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Research Article

Degree of Satisfaction among Postlingual Cochlear Implant Users in Oman

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Abstract

Background and Objectives: The reliability of cochlear implant in aural rehabilitation has been reported in numerous medical and healthcare related journals and its implementation are widely seen in many rehabilitation centers. However, the use of cochlear implants can be affected by the satisfaction of cochlear implant users. In addition, there is little or no data on the satisfaction of cochlear implant user in Oman in the literature. Hence this research considers conducting the study to find out the post-cochlear implantation satisfaction of postlingual Omani adult and adolescent users.

Subjects and Methods: The number of participants in this study was 21 (12 males and 9 females) and their age ranges from 15 years to 65 years. An Arabic version (back-to-back translated) of Satisfaction with Amplification in Daily Life (SADL) Questionnaire was used in the study to estimate the participants' satisfaction and was correlated with the participants' results of speech perception tests.

Results: All participants with the exception of one were satisfied as obtained from the SADL questionnaire. There was a significant correlation between the outcomes of speech perception tests with visual clues and the overall score of the SADL questionnaire ($r = 0.522$) and it is significant at $\alpha \leq 0.05$.

Conclusion: The results produced in this research are positive, further studies with a larger sample size are needed to generalize the findings.

Keywords: Satisfaction; Cochlear Implant; Oman; Satisfaction with Amplification in Daily Life

Abbreviations

dB: Decibel; SADL Questionnaire: Satisfaction with Amplification in Daily Life Questionnaire

Introduction

A multi-channel cochlear implant is implanted surgically and provides an alternative aural rehabilitation option for people with sensorineural hearing loss when they do not benefit from hearing aids. Clients with severe to profound sensorineural hearing impairment might not benefit from conventional hearing aids; therefore, the cochlear implantation may be an alternative or the only possible option for these clients [1]. Even with the availability of the most powerful hearing aids, these clients might also suffer from some hearing difficulties with their residual hearing [2]. These difficulties can arise even in good listening conditions for people with hearing disorders, such as having a conversation with only one speaker in quiet. One of the key reasons for these

difficulties is the altered sound perception caused by the damaged hair cells in the inner ear and narrow hearing dynamics [2]. Thus, for people experiencing these difficulties, cochlear implants may be a better option because these devices can convey the sound signal input directly to the vestibulocochlear (VIII) nerve and replace the role of the damaged hair cells in the cochlea [3].

As stated by an international survey on cochlear implant candidacy, the average audiometric threshold of more than 75 to 80 dB HL at frequencies above 1 kHz should be considered an indication for cochlear implantation [4]. The majority of cochlear implant recipients benefit immensely from their cochlear implants because of advancements in cochlear implant technology and clinical procedure, candidacy expansion, and early detection of hearing impairment in children [5]. However, some cochlear implant users may get undesirable outcomes, such as adults who do not develop excellent open-set speech recognition. Gaylor., *et al*. reviewed published literature on the usefulness of cochlear implantation in adults from January 2004 to May 2013 [6]. In this research, unilateral cochlear implantation in adults substantially impacts their quality of life and hearing. Many studies have shown that cochlear implantation can improve the understanding of older adults' speech [7].

The satisfaction of cochlear implant users can impact the use of cochlear implants. A limited number of studies are conducted to address this satisfaction [8]. Furthermore, there is also little or no data on cochlear implantation outcomes and cochlear implant users' satisfaction in Oman in the literature. Patients' perceived satisfaction can significantly impact the cochlear implant retention and successful use. Satisfaction is generally estimated subjectively and is determined by clients' experience. The user's satisfaction can be affected by communication difficulties after the intervention, the difficulties faced throughout rehabilitation, and users' aspirations in the audiology field [8]. One of the self-report satisfaction questionnaires used with cochlear implant users is the Satisfaction with Amplification in Daily Life (SADL) questionnaire. The SADL was first developed by Cox and Alexander in 1999 to assess hearing aid users' satisfaction and was then adapted to be used with cochlear implant clients in Ou., *et al*. study in 2008 [9]. The SADL was further evaluated for validity and reliability to measure cochlear implant users [10].

