistically significant difference between pre- and postimplant scores in the scale "general health," in the other scales the differences were not statistically significant (Table 5).

The results in the HSCL-25 showed statistically significant differences between pre-implant scores and scores 12 months after implant; there was a significant reduction in degree of anxiety and depression (Table 6). Six of the patients (22%) had an HSCL-25 score >1.75 before surgery and 5 (19%) after surgery. Nineteen patients had better and six had worse HSCL-25 score after surgery. In two patients, the score was unchanged. The differences in the anxiety and depression subcategories were not statistically significant with Bonferroni correction.

In the linear regression analysis we found that change in HSCL-25 score was statistically significantly associated with postoperative PQLF score when adjusted for the corresponding preoperative PQLF score, both in the bivariate and multivariate

TABLE 4. Mean IRQF scores before and after surgery

	Preop mean (SD)	Postop (SD) mean (SD)	Diff mean (SD)	<i>p</i> value
Feelings for patient	4.22 (0.55)	4.49 (0.54)	0.27 (0.35)	0.01*
How hearing loss affects life	3.21 (0.57)	3.58 (0.56)	0.37 (0.58)	0.02*
Communication	3.66 (0.78)	4.22 (0.73)	0.56 (0.74)	0.01*
Hobbies and activities	2.45 (0.74)	2.81 (0.78)	0.36 (0.56)	0.02*
Safety and welfare	2.42 (0.86)	2.73 (1.01)	0.31 (0.88)	NS*
Total	3.35 (0.41)	3.72 (0.44)	0.37 (0.39)	<0.01

p value: Paired-samples *t* test; 23 items, *n* = 24.

* With Bonferroni correction.

TABLE 5. Mean SF-36 scores before and after surgery

Scales	Preop mean (SD)	Postop mean (SD)	Diff mean (SD)	<i>p</i> value
Physical functioning	80.8 (18.7)	81.9 (23.8)	1.0 (15.0)	0.74
Social functioning	73.1 (26.1)	78.2 (32.3)	5.1 (31.1)	0.40
Role-physical	71.0 (40.0)	80.0 (35.4)	9.0 (40.1)	0.27
Role-emotional	78.7 (34.5)	85.3 (30.6)	6.7 (41.9)	0.44
Bodily pain	75.1 (26.8)	81.0 (24.1)	5.9 (23.4)	0.20
Mental health	76.2 (18.2)	79.7 (21.2)	3.5 (23.3)	0.45
Vitality	58.8 (21.8)	66.2 (20.7)	5.9 (26.8)	0.17
General health	72.6 (21.6)	79.8 (21.4)	7.2 (14.5)	0.02

n = 27.

TABLE 6. Mean HSCL-25 score before and after surgery

	Preop (SD)	Postop (SD)	Diff (SD)	<i>p</i> value
HSCL-25 Anxiety	1.40 (0.37)	1.30 (0.27)	-0.10 (0.25)	0.08*
HSCL-25 Depression	1.62 (0.49)	1.44 (0.42)	-0.19 (0.46)	0.09*
HSCL-25 Total	1.53 (0.41)	1.38 (0.33)	-0.15 (0.35)	0.03

p value: Paired-samples *t* test, *n* = 27.

* With Bonferroni correction.

model. Duration of deafness before surgery, age, sex, and postoperative sentence test score did not show statistically significant association with postoperative PQLF score (Table 7). A difference between pre- and postoperative HSCL-25 score of 0.777 was associated with a difference in postoperative PQLF score of 1.

DISCUSSION

Our results show that the cochlear implant recipients after surgery achieved statistically significant improvements in the ability to communicate, were less isolated, had less feeling of being a burden, and had better relations with their nearest and friends compared with before surgery. These are important aspects of quality of life after the definition by WHO, where "...physical health, psychological state, level of independence, social relationships, and their relationships to salient features of their environment" are mentioned as important factors (WHO QOL Group, 1993). In a newly published qualitative study of 17 adult cochlear implant recipients, the core category for the patients interweaved was "coming back to life" (Hallberg & Ringdahl, 2004). It is obvious that the improved communication by having a cochlear implant has a broad effect on the patients' daily lives. Another qualitative study found that cochlear implant recipients described improvement in interpersonal communication skills and social confidence as the most important outcomes (Hogan, 1997). In the report by Maillet et al. (1995) in which the PQLF and the IRQF were used, the scores were

calculated as a sum score of all the questions. In this way, information is lost about which particular aspects of the patients' lives were most improved. Hinderink et al. (2000) have developed a disease-specific HRQOL instrument that has been used in a retrospective report by Krabbe et al. (2000). In addition, they used a generic measure, the SF-36. The cochlear implant recipients were also compared with deaf candidates on the waiting list for implantation. They found statistically significant differences in all six domains of the specific instrument and in five of eight of the domains of the SF-36 in the retrospective study. The differences between the candidates on waiting list and the cochlear implant recipients were, however, statistically significant only in two of eight scales of the SF-36. Generic HRQOL measures are intended to cover a wide range of conditions. We found statistically significant differences in only one of eight domains of the SF-36, and we conclude that the generic HRQOL measure SF-36 probably is not suitable to detect change in quality of life in cochlear implant recipients.

