Cochlear Implantation Has a Positive Influence on Quality of Life, Tinnitus, and Psychological Comorbidity

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Objectives: To determine the effect of cochlear implantation (CI) on health-related quality of life (HRQoL), tinnitus, and psychological comorbidity in patients with severe to profound postlingual hearing loss and to analyze the relationship between these parameters.

Study Design: Prospective study.

Methods: Using six validated questionnaires, we evaluated the pre-CI and post-CI scores of HRQoL, tinnitus, perceived stress, symptoms of depression and anxiety, and coping strategies in 43 patients implanted unilaterally with a multichannel implant for at least 6 months.

Results: In addition to improvements in hearing, speech understanding, and disease-specific HRQoL, psychological comorbidity was reduced and coping strategies were improved following CI. In the 39 tinnitus patients, their tinnitus was reduced. We found negative correlations between HRQoL and stress, depression, and anxiety. Pre-CI, tinnitus severity did not correlate with HRQoL and psychological comorbidity. However, patients with a high-level tinnitus had lower HRQoL as well as a higher level of perceived stress and anxiety symptoms than patients with a low-level tinnitus and no/incidental tinnitus before CI. Moreover, patients with severe hearing loss had a higher level of perceived symptoms of stress and depression than patients with profound hearing loss before CI.

Conclusions: The present study provides evidence that tinnitus and psychological comorbidity may play an important role in the rehabilitation of CI patients, and that there is a correlation between HRQoL and these parameters. In addition to hearing tests, tinnitus, stress, and psychological comorbidity should be assessed using validated questionnaires before and after CI. This will help to improve the rehabilitation process.

Key Words: Cochlear implant, health-related quality of life, tinnitus, psychological comorbidity.

Level of Evidence: 2b.

INTRODUCTION

In recent years, improved implants and new and/or improved methods of surgery led to a broadening of indication criteria for cochlear implant treatment. This applies, for instance, to treatment at an advanced age as well as implant indications in patients with residual hearing. Therefore, studies investigating the effect of cochlear implantation (CI) not only on hearing and speech understanding but also on the patients’ health-related quality of life (HRQoL), tinnitus, and psychological comorbidity as well as on the relationship between these parameters will help assess the complex success of treatment following CI therapy and enable a better overall evaluation and comparison of the outcome.

Some authors who have investigated the effect of CI on patients’ daily lives and their psychological well-being have found that not only hearing and speech production but also HRQoL and psychological well-being improved.1–4 A recent prospective study has demonstrated that supplying postlingually deafened adults with a cochlear implant is associated with an improvement in the quality of life and a reduction in the degree of depression and anxiety.3

Some patients with hearing loss also suffer from tinnitus. The prevalence of tinnitus is even higher in profoundly hearing-impaired patients and reaches 67% to 100% in CI candidates.5,6

Tinnitus-related distress is also associated with psychological comorbidity such as stress, depression, and anxiety.7–9 Interestingly, current literature reports a marked suppressive effect of CI on tinnitus in most cochlear implant users (for review, see Baguley and Atlas10 and Quaranta et al.11). Andersson et al.8 using validated questionnaires, have retrospectively examined cochlear implant users, who reported tinnitus post-CI. The study has shown that in 24.5% of the patients, tinnitus was related to hearing problems, anxiety, and depression following implantation. However, no pre-CI or disease-specific HRQoL data were given. To our best
knowledge, the association between HRQoL, tinnitus severity, and psychological comorbidity in patients before and after CI has not yet been studied.

The aim of our study was to evaluate the effect of CI on HRQoL, tinnitus, psychological comorbidity, and coping strategies in patients with severe to profound postlingual hearing loss. In addition, we aimed to characterize the association between HRQoL and psychological comorbidity and coping strategies and between tinnitus impairment and the parameters measured in the situation before and after CI using validated questionnaires. Moreover, we compared the following groups in relation to the above parameters: 1) patients with high-level tinnitus, low-level tinnitus, and with no or incidental tinnitus; and 2) patients with severe and profound hearing loss.