One should note that cochlear implantation is a costly aural intervention. Therefore, estimating the satisfaction after cochlear implantation of Omani cochlear users can further help to assess Oman's health services. Furthermore, it is useful to measure clients' satisfaction to indicate the effectiveness of the cochlear implantation program in Oman. This study would also help in providing the Arabic version (back-to-back translated) of Satisfaction with Amplification in Daily Life (SADL) Questionnaire and would aim to assess the satisfaction of cochlear implant adolescents and adults users in Oman.

Materials and Methods

Participants and inclusion criteria

The population of this study was Omani post-lingual adolescents and adults with sensorineural hearing loss. The participants must use their cochlear implants for at least one year before conducting the study. They must have multi-channel cochlear implants, and these cochlear implants are their primary intervention plan. Also, bimodal users and any coding strategy of cochlear implants are permissible for inclusion. In this study, patients with additional disabilities were excluded. This study was started after getting the ethical approval from the university (KHAS 48/18) and hospital/ the ENT department.

Research methods and recruitment

The researcher explained the nature and purpose of the study to all participants, who were then asked to sign the informed consent form. An audiologist performed audiological tests, namely the free-field audiometry test for all participants. Upon conclusion of the test, participants were requested to fill the SADL questionnaire. The researcher then collected the results of the audiological tests and SADL questionnaire for further analysis.

Research procedure

The audiological tests

Sound field audiometry and speech audiometry were performed for every participant. Regarding a speech audiometry test, the word recognition score was obtained by an open set of 20 monosyllabic words, transmitted using an audiometer with loudspeakers to generate a monitored live voice. These monosyllabic words are phonetically balanced monosyllabic classical words evaluated for their familiarity and homogeneity in the Saudi population [10]. These words are either taken from newspapers, children's stories, and primary school books [10]. In Omani schools,

universities, and mass media such as TV news, classical Arabic is the teaching language. Therefore, the Saudi monosyllabic Arabic words are used as speech materials in Omani speech audiometry. The speech audiometry tests were administered in a sound-proof booth via loudspeakers, placed in front of the client at around 80 cm away from the client at the same height as the client's head.

In the study of Ashoor and Prochazka (1982), 74 normally hearing students and staff members of the same university were involved in a speech audiometry test where speech level hit > 90% above 50 dB and nearly 100% at 55 dB [10]. Thus, the speech level was set at around a typical conversational level (55 dB HL) to determine the cochlear implant benefits. The speech audiometry test was also in a quiet environment and was performed under both auditory-visual listening and auditory-only situations. The score of the test was based on the percentage of the words that were correctly recognized.

Regarding aided sound field audiometry, frequency-modulated tones (warble noise) were used as a signal. The sound sources represented two loudspeakers positioned about 1m away from the client and nearly head height for a sitting client. These loudspeakers were situated at a 45° angle from the reference point (the listener's head) on the client's right and left sides. The client's hearing response threshold was then considered the lowest intensity level of the sound signals responded by the client. Then, at 500, 1000 and 2000 Hz, the client's average hearing threshold was measured and recorded.

The translation of SADL questionnaire

English is the default language used by SADL questionnaire (Appendix 1), whereas the population of the study participants is Arabic native speakers. Hence, the English version of the SADL questionnaire is translated into Arabic, and then it is translated back into English.

Firstly, the English version of SADL is translated into Arabic by a professional bilingual (Arabic/English) translator. Then, this Arabic version of the SADL is translated back into English by another professional bilingual (Arabic/English) translator who is not familiar with the original English version of SADL.

In order to adopt an Arabic version of the SADL questionnaire in Omani culture and get a face validation of the Arabic version of SADL questionnaire, five cochlear implant users, who were not eligible to be included in this study, were asked to fill the Arabic version of SADL questionnaire as a pilot study before eventually using it in the main study (Table 1). This questionnaire's internal consistency was then estimated by using Cronbach's Alpha, as shown in table 2. The result of Cronbach's Alpha coefficient was 0.769, which reflects excellent internal consistency. Taking their opinion about the SADL questionnaire, the results are compared with their subjective overall satisfaction with the cochlear implant. The pilot study outcome showed that the designed Arabic version of the SADL questionnaire could measure cochlear implant users' satisfaction.

