



부분 난청과 고심도 난청 성인의 말지각 및 건강 관련 삶의 질 연구

A Study on Speech Perception and Health-Related Quality of Life in Adults With Partial Deafness and Severe-Profound Hearing Loss

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Purpose: The objective of this study was to examine pre and post-operative speech perception and Health-Related Quality of Life (HRQoL) in adults with Partial Deafness and Severe-Profound hearing loss. **Methods:** The study design was a retrospective review of speech perception performance and HRQoL for 13 adults with Partial Deafness and 13 adults with Severe-Profound hearing loss at pre-operation and one-year post-op. Monosyllabic words, disyllabic words, and sentence tests were used to evaluate their speech perception. To evaluate their HRQoL, the Nijmegan Cochlear Implant Questionnaire (NCIQ) was used. **Results:** Both two groups showed significant improvements in all speech perception tests and all items in NCIQ after cochlear implantation(CI). Scores of a monosyllabic, disyllabic, sentence and physical functioning of NCIQ in the Partial Deafness group were significantly higher than those of the Severe-Profound group before CI. After CI, the scores of sentence test and physical functioning of NCIQ in the Partial Deafness group were significantly higher than those of the Severe-Profound Group. However, there were no statistically significant differences between the two groups in the area of psychological and social functioning before and after CI. **Conclusions:** These results suggested that CI has a positive impact on speech perception performance and HRQoL in adults with Partial Deafness and Severe-Profound hearing loss. Although the Partial Deafness group presented better speech perception performance than those who have Severe-Profound hearing loss, there was no significant difference in psychological and social functions between two groups. HRQoL is a critical component when evaluating CI intervention. More sensitive measures are required to sensitively evaluate the performance of adults with hearing loss for each hearing loss type.

목적: 이 연구에서는 부분 난청 성인과 고심도 난청 성인의 인공와우이식 전과 후의 말지각 및 건강 관련 삶의 질의 특성을 알아보기로 하였다. **방법:** 본 연구에는 13명의 부분 난청, 13명의 고심도 난청, 총 26명의 후천적 난청 성인이 참여하였고, 이들의 인공와우이식 전, 술 후 1년 시점의 말지각 및 건강 관련 삶의 질(HRQoL)을 후향적으로 분석하였다. 말지각 검사는 조용한 상황에서 1음절, 2음절, 문장 검사를 실시하였고, 건강 관련 삶의 질을 알아보기 위해 Nijmegan Cochlear Implant Questionnaire(NCIQ) 설문지를 번역하여 사용하였다. **결과:** 두 그룹 모두 인공와우이식 후 말지각과 건강 관련 삶의 질에 유의한 향상을 나타냈다. 인공와우이식 전에는 부분 난청 성인의 1음절, 2음절, 문장 말지각 점수와 건강 관련 삶의 질의 신체 기능이 고심도 난청 성인보다 유의미하게 높았다. 인공와우이식 후에는 부분 난청 성인의 문장 말지각 점수와 NCIQ의 신체적 기능 수행력이 유의하게 더 높았다. 하지만 인공와우이식 전과 후 모두 심리, 사회적 기능에서는 두 그룹 간 유의미한 차이가 없었다. **결론:** 인공와우이식은 부분 난청 성인과 고심도 난청 성인의 말지각 및 건강 관련 삶의 질에 긍정적인 영향을 끼쳤다. 부분 난청 성인은 고심도 난청 성인에 비해 높은 말지각 수행력을 보이지만, 심리, 사회적 기능에서는 두 그룹 간 유의미한 차이를 보이지 않았다. 건강 관련 삶의 질은 인공와우 중재를 평가할 때 중요한 요소이고, 청력 유형별로 난청 성인의 수행력을 민감하게 평가하는 도구가 마련되어야 할 것이다.

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Keywords : Partial Deafness,
Severe-Profound hearing loss,
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이 논문은 장성진(2015)의 제9회 APSCI의 포스터 발표를 수정·보완하여 작성한 것임.

검색어 : 부분 난청, 고심도 난청, 인공와우수술,
말지각, 건강 관련 삶의 질

I. Introduction

Partial Deafness is a special type of sensorineural hearing loss, with a severe to profound impairment at frequencies above 1-2kHz and normal to moderately deteriorated hearing acuity at lower frequency bands (Cosetti & Waltsman, 2011; Skarzynski, 2012), with an audiogram akin to a ski-slope hearing loss (Skarzynski et al., 2006; Skarzynski et al., 2010). Adults with Partial Deafness have a relatively good audio-oral communication and support from lip-reading. However, noisy and multi-talker situations remain very challenging for this population (Cieśla et al., 2016). Often these patients remain beyond the scope of effective treatment with hearing aids only since amplification at frequencies above the region of substantial residual hearing provides little or no benefit for individuals with steeply sloping audiograms (McDermott & Dean, 2000). Therefore, one suggested, and successful treatment option for Partial Deafness is cochlear implantation (CI), including a combination of a cochlear implant and a hearing aid in one ear (electroacoustic system, EAS; Cosetti & Waltzman, 2011). Results suggest hearing preservation following cochlear implantation to allow for sufficient amplification in the low frequencies (Gantz & Turner, 2003; Kiefer et al., 2004). Speech results confirm the significant benefit of EAS, demonstrating a strong synergistic effect of combining the hearing aid and cochlear implant in the same ear, most particularly noted in noise (Gstoettner et al., 2004; Kiefer et al., 2004).