SUBJECTS AND METHODS

Fifty-eight postlingually deafened adults were recruited from a group of 230 patients who were implanted unilaterally with a multichannel cochlear implant for at least 6 months. The study was conducted at the ENT Department of the Charité Hospital over a period of 2 years (2007–2009). Criteria for inclusion were: speech perception of ≤40% using the Freiburg monosyllable test in quiet (65 dB SPL) with a fitted hearing aid. The study was approved by the local Ethics Committee.

A total of 43 patients (74%; 12 males, 31 females) completed the questionnaires before and after CI. The mean age in this group at the time of implantation was 51.7 ± 16.9 years (range: 19–77). The mean duration of deafness before implantation was 12.9 ± 15.5 years (range: 0.4–70 years). Regarding the pathogenesis of deafness, there were 17 patients with progressive hearing loss, 6 patients each with sudden hearing loss and meningitis, respectively, and 4 patients with otosclerosis. One patient each had Menière’s disease, Usher’s syndrome, trauma, noise trauma, and Cogan’s syndrome. In three of the patients, the reason for deafness was unknown. In order to analyze the influence of the etiopathology on HRQoL, tinnitus, and psychological comorbidity, the patients were grouped into five diagnosis groups: progressive hearing loss, sudden hearing loss, meningitis, otosclerosis, and others. Neither patient’s age nor the duration of deafness differed between these groups. The mean time after CI when the patients completed the questionnaire was 14.8 ± 3.2 months (range: 9–24). All patients received a multichannel implant. The most commonly used type was the Nucleus Freedom (n = 25), followed by Sonata (n = 17) and Pulsar (n = 1). The following six questionnaires were used to obtain information on HRQoL, tinnitus, and psychological comorbidity.

Nijmegen Cochlear Implant Questionnaire (NCIQ)

The NCIQ is a disease-specific questionnaire measuring HRQoL, which was recently designed and validated. The NCIQ was translated into a German version by native German and English speakers using forward–backward translation. The NCIQ covers three general domains with six specified subdomains: physical domain (NCIQ1, basic sound perception; NCIQ2, advanced sound perception; NCIQ3, speech production), psychological domain (NCIQ4, self-esteem), and social domain (NCIQ5, activity limitations; NCIQ6, social interactions). Each subdomain comprises 10 items, each formulated as a statement with a five-point response scale ranging from “never” to “always” (55 statements) or from “no” to “good” (5 statements). If a statement does not apply to a patient, a sixth answer can be given: “not applicable.” Scores range from 0 (very poor) to 100 (optimal). Since its validation, the NCIQ has been used as a standard test to evaluate HRQoL in patients with cochlear implants or hearing aids.

Tinnitus Questionnaire (TQ)

The TQ evaluates tinnitus at four severity levels according to the TQ total score: low (1–30), moderate (31–46), severe (47–59), and very severe (60–84). A total of 52 items are used to assess specific fields of tinnitus-related distress by means of subscales labeled: emotional distress (Em), cognitive distress (Co), intrusiveness (Inti), auditory perceptual difficulties (Aku), sleep disturbances (Sl), and somatic complaints (Som). Tinnitus is considered to be “compensated” at a TQ level of ≤46 (no secondary symptoms) and “decompensated” at a TQ level of ≥47 (permanent annoyance and psychological strain; accompanied by complaints like depression, anxiety, impaired sleep, and concentration). The TQ has been sufficiently evaluated and in Germany, it is regarded as the method of choice to determine the severity level of tinnitus. The split-half reliability is 0.94.

Perceived Stress Questionnaire (PSQ)

To register the stress perceived by the patients, we used the PSQ. It comprises 30 items, which allow a subdivision into four subscales: worries, tension, joy, and demands. The subscale “joy” was recoded in the total score. According to Kocalevent et al., the cut-off score for a low level of perceived stress is 0.45 using the PSQ-30. The split-half reliability is in the range of 0.80–0.88.

Brief COPE

Coping strategies were evaluated using the German version of the Brief COPE, which is an abbreviated form of the COPE inventory. It measures coping behavior in difficult or unpleasant situations. The COPE consists of 14 scales, each represented by two items. The 28 items are summarized in four scales: focus on positive coping (positive reframing, humor, acceptance), active coping (active coping and planning), seeking support (instrumental and emotional support, religion), and evasive coping (denial, self-blame, venting). The values ranged from 1 (not at all) to 4 (very much). Internal consistencies were within an acceptable range (Cronbach’s α = 0.61–0.81).