Participants	Gender	Means	Satisfied/Dissatisfied
1	Male	3.87	Satisfied
2	Male	4.73	Satisfied
3	Male	4.8	Satisfied
4	Female	5.67	Satisfied
5	Male	3.6	Satisfied

Table 1: The results of the Arabic version of SADL in the pilot study.

Reliability Statistics	
Cronbach's Alpha	N of Items
0.767	15

Table 2: Cronbach's alpha reliability coefficient.

After the pilot study, question number 14 was not specific in an Omani populace because the Ministry of Health provides cochlear implants freely. However, spare parts and cochlear implant repair are considered relatively expensive for them compared to repairing hearing aids. Therefore, question number 14 is modified by adding the spare parts' price for the cochlear implant and repairing them as the final version of the SADL-Arabic questionnaire. Finally, all versions of SADL are reviewed by two experienced audiologists who are fluent in Arabic and English languages.

In this study, the final Arabic version of the SADL questionnaire was then used, and all participants completed it in a room with the examiner's presence. The examiner would give a brief explanation if the participant required a clarification that is related to some doubtful questions without interfering in any manner with their answers.

The score system of SADL questionnaires

The SADL gives an overall score of satisfaction. Questions 1, 3, 5, 6, 8, 9, 10, 11, 12, 14 and 15 have the "not at all" that indicates complete dissatisfaction with a score of 1, while the "very much" indicates total satisfaction with a score of 7 [8]. On the other hand, questions 2, 4, 7, and 13 are considered the "not at all" total satisfaction with 7, whereas the "very much" indicates complete dissatisfaction with a score of 1.

After finding the mean scores of the SADL questionnaire, the participants were listed, depending on their results, as dissatisfied or satisfied groups. Participants who get a mean score of > 3.5 scores will be in the "satisfied" group, while those with ≤ 3.5 will be in the "dissatisfied" group [8].

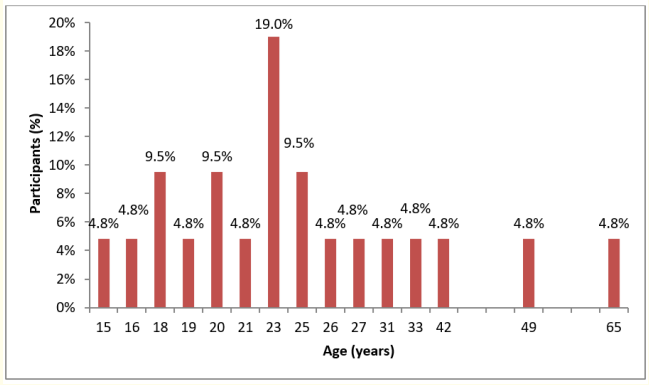

Figure 1: Patients' actual age distribution.

Results

Participants

The total number of Omani post-lingual adolescents and adults who met the study's criteria was 30 from local hospital data. Nine of postlingual cochlear implant users did not participate due to reasons. Therefore, the number of participants in this study was 21 (12 males and 9 females) and their age ranges from 15 years to 65 years as shown in figure 1. All participants in this study have a unilateral cochlear implant because the hospital only offers a single cochlear implant device per patient for free in Oman. Only six participants had speech perception tests before their cochlear implantation surgery, as retrieved from their medical files. The reason for obtaining a few preimplantation speech test results is that these tests are not included in cochlear implantation criteria at the hospital. Furthermore, these speech tests were carried out using different speech materials, i.e. sometimes using sentences or monosyllabic words. Therefore, it is impossible to compare the results of these tests to speech perception tests after cochlear implantation. This became one of the limitations imposed on the study due to improper record keeping.