Skarzynski and colleagues reported that improvements in monosyllabic scores over time in both quiet and noise were significant, particularly within the first three months of Partial Deafness cochlear implantation use (Skarzynski et al., 2006). Another research showed that the length of the electrodes does not affect the degree of hearing preservation or speech understanding, and mean speech recognition in quiet was 30% before implantation and improved to 78.5% at 12months postoperatively (Skarzynski et al., 2019). Amoodi and colleagues evaluated a group of postlingually deafened adults, whose aided speech recognition exceeded commonly accepted candidacy criteria for CI. This group of patients demonstrates a significant improvement in speech and word recognition performance and hearing-related handicaps after CI (Amoodi et al., 2012). These results suggested that CI positively impacts on speech perception in adults with Partial Deafness.

Hearing impairment is not only a disability (a communication dysfunction) but can also be perceived by an individual as a handicap with its psychosocial effects. The extent of the handicap, however, cannot be predicted from the audiometric profile itself. It has been argued that

behavioral and affective variables have to be considered to provide successful management of the disease (Cieśla et al., 2016). In recognizing the need to measure and objectify the benefits or limitations of medical interventions on an individual's social, emotional, and physical well-being, the term quality of life (QoL) has been defined (Loeffler et al., 2010). QoL is a broad-ranging concept, referring to an individual's perception of his/her position in life, affected in a multifaceted way by psychological state, level of independence, social relationships, personal beliefs, and physical health (World Health Organization, 1998). More specifically, this general health status of patients, often referred to as health-related quality of life (HRQoL), has been recognized as a more comprehensive measure of medical intervention outcomes (Mo et al., 2005).

Cochlear implantation does not only affect the hearing, speech perception, and speech production abilities of patients, but it also has a broader impact on social functioning, daily activities, and self-esteem (Hinderink et al., 2000; Hirschfelder et al., 2008). Therefore, in order to capture CI patient outcomes more holistically, the functional impact of permanent hearing loss and consequent treatment on personal well-being should be assessed through HRQoL measures (Capretta & Moberly, 2016). In recent years, in addition to standard speech perception testing, HRQoL has become a widespread outcome measure to quantify and monitor cochlear implant outcomes (le Roux et al., 2017). Hinderink and colleagues developed the Nijmegen Cochlear Implantation Questionnaire (NCIQ), which is a quantifiable, self-assessment HRQoL instrument for use in cochlear implant (CI) users. Validity, reliability, and sensitivity to clinical changes have been confirmed for the NCIQ. The data obtained with the NCIQ reflected that a CI had significant effects on several health-related QoL aspects, including the social and psychological domains (Hinderink et al., 2000). Chung and colleagues reported significant improvement of HRQoL even just one year after CI as categorically stratified by the SF-36 health questionnaire (Chung et al., 2012). The significant improvement between pre and post-implantation HRQoL scores was documented for unilaterally implanted postlingually (Mo et al., 2005; Olze et al., 2011), as well as prelingually (Straatman et al., 2014) deafened adult CI recipients. Similarly, HRQoL measures revealed a positive effect of implantation for postlingually deafened elderly patients (Orabi et al., 2006; Sanchez-Cuadrado et al., 2013), and also adult patients implanted for unilateral Deafness (Arndt et al., 2011; Vermeire & Van De Heyning, 2009). The results from the literature show that cochlear implants have a positive impact on speech perception and HRQoL among adults with

Severe-Profound hearing loss.

Several studies on quality of life according to the onset of hearing have indicated that some authors suggest that underdeveloped communication skills at an early age can deteriorate emotional and social development (and potentially also neurological). On the other hand, others arguing that an altered identity from hearing to deaf in later-onset Deafness can be more detrimental to mental health (Øhre et al., 2011). Several large and medium population studies have indicated increased mental distress among patients with an acquired postlingual hearing impairment (with onset after developing language skills), as compared to the general population. Depressive/anxiety symptoms and social isolation were found most distinctive (Hallam et al., 2006; Kerr & Cowie, 1997; Kobosko et al., 2015). Findings concerning the correlation between audiological measures, such as pure-tone audiometry and mental health have been contradictory, probably since numerous factors can be contributed to the development of mental distress and a sensory impairment can be one of those (Øhre et al., 2011).