General Depression Scale

Depression can be a primary disorder or a comorbid disorder. A hearing handicap and chronic tinnitus may be associated with depressive symptoms such as anxiety or emotions such as helplessness. For our study, we chose the full version of the general depression scale (ADS) by Hautzinger and Bailer, which includes 20 items. The total score of all answers ranges between 0 and 60 and indicates the depressive pathology at a given moment. Increased ADS scores (≥23) point to a depressive disorder.

Generalized Anxiety Disorder (GAD-7)

The GAD-7, which was designed as an instrument for screening generalized anxiety disorders and assessing their severity, has high reliability and validity in clinical practice and research. The seven-item scale asks the patients if, and how often, during the 2 weeks prior to examination, they were bothered by the seven core symptoms of generalized anxiety disorder. Response options are “not at all,” “several days,” “more...
than half the days," and "nearly every day," scored as 0, 1, 2, and 3, respectively. The total score ranges between 0 and 21 with the GAD-7 score ranges of 5–9, 10–14, and 15–21, representing mild, moderate, and severe anxiety symptom levels. These cut points were chosen based on receiver operating characteristic analyses in the GAD-7 primary care validation study.18

**Auditory Performance**

The speech perception of all 43 patients who completed the questionnaires was measured using the Freiburg monosyllable test in quiet (65 dB SPL) with a hearing aid before implantation. After implantation, the Freiburg monosyllable test in quiet (65 dB SPL) and the HSM sentence test (70 dB SPL) in noise (signal-to-noise ratio = 15 dB) were used.

**Statistical Analysis**

Changes in the patients’ scores were tested for significance using the nonparametric Wilcoxon matched pairs test because the data could not be adapted to normal distribution (Kolmogorov-Smirnov test). The number of patients with a higher or lower severity level of tinnitus or comorbidity before and after CI was compared using the chi-square test for frequency data. Correlation analyses were made using Spearman’s rank correlation. The scores of the subgroups were compared using the Mann-Whitney U test. Significance was set at \( P < 0.05 \). The results were shown as mean ± standard deviation in the text. The graphics show the mean ± standard error of the mean. Statistical analysis and graphics were made using Statistica 7.1 (StatSoft).

**RESULTS**

**HRQoL Improves after Cochlear Implantation**

Cochlear implantation resulted in a statistically significant increase in disease-specific HRQoL, as measured by the NCIQ. The mean total score of the CI candidates was 39.3 ± 15.1 and this increased to 60.3 ± 13.1 post-CI (\( P < .0001 \)). There were also highly significant improvements in all six subdomains of the NCIQ, with basic sound perception (NCIQ1) being most improved by 38 points (Fig. 1).

We did not find any correlation between duration of deafness or patients’ age and the NCIQ scores.

**Changes in Auditory Performance after Cochlear Implantation**

Before CI, the patients’ speech perception was 4.0 ± 10.1% according to the Freiburg monosyllable test in quiet (65 dB SPL) with a hearing aid. After CI, speech understanding was 48.1 ± 25.1% (\( P < .0001 \)) according to the Freiburg monosyllable test in quiet (65 dB SPL). According to the HSM sentence test in noise, the patients reached 47.4 ± 32.3% after CI (70 dB SPL, signal-to-noise ratio = 15 dB).

There was a negative correlation between duration of deafness and auditory performance after CI (monosyllable test: \( r = -0.42, P < .01 \); sentence test: \( r = -0.35, P < .05 \)), but not between age and auditory performance.

Thirty-six of the CI candidates had 0% speech perception (profound hearing loss) and 7 CI candidates had 10% to 40% (24.3 ± 11.0%) speech perception according to the Freiburg monosyllable test in quiet with hearing aid (severe hearing loss). Following CI, the patients with profound hearing loss had 46.3 ± 25.5% and 43.7 ± 33.9% speech perception as measured by the Freiburg monosyllable test and HSM sentence test, respectively.