We found statistically significant reduction in degree of depression and anxiety. Six patients had scores indicating a "psychiatric case" before surgery and five after surgery. The majority had no or mild psychiatric disturbances (Sandanger et al., 1999). The subgrouping shows that the improvement was largest in the depression category. This is a very interesting result; it is known from the literature that there is a connection between acquired hearing loss and psychological disturbances (Jones & White, 1990; Thomas, 1981). The association we found

TABLE 7. Linear regression analysis

Independent variable	Cases/ <i>n</i>	β Unadjusted (95% CI)	β Adjusted		
			<i>p</i> value	(95% CI)	<i>p</i> value
Sex					
Female*	15/27	0.024 (-0.279-0.327)	0.87	0.033 (-0.261-0.327)	0.82
Age		0.003 (-0.007-0.014)	0.51	0.007 (-0.01-0.02)	0.25
HSCL-25 difference		0.434 (0.15-0.853)	0.04	0.777 (0.278-1.275)	<0.01
Sentence test (0-100)		0.003 (-0.002-0.009)	0.26	-0.001 (-0.008-0.006)	0.77
Duration of deafness		-0.009 (-0.024-0.007)	0.26	-0.010 (-0.033-0.013)	0.39
Preoperative PQLF score				0.570 (0.291-0.848)	<0.01

Dependent variable: Postoperative PQLF score, the analysis is corrected for the corresponding preoperative score both in the adjusted and the unadjusted models.

Unadjusted = bivariate; adjusted = multivariate.

* Male = reference category; $R^2 = 0.44$.

between reduction in depression and anxiety and improvement in quality of life strongly suggests that psychosocial difficulties and emotional status are important factors for change in quality of life among these patients, which is also illustrated by the large impact in the regression analysis.

Duration of deafness, sentence test results, age, and sex did not show significant association with change in quality of life. Maillet et al. (1995) found significant correlation between duration of deafness and quality of life; they did not, however, find a significant correlation between speech perception scores and quality of life. Knutson et al. (1998) did not find significant correlations between degree of depression and audiological benefit. A possible explanation to the lack of correlation between speech perception scores and improvement in quality of life might be the fact that some of those patients with low scores on speech perception tests might have had a more severe deafness before surgery. Residual hearing has been found to be one of the most important factors for a good result in terms of speech perception (Gomaa, Rubinstein, Lowder, Tyler, & Gantz, 2003; Summerfield & Marshall, 1995b; van Dijk et al., 1999). For a profoundly deaf patient, even a relatively poor postoperative hearing performance might give the same improvement in quality of life as a better result in a patient with less profound preoperative deafness.

When measuring changes in psychological state and quality of life from medical treatments, there will always be a possibility that one is measuring changes resulting from the feeling of being taken care of, instead of changes resulting from a specific treatment. For high technology and expensive treatments such as cochlear implantation, this is especially important to bear in mind. This uncertainty is much greater in retrospective reports, where recall bias is an additional problem. The ideal study would be a double-blinded, randomized trial with two or more alternative treatments. This is not possible to perform, as cochlear implantation is vastly superior to all other treatments in postlingually deafened adults. When we compare the pre-implant scores of the PQLF in this material with the scores of the not-operated cochlear implant candidates in our previous report (Mo et al., 2004), we find that the results are comparable in all categories. The postoperative results in this study are also at the same level as the cochlear implant recipients in the previous report. The cochlear implant recipients in the previous study had been using their implant for from 8 months to 14.5 years (mean, 6.3 years). This strongly suggests that the improvement in quality of life is lasting and not only a result of feeling taken care of. This is also an important finding regarding

the validity and the reliability of the questionnaire. The mean HSCL-25 score among the cochlear implant recipients in the previous report was 1.39, slightly above the postoperative score in this study.

A replication study after 24 to 36 months of cochlear implant use would be interesting. Previous studies have shown that improvements in psychological state after cochlear implantation have been reduced from 12 to 36 months after surgery (Knutson et al., 1998). There is still some uncertainty about the duration of improvement in QOL more than 12 months after surgery in cochlear implant recipients. We recommend a follow-up period of 24 months or more to investigate if the changes in QOL or psychological state are lasting.

People close to a deaf or profoundly hearing-impaired person must learn to cope with a range of issues in their daily lives because of the communication difficulties related to deafness. The benefit from cochlear implant to the relatives' lives is an important question, which has not been subject to many previous reports. Maillet et al. (1995) used the IRQF in a prospective report and found significant improvement in the scores after surgery, but they had not divided the questions into different categories, so an interpretation of the results is difficult. Our results, in which the postimplant scores were significantly higher than the pre-implant scores in all categories of the IRQF except "safety and welfare," give important indications of the impact cochlear implantation has on the relatives' daily lives. The statistically significant improvements in the categories "how hearing loss affects life," "communication," "hobbies and activities," and "feelings for the patient" show that people near to the cochlear implant recipients benefit substantially from the patients' improvement in hearing and communication. The effect on the daily lives of the nearest to the cochlear implant recipients is in our opinion an important factor in the evaluation of both cochlear implant candidates and the outcome after cochlear implant operations.

Improvement in hearing after cochlear implant operation gave statistically significant improvement in quality of life to postlingually deaf adults and to the "index relative," when evaluated with disease specific questionnaires. We also found statistically significant reduction in anxiety and depression 12 to 15 months after implantation. There was statistically significant difference in only one scale of the generic HRQOL instrument SF-36. There was a statistically significant association between reduction in depression and anxiety and improvement in quality of life. Duration of deafness and audiological benefit did not show significant association with change in quality of life. The improvements in qual-

ity of life seemed to be closely related to reduction of depression and anxiety, leading to less isolation. The patients may feel that they are less of a burden in their social environment and that they have improved relations with their friends and family. For further QOL investigations, we recommend including a measure of psychological change in addition to one or more disease-specific instruments; we do not think the generic measure SF-36 is sensitive enough in this patient category.

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