Adults with Partial Deafness are more likely excluded from CI candidacy, because they do not entirely fulfill the recommended audiological criteria, but they are still struggling with hearing aids. Our study was to examine adults with Partial Deafness in pre and post operative speech perception and HRQoL as compared to adults with Severe-Profound hearing loss to figure out the characteristic of adults with Partial Deafness and provide necessary information on counseling and rehabilitation for them. The specific research questions for this study are as follows.

First, did speech perception and HRQoL improve after cochlear implantation in adults with the Partial Deafness and Severe-Profound hearing loss?

Second, was there a statistically significant difference in speech perception and HRQoL between the Partial Deafness group and Severe-Profound hearing loss group?

II. Methods

1. Participants

13 adults with Partial Deafness and 13 adults with Severe-Profound hearing loss participated in the study. All patients recruited to our study were patients in the Soree Ear Clinic between the years 2013 and 2018. All subjects complied with the following eligibility criteria: (1) the postlingual onset of Deafness (2) the duration of Severe-Profound hearing loss was less than ten years (3) the

score of speech intelligibility rating (SIR) was 5 (4) without additional disabilities (5) had well developed verbal skills and used auditory-verbal communication. Only patients under the age of 61 were included to exclude the potential effect of hearing deterioration due to age (such as presbyacusis). Their aided thresholds were 25–35dB HL in the range of 250 to 4000Hz after CI.

Partial Deafness had low-frequency hearing (Pure tone threshold \leq 65dB HL from 250 to 500Hz) and severe or profound hearing loss in the high frequencies (Pure tone threshold \geq 70dB HL at 1500Hz). There were 3 male and 10 female subjects, and the mean age of patients was 41 years (SD=12.72; range 20–59yr).

Severe-Profound hearing loss is defined as a severe or profound hearing loss at all pure tone audiometric frequencies ($>$ 70dB HL at frequencies 250–8000Hz). There were 5 male and 8 female subjects, and the mean age of patients was 51 years (SD=9.03; range 36–61yr). Sociodemographic information on them is presented in Table 1.

Table 1. Participants' information

Case no.	Sex	Age of CI	Site of CI	Internal device	External device
P1	F	20	Lt	CI422	CP910-EAS
P2	F	32	Rt	CI422	CP910-EAS
P3	M	59	Rt	FLEX24	DUETII
P4	M	36	Rt	CI422	N6 EAS
P5	F	55	Rt	FLEX24	SONNET EAS
P6	F	57	Rt	FLEX24	SONNET EAS
P7	F	42	Rt	FLEX28	SONNET EAS
P8	F	32	Rt	FLEX28	SONNET EAS
P9	F	33	Rt	FLEX28	SONNET EAS
P10	F	24	Bo	FLEX28	RONDO
P11	F	43	Rt	FLEX24	RONDO
P12	M	47	Rt	CI422	N6 EAS
P13	F	53	Lt	FLEX28	OPUS2
S1	F	51	Rt	FLEX28	OPUS2
S2	M	41	Lt	FLEX28	OPUS2
S3	F	53	Lt	FLEX28	OPUS2
S4	M	59	Lt	CI422	CP910-CI
S5	F	56	Lt	FLEX28	RONDO
S6	F	49	Lt	FLEX28	RONDO
S7	F	58	Rt	FLEX28	OPUS2
S8	F	34	Lt	FLEX28	RONDO
S9	F	39	Rt	FLEX28	RONDO
S10	M	36	Rt	CI422	CP920-CI
S11	M	61	Rt	FLEX28	RONDO
S12	M	61	Lt	FLEX28	SONNET
S13	F	45	Rt	CI522	KANSO

CI=cochlear implant; P=partial deafness; S=severe-profound hearing loss; Bo=Both.

2. Evaluation tools

1) Speech perception tests

Tests of speech perception were performed using the monosyllabic word test (Lee et al., 2009), disyllabic word test and the Korean version of the Central Institute of Deafness

(K-CID) sentence test (Jang et al., 2012), which were used for follow-up evaluation in Soree Ear Clinic. The monosyllabic word test includes 50 words per list (2 lists). The disyllabic word test includes 30 words per list (6 lists). The Sentence test includes 50 sentences per list (7 lists). Lists of each test were randomized among test conditions (Kim et al., 2017). The tests were administered under the quiet conditions at 65dB SPL presentation levels. The responses were calculated as the percentage of correct words in the lists. Speech perception tests were conducted preoperatively and 12 months after CI. The speech perception tests were conducted in a quiet room under both aided with hearing aids before CI. At one year post-op CI, the tests were conducted in a quiet room under uni-CI (or EAS).