In the seven patients with severe hearing loss, the values were 57.1% ± 22.5% (\( P < .05 \) vs. before CI) and 65.9% ± 12.4%, respectively, but they did not differ significantly from the group with profound hearing loss.

**Decrease of Tinnitus-Related Distress after Cochlear Implantation**

Thirty-nine of the 43 CI patients (90.7%) reported tinnitus before implantation, whereas four patients did not. The mean total score of the TQ in patients with tinnitus was 30.9 ± 18.8 before CI, decreasing to 23.6 ± 15.8 after CI (\( P < .01 \)). Of the six TQ subscales, the four scales Em, Co, InTi, and Sl were found to be significantly reduced following CI, with the subscale Co undergoing the greatest degree of change (Fig. 2).

The initial number of patients with high-level tinnitus (TQ score ≥47) decreased from 9 to 5 following surgery. Accordingly, the number of patients with low-level tinnitus (TQ score <47) increased from 30 to 34 (chi-square test, not significant). Tinnitus had decreased in 22 patients, 3 patients reported disappearance of tinnitus, and 14 patients did not report any changes in their tinnitus. In the four patients who were tinnitus-free before surgery, CI did not induce tinnitus.

Tinnitus severity did not correlate with duration of deafness or patients’ age.

**Decrease in Psychological Comorbidity following CI**

Perceived stress (PSQ scores) decreased from the initial 0.48 ± 0.20 to 0.33 ± 0.16 (\( P < .0001 \)). Similarly, all four subscales of the PSQ improved significantly, with CI being most effective in dealing with “worries”...
Correlation between Tinnitus-Related Distress and HRQoL, Psychological Comorbidity, and Coping Strategies Emerges after CI

We did not find any linear correlation between tinnitus-related distress, as measured by the TQ, and the scores of the other questionnaires except for the subscale “evasive coping” of the Brief COPE ($r = .335$, $P < .05$) before CI.

After CI, tinnitus impairment was associated with lower HRQoL (NCIQ, $r = -.49$, $P < .001$), higher perceived stress (PSQ, $r = .52$, $P < .001$), a higher level of depressive symptoms (ADS, $r = .58$, $P < .0001$), and a higher level of anxiety disorders (GAD-7, $r = .65$, $P < .0001$). In addition, the TQ correlated with “evasive coping” ($r = .32$; $P < .05$) and negatively with “positive coping” ($r = -.53$, $P < .001$) according to the Brief COPE.

Because of the lack of linear correlations between tinnitus distress and quality of life and psychometric parameters before CI, we subdivided the patients into three groups: 1) high-level tinnitus (TQ $\geq 47$ scores, $n = 9$), 2) low-level tinnitus (TQ $< 47$ scores, $n = 24$), and 3) no/incidental tinnitus ($n = 10$), and compared the results of these groups. Six of the CI candidates reported having tinnitus incidentally (TQ $\leq 8$ scores). As shown in Figure 4, HRQoL was improved in all subgroups post-CI. Scores according to the PSQ, ADS, and GAD-7 were reduced in all groups with the reduction of the GAD-7 score not reaching statistical significance in the low-level group. Positive coping strategies only improved in the group with no/incidental tinnitus.

A comparison between patients with low-level tinnitus and no/incidental tinnitus did not reveal differences before CI. Patients with high-level tinnitus had significantly lower NCIQ scores as well as higher scores in

Correlation between HRQoL and Psychological Comorbidity and Coping Strategies before and after CI

Before CI, we found negative correlations between disease-specific HRQoL, as measured by the NCIQ, and the PSQ total score ($r = -.53$, $P < .001$), the ADS score ($r = -.46$, $P < .01$), and the GAD-7 score ($r = -.56$, $P < .001$). Moreover, the scores of the NCIQ and the subscale “focus on positive” of the Brief COPE showed a significant positive correlation ($r = .44$, $P < .01$).

After CI, there were negative correlations between the NCIQ and the PSQ ($r = -.55$, $P < .001$), the ADS ($r = -.52$, $P < .001$), and the GAD-7 ($r = -.45$, $P < .01$) simi-

Fig. 2. Scores of the TQ subscales measured in the patients with tinnitus before and after the CI. Em, emotional distress; Co, cognitive distress; Inti, intrusiveness; Aku, auditory perceptual difficulties; Sl, sleep disturbances; Som, somatic complaints. $*P < .05$, $**P < .001$ versus before CI.