The audiological tests

In this research, all participants had a speech perception test (with and without visual clues) and aided audiometry. Figure 2 and 3 indicate participants' speech perception tests. The highest result of the speech perception test with visual clues was 100%, and its minimum score was 20% with a mean score of 75%, whereas the maximum result of speech perception without visual clues was 90%, and its minimum score was 0% with a mean score of 36.9%. The aided audiometry results of participants are shown in figure 4. From the computational data, the mean aided audiometry average for participants was 32.35 dB HL (Figure 2). It also shows that 15 participants got their results of aided sound field audiometry average (500, 1000, and 2000 Hz) between 20 and 40 dB HL, whereas four participants had their results from 50 to 60 dB HL. Three participants only had their results of aided audiometry below 20 dB HL.

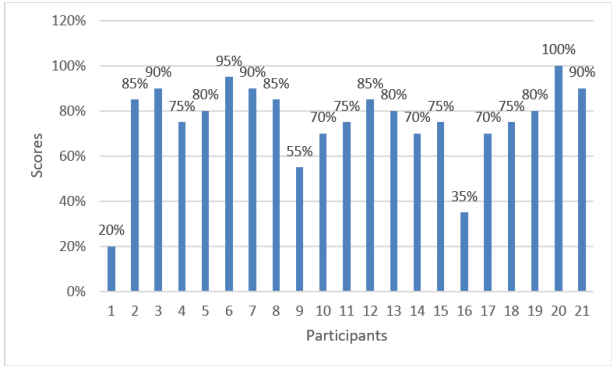

Figure 2: Speech perception test with a visual clue in percentile.

Results of the SADL questionnaire

All participants filled the Arabic version of the SADL questionnaire and figure 5 illustrates that the participants' mean value re-

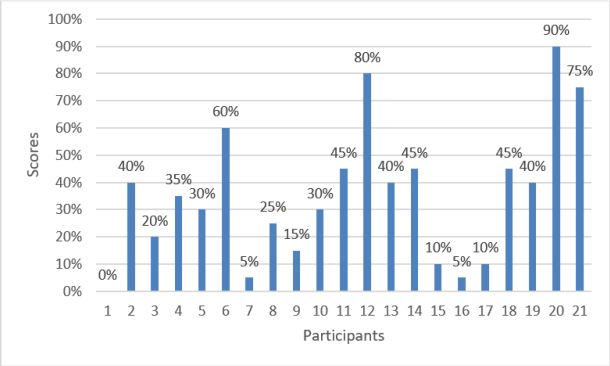

Figure 3: Speech perception test without a visual clue in percentile.

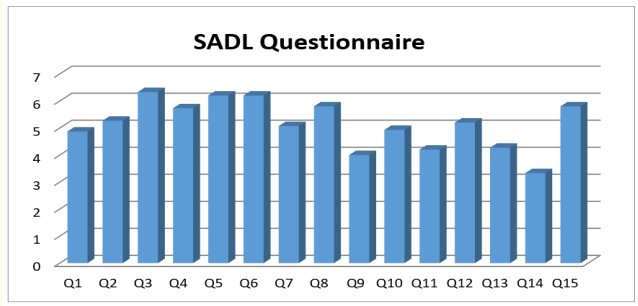

Figure 5: Participants' mean value response to questions of Arabic SADL questionnaire.

Figure 6: Boxplot of satisfaction questionnaire results.

Figure 4: Aided sound field audiometry average.

sponse per each question. The highest average score was in question 3 and the lowest score was in question 14. The overall results from the Arabic version SADL questionnaire are thus illustrated in figure 6 which shows the mean for all participants' overall scores. Their overall score ranges between 3.19 and 6.06. These results indicate that all participants were satisfied except for one client who got an overall score 3.19 in SADL questionnaire.

A correlation between SADL questionnaire results and postimplant speech audiometry results and Aided audiometry average was conducted using the Pearson correlation coefficient (SPSS) in table 3 and 4, respectively. In table 3, there was a significant correlation between the outcomes of speech perception tests with visual clues and the overall score of the SADL questionnaire ($r = 0.522$), and it is significant at $\alpha \leq 0.05$. This means that when the speech perception tests with Visual clues increase, client satisfaction increases. However, there was no significant correlation between the results of speech perception tests without visual clues and the overall score of the SADL questionnaire ($r = 0.261$), and it is not significant ($\alpha \geq 0.05$). In table 4, a negative correlation having significance between aided audiometry average (dB HL) and the overall scores of the SADL questionnaire ($r = 0.443$-), which is significant at $\alpha \leq 0.05$. This correlation means when the aided