2) Health-Related Quality of Life Questionnaire

The researcher translated Nijmegen Cochlear Implant Questionnaire (Hinderink et al., 2000). The NCIQ was completed by participants as a measurement of HRQoL. The NCIQ is a disease-specific, self-report questionnaire developed specifically for CI recipients (Hinderink et al., 2000). The tool has been proven useful in the longitudinal assessment of the hearing-loss-related quality of life before and after CI with relatively good consistency across subdomains, test-retest coefficients and responsiveness indices (Hinderink et al., 2000; Hirschfelder et al., 2008; Klop et al., 2008). There are three domains: physical, psychological, and social functioning. The following subdomains are specified: basic sound perception, advanced sound perception, and speech production in the physical domain; and activity and social functioning in the social domain. The psychological domain consists of only one subdomain: self-esteem. There are 60 items in the questionnaire which the patient responds to on a 6-point Likert scale. Each item was formulated as a statement with a 5-point response scale to indicate the degree to which the statement was true. These five response categories were as follows: never (1), sometimes (2), often (3), mostly (4), and always (5) for 55 of the total 60 items. The other five items were answered according to the CI user's ability to act on the question. Response categories for these five items were as follows: no (1), poorly (2), moderate (3), adequate (4), and good (5). Throughout the questionnaire, respondents were also offered a sixth response category to cover items that were not relevant to them. The maximum score on each scale (10 questions) is 50. The maximum score on each scale has been converted to 100 percentage. Patients completed all

the written questionnaires on their own. An example of the questions of NCIQ is presented in Appendix 1.

3. Data collection

All patients participated in a preoperative assessment before CI and regular follow-up of CI by an ENT specialist at Soree Ear Clinic in Seoul. First, patients were asked about details of their hearing impairment, and the use of, and satisfaction with hearing aids before CI. All patients using hearing aids were satisfied with the fitting at the time of the study. Monosyllabic, disyllabic, and sentence recognition performance were assessed using one 50-item list of the monosyllabic word test, one 30-item list of the disyllabic word test, and two 10-sentence lists of the K-CID test in a sound-isolated room at 65 dB SPL in quiet. All subjects were tested in one condition: Both hearing aids. After the speech perception test, the patients were administered the NCIQ and completed all the written questionnaires on their own.

Second, in the one-year post-op assessment, pure-tone testing was performed before the speech perception test to make sure that aided thresholds is in the 20 to 35 dB with CI. During the speech perception test, all subjects were tested in one condition: CI (or EAS) only. The contralateral ear was plugged. After the speech perception test, the patients were administered the NCIQ and tested in best-aided condition (contralateral ear unplugged or bimodal). The order of testing and speech test lists was randomized. During the testing, no changes were made to the fitting parameters for the CI or HA.

4. Data analysis

First, a paired *t*-test was conducted to assess the effect of a cochlear implant on the speech perception performance and HRQoL. Second, a comparative between-group analysis using a two-sample *t*-test was performed to assess the effect of Partial Deafness and Severe-Profound hearing loss on the speech perception performance and HRQoL. All statistical analyses were done with IBM SPSS Statistics version 24.

III. Results

1. Speech perception and HRQoL after CI

There were highly significant improvements in all three speech perception tests. Cochlear implant led to improvements

in monosyllabic ($t=-9.090, p<.001$), disyllabic ($t=-10.985, p<.001$), sentence ($t=-9.433, p<.001$) in quiet, with the most improvement in the order of disyllabic word (59.3%), sentence (58.2%), and monosyllabic word (40.5%). CI resulted in a statistically significant increase in disease-specific HRQoL, as measured by the NCIQ. Cochlear implantation led to improvements in basic speech perception ($t=-9.823, p<.001$), advanced speech perception ($t=-6.114, p<.001$), speech production ($t=-3.271, p<.01$), self-esteem ($t=-6.253, p<.001$), activity limitation ($t=-6.276, p<.001$), and social interaction ($t=-5.583, p<.001$). In the HRQoL area, the most significant improvement was made in basic speech perception (46%), followed by activity limitation (33.9%), advanced speech perception (32.3%), self-esteem (32%), social interaction (29.3%), and speech production (13.6%) in order. The results are presented in Table 2 and Figure 1.

Table 2. Comparison of speech perception and HRQoL between pre and post-Cl

	M	SD	t	df
Pre_monosyllabic - Post_monosyllabic	-40.500	22.718	-9.090***	25
Pre_disyllabic - Post_disyllabic	-59.346	27.548	-10.985***	25
Pre_sentence - Post_sentence	-58.269	31.498	-9.433***	25
Pre_BSP - Post_BSP	-46.038	23.899	-9.823***	25
Pre_ASP - Post_ASP	-32.385	27.007	-6.114***	25
Pre_SP - Post_SP	-13.654	21.287	-3.271**	25
Pre_SE - Post_SE	-32.000	26.095	-6.253***	25
Pre_AL - Post_AL	-33.962	27.593	-6.276***	25
Pre_SI - Post_SI	-29.346	26.800	-5.583***	25

Pre=pre CI; Post=post CI; BSP=basic speech perception; ASP=advanced speech perception; SP=speech production; SE=self-esteem; AL=activity limitation; SI=social interaction.