Fig. 3. Scores of the PSQ subscales measured in all patients before and after CI. $*P < .05$, $**P < .01$, $***P < .0001$ versus before CI.

larly to the situation before CI. In addition, there was a negative correlation between the NCIQ and the subscale “evasive coping” of the Brief COPE ($r = -.46; P < .01$).
PSQ, GAD-7 and “evasive coping” than the patients of the other two groups before CI. Patients with high-level tinnitus also had higher ADS scores than patients with no/incidental tinnitus, and lower scores of “positive coping” than patients with low-level tinnitus.

After CI, the nine patients who originally had high-level tinnitus still had significantly lower NCIQ and higher PSQ, ADS, and GAD-7 scores compared to the patients with no/incidental tinnitus. The differences between the two groups with high- or low-level tinnitus were significant in relation to anxiety disorder (GAD-7). In addition, the scores for the PSQ and the subscale “focus on positive” of the Brief COPE found in the patients with low-level tinnitus were worse than in patients with no/incidental tinnitus.

Difference between Patients with Profound and Severe Hearing Loss

Before CI, the NCIQ and its subscales did not differ between the two groups. The seven patients with severe hearing loss had a total TQ score that was approximately 25% lower than that of the patients with profound hearing loss; however, this difference was not statistically significant (Fig. 5). Nevertheless, scores from the subscale “somatic complaints” were significantly higher in patients with severe hearing loss than in patients with profound hearing loss (3.33 ± 2.8 and 1.38 ± 1.84, *P < .05). The patients with severe hearing loss had higher levels of perceived stress (PSQ) and depressive symptoms (ADS) than the patients with profound hearing loss.

After CI, we found no significant differences between the scores of patients with profound and those with severe hearing loss. Analysis of the values before and after CI demonstrated a significant increase in HRQoL and a reduction in perceived stress and depressive symptoms in both patient groups. The TQ and GAD-7 scores in patients with profound hearing loss and the scores for evasive coping in patients with severe hearing loss were reduced.

Influence of the Etiopathology on the HRQoL, Tinnitus, and Psychological Comorbidity

Before CI, patients with sudden hearing loss had lower NCIQ and higher PSQ, ADS, and GAD-7 scores as well as higher scores in the subscale “evasive coping” of the Brief COPE than the patients of the other groups; however, the differences did not reach the level of significance. The NCIQ scores improved in the group with sudden hearing loss by 38.8 ± 18.7 points. This increase was significantly higher in the group with severe hearing loss. Fig. 4. Psychometric parameters of the patients with high level of tinnitus, low level of tinnitus, and no/incidental tinnitus measured before and after the CI. *P < .05, **P < .01, ***P < .001 versus high level of tinnitus; #P < .05 versus low level of tinnitus; *P < .05, **P < .01, ***P < .0001 versus. before CI.
progressive hearing loss (15.5 ± 15.0) and group with other etiopathology (16.4 ± 15.9; P < .05). In patients with tinnitus, the improvement of the TQ score did not differ between the disease groups.

**DISCUSSION**

The present work has demonstrated that 1) in addition to an improvement in hearing and speech understanding and an increase in HRQoL, CI users enjoy a number of further benefits, as shown by reductions in tinnitus and psychological comorbidity. The CI decreased perceived stress, symptoms of anxiety and depression, and improved coping strategies in the patients. 2) Before and after CI, the hearing handicap influenced psychological comorbidity and coping strategies, as demonstrated by the negative correlations between the disease-specific quality of life (NCIQ) and the PSQ, ADS, and GAD-7 scores. This was partly true for the relationship between NCIQ and coping strategies. 3) Before CI, patients with a high severity level of tinnitus had lower disease-specific HRQoL as well as higher psychological comorbidity than patients with low-level tinnitus or no/incidental tinnitus, whose scores did not differ. After CI, higher tinnitus-related distress (TQ) was associated with lower HRQoL and higher psychological comorbidity in all patients. Even patients suffering from high-level tinnitus profited from CI, but they still had the lowest HRQoL and the highest comorbidity post-CI. 4) Pre-CI, patients with severe hearing loss suffered more severe somatic complaints, perceived stress-related and depressive symptoms than patients with profound hearing loss.