*** $p<.001$

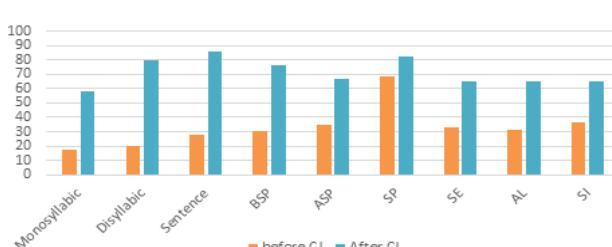


그림 1. 수술 전후에 따른 말지각과 건강과 관련된 삶의 질 차이

Figure 1. Comparison of speech perception and HRQoL between before and after CI

CI=cochlear implant, BSP=basic speech perception; ASP=advanced speech perception; SP=speech production; SE=self-esteem; AL=activity limitation; SI=social interaction.

2. Adults with Partial Deafness vs. severe-profound hearing loss

Before CI, Partial Deafness group obtained significantly

higher scores than those of the Severe-Profound hearing loss in monosyllabic ($t=3.694, p=.001$), disyllabic ($t=4.403, p<.001$) and sentence ($t=5.604, p<.001$). Furthermore, Partial Deafness group had significantly higher scores on the physical domain of NCIQ, basic speech perception ($t=4.295, p<.001$), advanced speech perception ($t=7.356, p<.001$), and speech production ($t=3.925, p=.001$). For the remaining scales of the NCIQ, self-esteem ($t=1.179, p>.05$), activity limitation ($t=0.670, p>.05$), social interaction ($t=1.063, p>.05$), no statistically significant differences were demonstrated between groups.

After CI, There were no significant differences in monosyllabic ($t=0.647, p>.05$), disyllabic ($t=0.105, p>.05$) scores between the groups. However, the Partial Deafness group obtained significantly higher scores than those of the Severe-Profound hearing loss in the sentence score ($t=2.684, p<.05$). Partial Deafness group had significantly higher scores on the physical domain of NCIQ, basic speech perception ($t=2.569, p<.05$), advanced speech perception ($t=3.021, p<.05$), and speech production ($t=2.902, p<.05$). No statistically significant between-group differences were demonstrated for the remaining scales of the NCIQ, self-esteem ($t=0.778, p>.05$), activity limitation ($t=0.511, p>.05$), social interaction ($t=0.883, p>.05$). The results are presented in Table 3, Figure 2 and 3.

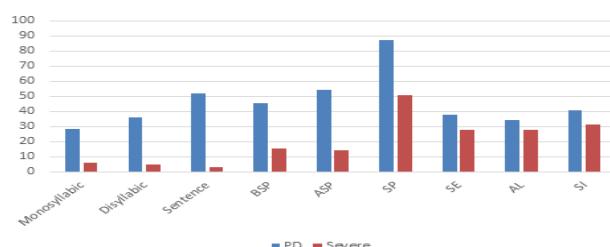


Figure 2. Comparison of speech perception and HRQoL between groups before CI

PD= partial deafness; Severe=severe-profound hearing loss; BSP=basic speech perception; ASP=advanced speech perception; SP=speech production; SE=self-esteem; AL=activity limitation; SI=social interaction.

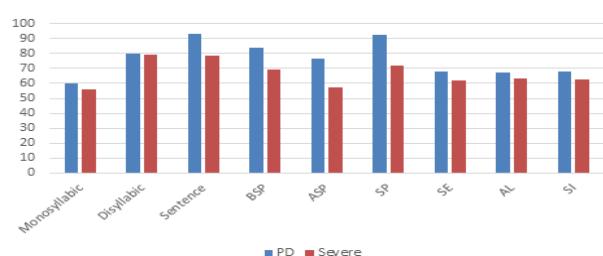


Figure 3. Comparison of speech perception and HRQoL between groups after CI

PD= partial deafness; Severe=severe-profound hearing loss; BSP=basic speech perception; ASP=advanced speech perception; SP=speech production; SE=self-esteem; AL=activity limitation; SI=social interaction.

Table 3. Comparison of speech perception and HRQoL between groups

	Group	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>
Pre_mono	P	13	28.62	20.630	3.694**	24
	S	13	6.08	7.643		
Pre_disyllabic	P	13	36.08	25.131	4.403***	24
	S	13	4.77	5.069		
Pre_sentence	P	13	52.15	30.854	5.604**	24
	S	13	3.38	5.709		
Post_mono	P	13	59.85	16.155	.647***	24
	S	13	55.85	15.351		
Post_disyllabic	P	13	80.00	10.512	.105	24
	S	13	79.54	11.865		
Post_sentence	P	13	93.46	5.532	2.684	24
	S	13	78.62	19.164		
Pre_BSP	P	13	45.54	21.227	4.295*	24
	S	13	15.38	13.793		
Pre_ASP	P	13	54.46	16.292	7.356***	24
	S	13	14.54	10.837		
Pre_SP	P	13	86.85	11.675	3.925***	24
	S	13	50.54	31.245		
Pre_SE	P	13	37.85	21.851	1.179**	24
	S	13	27.85	21.408		
Pre_AL	P	13	34.46	25.221	.670	24
	S	13	27.92	24.534		
Pre_SI	P	13	40.92	24.459	1.063	24
	S	13	31.15	22.368		
Post_BSP	P	13	83.85	11.022	2.569	24
	S	13	69.15	17.430		
Post_ASP	P	13	76.46	10.162	3.021	24
	S	13	57.31	20.475		
Post_SP	P	13	92.46	9.024	2.902**	24
	S	13	72.23	23.460		
Post_SE	P	13	67.92	15.370	.778*	24
	S	13	61.77	24.011		
Post_AL	P	13	67.23	15.466	.511	24
	S	13	63.08	24.868		
Post_SI	P	13	68.23	15.189	.883	24
	S	13	62.54	17.581		

Pre=pre CI; Post=post CI; mono=monosyllabic; P=partial deafness; S=severe-profound hearing loss; BSP=basic speech perception; ASP=advanced speech perception; SP=speech production; SE=self-esteem; AL=activity limitation; SI=social interaction.

* $p<.05$, ** $p<.01$, *** $p<.001$

IV. Conclusion

In this study, the performance of the speech perception and Health-Related Quality of Life (HRQoL) of adults with Partial Deafness and Severe-Profound hearing loss was examined.

First, both groups showed statistically significant

improvement in speech perception and HRQoL after CI. This means that CI has a positive effect on speech perception and HRQoL in adults with Partial Deafness and Severe-Profound hearing loss. In the speech perception, all three tests showed an average improvement of over 40%, with the most improvement in the order of disyllabic word, sentence, and monosyllabic word. In the HRQoL area, the most significant improvement was made in basic speech perception, followed by activity limitation, advanced speech perception, self-esteem, social interaction and speech production in order. This is consistent with the findings of Olze et al. (2011) that basic speech perception showed the greatest improvement in HRQoL. Hinderink et al. (2000) also reported that adults with Severe-Profound hearing loss showed the greatest improvement in basic speech perception and advanced speech perception after CI, and reported more than 30% improvement in the other four areas as well. This study is consistent in that the average of speech perception and HRQoL, excluding speech production, has improved by more than 30%. However, in this study, the speech production area alone showed less than 15% of improvement, which appears to have been affected by the fact that this study included adults with Partial Deafness, whereas only adults with Severe-Profound hearing loss were targeted in the study of Hinderink et al. (2000). The adults with Partial Deafness of this study showed that the average of their speech production area before CI already indicated 86.8% satisfaction, which can be interpreted as their quality of life in terms of speech production even before CI has affected the degree of improvement in post-operative scores.

Second, as a result of analyzing the difference between the adults group with Partial Deafness and the adult group with Severe-Profound hearing loss on speech perception and HRQoL, the Partial Deafness group showed significantly higher performance than the Severe-Profound hearing group in all monosyllabic, disyllabic word, and sentence speech perception tests before CI. In terms of HRQoL, the Partial Deafness group showed significantly higher performance than the Severe-Profound hearing loss group in the basic speech perception, advanced speech perception, and speech production areas corresponding to physical functions. However, there were no statistically significant differences between the two groups in the areas of self-esteem, activity limitation, and social interaction. This means that the adults with Partial Deafness have relatively low HRQoL satisfaction compared to their

speech perception performance, and that the subjective satisfaction level of adults with Partial Deafness who feel on their own in terms of psychological and social functioning is similar to the adults group with Severe-Profound hearing loss. This is consistent with the study of Amoodi et al. (2012), who reported that adults with post-lingual hearing loss with a HINT score of 60% or higher showed acceptable levels of performance on objective speech perception test conducted in quiet situations, but subjectively felt as difficult as CI subjects. These findings suggest that the HRQoL evaluation can be an important measure when considering CI subjects, and that evaluations should be made for the characteristics of each hearing loss type.