The present finding that implantation is followed by a significant increase in disease-specific HRQoL, as measured by the NCIQ and its six subdomains (including the social and psychological domains), corroborates the results of other studies. Additionally, several studies using different questionnaires confirm that CI improves the quality of life. A new finding is that patients with sudden hearing loss prior to the CI profited most from the CI because of their low initial NCIQ scores.

Thirty-nine of our 43 CI candidates (91%) reported tinnitus before implantation. This prevalence more or less agrees with the percentage of about 80% reported in a review of 18 studies. The mean TQ score of these patients was significantly reduced by the CI. The number of patients with high-level tinnitus decreased from 23% to 13%. In detail, 64% of the patients reported a reduction in their tinnitus-related distress or a disappearance of tinnitus.

The positive effect of CI on tinnitus was demonstrated in a number of previous studies, as compiled in

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![Graphs showing psychometric parameters before and after CI](image-url)
reviews by Baguley and Atlas and Miyamoto and Bichey, and was reported to range between 34% and 93% of the implanted patients. The mechanisms underlying the CI-induced tinnitus suppression have not yet been clarified. Some authors assume that this recovery is due to the improvement in the patients’ quality of life. The direct effect of CI on tinnitus may be due either to acoustic masking, electrical stimulation of the acoustic nerve, or CI-dependent reorganization of the central auditory pathway and cerebral areas, indicating the need for optimization of implant fitting in tinnitus sufferers.

A worsening of preexisting tinnitus was reported to occur in up to 8% of cases. The risk of developing tinnitus after CI ranges from 0% to 12%. In our study, neither the 39 patients with tinnitus nor the 4 patients who were tinnitus-free before surgery reported a worsening or induction of tinnitus post-surgery. Because the majority of our patients (84%) suffered from profound hearing loss before CI, changes in the frequency and intensity of tinnitus could not be evaluated.

Some previous studies used validated questionnaires to assess the tinnitus handicap in the implanted patients. However, data on tinnitus before and after CI often include rather general information: better, no change, or worse. Corroborating our work, recent research using a validated tinnitus handicap questionnaire has demonstrated a reduction in the total score after implantation in patients who suffered from tinnitus before and after CI. The authors also reported positive effects of implantation on the emotional subscale and on hearing.

In our study, psychological comorbidity declined noticeably following CI, as shown by the significant decrease in perceived stress (PSQ score down by 31%), depressive symptoms (ADS score down by 41%), and anxiety symptoms (GAD-7 score down by 43%). The number of patients with a higher level of perceived stress was halved from 56% to 28%; that of patients with a higher level of depressive symptoms declined from 35% to 16%, and that of patients with a higher level of anxiety symptoms declined from 26% to 4.7%.

In a recent study, we evaluated the long-term effect of a modified tinnitus retraining therapy on chronic tinnitus and found that the PSQ score, as measured after 1 year, was reduced only in patients with an initially higher level of perceived stress. The initial mean PSQ score was nearly the same in our present study, but reached a post-CI score that corresponded to the value found in the healthy German population. Initial and final tinnitus-related distress (TQ) was found to be nearly the same in the two studies. Thus, the greater reduction in perceived stress found in the present study may be caused by the recovery of hearing and speech perception rather than by the suppression of tinnitus. In addition, we examined the effect of tinnitus therapy on depressive symptoms in patients with chronic tinnitus and found that the ADS score was reduced only in patients with higher initial ADS values. The mean ADS score in our CI patients was initially higher than in the tinnitus-only patients. Moreover, it was reduced to a greater extent following CI than in the tinnitus-only patients following tinnitus therapy, which indicates that the hearing handicap has an additional influence on depressive symptoms in CI candidates.