Both groups also showed degraded quality of life in the psychological and social functioning of HRQoL before CI. Looking into the study participants' average quality of life on psychological and social area of HRQoL before CI, it is interpreted that both groups, shown with 35 to 40 percent by adults with Partial Deafness and 27 to 31 percent by adults with Severe-Profound hearing loss, suffer from health-related self-esteem, participation in activities and social interaction. In fact, the psychological evaluation conducted by Soree Ear Clinic showed that over 70% of the participants complained of psychological difficulties such as depression, inferiority, and anxiety in the BDI (Beck Depression Inventory), SCT (Sentence Completion Test), and MMPI-2 (Minnesota Multiphasic Personality Inventory-2) tests. This is consistent with the pilot study in which the adults with Partial Deafness and Severe-Profound hearing loss showed significantly more psycho-pathological symptoms, such as depression and anxiety, and significantly lower health-related quality of life compared to adults with normal hearing (Cieśla et al., 2016; Fellinger et al., 2007; Hallam et al., 2006; Kerr & Cowie, 1997). Given that both groups are post-lingual hearing impairment adults, study compared with adults with pre-lingual hearing loss showed that post-lingual Partial hearing impairment adults indicated significantly lower satisfaction than adults with pre-lingual Partial hearing loss in the areas of NCIQ activity limitation and social interaction in Cieśla et al. (2016). While adults with pre-lingual Partial Deafness develop ways to cope with adjusting to corresponding effective communication strategies due to the lifetime experience of disability (Øhre et al., 2011), post-lingual hearing impairment adults tend to experience confusion and anxiety as they suddenly lost their fluent audio-verbal communication ability as a result of hearing loss. Consequently, it is

highly likely that post-lingual hearing loss patients are not engaged in social participation (Kerr & Cowie, 1997; Luey et al., 1995). Thus, both groups urgently require speech perception and communication recovery through CI, and in addition, it suggests that they need social support such as interaction with groups that can share psychological support for them and sense of homogeneity before CI.

After CI, there was no statistically significant difference in monosyllabic and disyllabic word speech perception between Partial Deafness adults group and Severe-Profound hearing loss adults group. However, the performance of Partial Deafness adults in the sentence was significantly higher than Severe-Profound hearing loss adults. One possible explanation for the above result is the use of 'low-frequency hearing'. In this study, only the speech perception of the CI ear was examined during the speech perception test. Consequently, it is interpreted that adults with Partial Deafness may have utilized the residual hearing of the CI ear in the sentence speech perception test. As the residual hearing in Partial Deafness adults group of this study was shown in 5 patients with complete hearing preservation and 8 patients with Partial hearing preservation, they were able to utilize residual hearing even when the other ear was blocked. Low frequency sounds below 500Hz are frequencies that convey suprasegmental elements and vowel, such as melodies of speech, rather than individual speech sounds/phoneme (Kramer, 2014), which affect sentence perception rather than words. Therefore, the improvement of operative technique that preserved the residual hearing of the CI ear and the opposite ear as much as possible, and the wearing of aid equipment that can utilize the residual hearing will have a positive effect on the sentence speech perception of adults with Partial Deafness.

When comparing HRQoL of two groups after CI, the Partial Deafness group, as in the pre-operative results, showed significantly higher performance than the Severe-Profound hearing loss group in the basic speech perception, advanced speech perception, and speech production areas, which are the physical functioning of HRQoL. In other words, after CI, there was no significant difference between two groups in monosyllabic and disyllabic word speech perception tests except for sentences, but it means that the hearing-related quality of life was higher in adults with Partial Deafness than adults with Severe-Profound hearing loss. While the speech perception test in this study is an evaluation conducted in a limited space such as a quiet situation

and a test room, the physical functioning of HRQoL is to evaluate the hearing-related quality of life in daily life. Accordingly, this can be interpreted that adults with Partial Deafness who can utilize low frequencies show higher satisfaction in real situations where noise situations or conversations between multiple talkers are required. The result of comparing the differences between the two groups in the psychological and social functioning of HRQoL found that the Severe-Profound hearing loss group's scores of self-esteem, activity limitation and social interaction tended to be lower than Partial Deafness group on average, but there was no significant difference between the groups. This is consistent with Kobosko et al. (2018)'s study that the comparison of self-esteem in four groups, which include patients with pre-lingual Partial Deafness, patients with pre-lingual severe-profound hearing loss, patients with post-lingual Partial Deafness and patients with post-lingual severe-profound hearing loss. They showed that the self-esteem of patients with post-lingual severe-profound hearing loss was weakest. However, the self-esteem of patients with post-lingual Partial Deafness and patients with post-lingual severe-profound hearing loss did not show statistically significant differences between the two groups. These results indicate that adults with Partial Deafness have a significantly higher quality of life satisfaction than adults with Severe-Profound hearing loss in the physical functioning of HRQoL. However, it means that the Partial Deafness group's quality of life in psychological and social functioning is similar to that of Severe-Profound hearing loss group.

Both groups score around 60% of their psychological and social function after CI. These results indicate that unilateral CI is not a perfect alternative for improving psychological and social quality of life for adults with post-lingual Deafness, and it suggests the need for follow-up studies on factors affecting the overall improvement in HRQoL satisfaction of adults with hearing loss as per hearing characteristics. In this study, among hearing loss whose HRQoL total score and each sub-area score were 80% or more after CI, P10 was the only patient with Partial hearing loss who received simultaneous bilateral CI in both ears. According to her actual report, she could hear sounds on both sides, so she had a little difficulty when she was in noisy places or talking with several people. This is consistent with the results of Olze et al. (2012), who reported that the speech perception scores correlated significantly with HRQoL in bilateral CIs rather than unilateral CI. Therefore, further

research is needed to determine whether bilateral CIs could be an alternative for improving HRQoL in adult CI subjects.

Taken together, the results of this study showed significant improvements in both speech perception and HRQoL sub-areas after CI for both adults with Partial Deafness and adults with Severe-Profound hearing loss. This confirmed that as well as adults with Severe-Profound hearing loss, adults with Partial Deafness who have a relatively high sentence speech perception score in a quiet situation could also receive positive help in the overall area of HRQoL with improved speech perception through CI. The results of analyzing the differences between groups in speech perception and HRQoL found that adults with Partial Deafness showed significantly higher performance than Severe-Profound hearing loss group in speech perception tests and HRQoL's physical functioning before CI. However, they indicated similar quality of life characteristics as adults with Severe-Profound hearing loss in psychological and social function. This means that, despite their relatively good speech perception ability, adults with Partial Deafness show the quality of life felt by adults with Severe-Profound hearing loss in psychological and social functions. After CI, there was no significant difference in word speech perception between two groups, but the sentence score of adults with Partial Deafness was significantly higher. It is interpreted that Partial Deafness adults' residual hearing has a positive effect on sentence perception. After CI, adults with Partial Deafness showed significantly higher performance in HRQoL physical function as pre-operation, but there was no significant difference in psychological and social function between the two groups. Both groups showed about 60% satisfaction in psychological and social function after CI. Consequently, after CI, it is necessary to develop an intervention program that can improve their psychological and social satisfaction, and carry out follow-up studies on factors affecting their HRQoL improvement. The results of this study suggest that HRQoL can be an important criterion for the selection of CI subjects, and assessment tools to sensitively evaluate the performance of adults with hearing loss for each hearing type should be prepared.

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Appendix 1. Items of Nigmegan Cochlear Implant Questionnaire

	영역	문항
		6. 당신이 일을 하거나 공부를 할 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		12. 당신이 운전을 하거나 차량들 속에 있을 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		18. 당신이 '소리를 잘 못 듣는 것'이 여가활동을 하는 동안에 심각한 문제가 됩니까?
		24. 당신이 '소리를 잘 못 듣는 것'이 가정생활을 하는 데에 심각한 문제가 됩니까?
		30. 당신이 '소리를 잘 못 듣는 것'이 쇼핑을 할 때 심각한 문제가 됩니까?
활동		36. 당신이 텔레비전을 볼 때 '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		41. 파티(예, 생일 잔치)에 참여하는 것에 당신의 '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		46. 공적인 문제들을 처리할 때, 청각장애가 심각한 문제가 됩니까? (예, 보험, 전세 계약 등)
		51. 당신이 외출을 하거나 여행을 갈 때 '소리를 잘 못 듣는 것'이 심각한 장애가 됩니까?
		55. '소리를 잘 못 듣는 것' 때문에 직장 또는 인간관계에서 나서지 못합니까?
		2. 당신이 건청인(청각장애가 없는 사람)들과 어울려 지내는 데에 '소리를 잘 못 듣는 것'이 심각한 장애가 됩니까?
		8. 당신이 청각장애인들과 어울려 지내는 데에 청각 장애는 심각한 문제가 됩니까?
		14. 취미 생활, 스포츠 활동 시 또는 주말에 여러 사람들과 어울릴 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		20. 함께 살고 있는 가족과 어울릴 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
사회적		26. 당신은 청각장애 때문에 회사에서 따돌림을 당합니까?
상호작용		32. '소리를 잘 못 듣는 것'이 심각한 문제가 될 수 있는 장소(예, 계모임, 콘서트 등)에 자주 갑니까?
		38. 이웃사람들과 어울릴 때, '소리를 잘 못 듣는 것'이 심각한 방해가 됩니까?
		43. 친구들과 어울릴 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		48. 가족들과 어울릴 때, '소리를 잘 못 듣는 것'이 심각한 문제가 됩니까?
		53. 여러 사람들과 대화하는 상황에서, 다른 사람들이 당신의 의견을 진지하게 받아들입니다? (그들이 당신의 청각장애를 알고 있어도)