The impact of CI on psychological comorbidity such as anxiety and depression has been previously investigated. A prospective clinical trial, Knutson et al. examined the psychological change in 37 patients over a period of 54 months after CI. The authors found significant changes using the Minnesota Multiphasic Personality Inventory (MMPI). On the Depression Scale, the only significant differences were detected in the initial follow-up period, whereas the improvement on the MMPI Paranoia and Social Introversion Scales persisted throughout the follow-up period. In contrast to our results, CI had no influence on depressive symptoms, as measured pre- and post-CI using the Beck Depression Inventory.

The association between acquired hearing loss and psychosocial and emotional status was investigated in earlier reports, which revealed that hearing loss is associated with a number of specific difficulties that can be related to the quality of life. In particular, depression, social anxiety, social isolation, extreme loneliness, and elevated distrust were identified among persons with acquired moderate to severe hearing loss. We have confirmed these observations in our present study. A high level of perceived stress, depressive symptoms, or anxiety disorder was associated with a low level of disease-specific HRQoL before, but also after, CI. In addition, a higher HRQoL correlated with better coping strategies.

In a prospective study, Mo et al. evaluated changes occurring in implanted patients and studied HRQoL, depression, and anxiety. The authors found that a post-CI reduction in anxiety and depression is associated with a gain in the quality of life. Moreover, the implants improved the daily lives of patients’ relatives. However, the authors provided no data on tinnitus or the relation between tinnitus and HRQoL or psychological comorbidity.

Only limited data on the quality of life of deaf patients with tinnitus before and after implantation are available in specialist literature. In two studies using non-validated surveys, the authors proposed that the improvement in the quality of life which was noted post-CI may influence reporting of tinnitus. Interestingly, a study investigating the benefits of a second CI reported that positive changes to the quality of life were associated with the improvements in hearing, but these were counterbalanced by negative changes associated with an aggravation of tinnitus.

Reports on the effect of CI on psychological comorbidity and tinnitus-related distress are rare in specialist literature. Andersson et al., using validated questionnaires, retrospectively examined 111 implanted patients who also had tinnitus (Tinnitus Handicap Inventory, Hospital Anxiety and Depression Scale). They found that tinnitus distress was associated with hearing problems, anxiety, and depression. However, the authors provided no data on the pre-CI situation or on disease-specific HRQoL.
Our study has shown that tinnitus affects HRQoL, psychological comorbidity, and coping strategies in patients with a high severity level of tinnitus before implantation. In patients with low-level tinnitus, tinnitus-related distress may be masked or overlaid by the hearing handicap before surgery. It is possible that this distress first emerges after implantation. In cases of high severity, tinnitus has an additional negative influence on HRQoL and psychological comorbidity. Our post-CI results confirm that a high level of tinnitus is associated with lower HRQoL and higher stress, depressive symptoms, and anxiety disorder as well as poorer coping strategies.

A further interesting finding is that patients with severe hearing loss and tinnitus had a higher level of somatic complaints, perceived stress, and depressive symptoms prior to surgery than patients with profound hearing loss and tinnitus. This may be due to the fact that patients with severe hearing loss still live in the world of hearing people, but their hearing capability is insufficient to function well in that world. It is likely that a sense of isolation as well as straining to understand contextual sound may lead to stress reactions or depressive symptoms. On the other hand, the total TQ score of patients with severe hearing loss was somewhat lower than that of patients with profound hearing loss. This corroborates our recent findings from a comprehensive tinnitus-only study, where we demonstrated that the degree of hearing loss is associated with the severity of tinnitus as measured by the TQ.27

One shortcoming of our study is the small number of patients studied. A large and comprehensive pre–post study is necessary to gain more insight into the differences between CI patients with and without tinnitus, with different degrees of pre-CI hearing loss or different diagnosis. It will be important in the future to examine the influence of age, gender, and duration of deafness/hearing loss on therapy success in multiple analyses.

CONCLUSIONS

Our present study provides evidence that tinnitus and psychological comorbidity are important factors that significantly affect the quality of life of CI patients. CI candidates with tinnitus (especially with high-level tinnitus) may be treated with a tinnitus-specific implant fitting and/or tinnitus-specific therapy following surgery. The addition of psychosomatic or psychological therapy/consultation is needed in severe cases. The use of standardized assessment of tinnitus-related distress, perceived stress and psychological comorbidity before and after CI is expected to improve the rehabilitation process in implanted patients.

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