Correlation		Questionnaire SADL
The results of speech perception tests (with Visual clues)	Pearson Correlation	0.522*
	Sig. (2-tailed)	0.015
	N	21
The results of speech perception tests (without visual clues)	Pearson Correlation	0.261
	Sig. (2-tailed)	0.253
	N	21

Table 3: Correlation between SADL questionnaire results and postimplant speech audiometry results of Omani post-lingual clients with cochlear implantation.

Note: Significance at $\alpha \leq 0.05$.

Correlation		Questionnaire SADL
Aided audiometry average (dB HL) post	Pearson Correlation	-0.443*
	Sig. (2-tailed)	0.044
	N	19

Table 4: The correlation between the overall scores of the SADL questionnaire and Aided audiometry average

Note: Significance at $\alpha \leq 0.05$.

audiometry average (dB HL) of participants increases, their satisfaction decreases.

Discussion

Nowadays, as implant technology and speech processing are dramatically enhanced, most post-lingual cochlear implant users can recognize some open-set monosyllable words and sentences [11]. The mean scores on an English word in speech perception test in quiet ranges from 35% to 45%, and the personal performance ranges from 0% to 90% [11]. There are considerable unexplained variations in the speech recognition performance among cochlear implant users, although postoperative speech recognition tests in quiet indicate that the mean of monosyllable words and words in sentences are nearly 60% and 70%, respectively [12].

The participants' performance on the speech perception test with visual clues ranged from 20% to 100% with a mean score of 75%, whereas their performance on speech perception without visual clues was between 0% and 90% with a mean score of 36.9% in this study. The participants' average scores from the speech audiometry test with and without visual clues are considered relatively within expected speech performance values after cochlear implantation. In table 5, some examples of studies that conducted a word recognition test are shown with values ranging from 36% to 69%. Moreover, the participants with poor speech audiometry tests without visual clues are expected to have communication difficulties in situations where they can't see the speaker's face, such as phone calls.

Article	The mean of the word recognition test
Capretta and Moberly (2016)	69%
Damen, Beynon, Krabbe, Mulder and Mylanus (2007)	36%
(Olze., *et al*. 2012)	56%

Table 5: Studies which conducted word recognition test.

In addition, the complex communication, which the people with hearing loss face every day, is inadequately represented by speech recognition tests [13]. Some cochlear implant users still struggle in their daily activities, even when they perform so well in speech audiometry in the clinic [14]. Hence, the speech audiometry alone in a clinical setting is more likely to provide inadequate ideas about cochlear implantation's benefits and limitations [14]. To improve speech recognition performance without visual clues, the participants can follow an active aural rehabilitation therapy following the implantation because of the degraded speech signals received from their cochlear implant processors. Although the availability of advanced cochlear implant technology and processing strategies is over 30 years, this degradation of speech signals is considered the main limitation of cochlear implant usage [12]. Therefore, many cochlear implant users require a more extensive, focused aural rehabilitation (6 months or more) to revitalize or make sense of their speech signal degradation [12].

In the SADL questionnaire, only one person in this study got a dissatisfaction result. The findings of the Arabic version of the

SADL questionnaire in this study indicate that cochlear implant satisfaction among Omani post-lingual cochlear implant users is very positive. These positive results are compatible with previous research, which showed that even adult cochlear implant users with early-onset hearing loss are satisfied with their implant [15].

Open-set speech audiometry tests are commonly used to measure cochlear implant success [15]. However, cochlear implant users can acquire considerable functional benefits from their implants, even though they do not exhibit significant improvements in their speech skills [14]. Furthermore, satisfaction as a result of hearing devices usually represents the user's overall satisfaction with the experience of using the hearing device, as well as the accessibility to services, the competence service provider, and the device comfort [16]. The positive SADL questionnaire results in this study suggest that the cochlear implantation as an aural intervention for the participants in this study was a useful intervention.

The overall score of the Arabic version SADL questionnaire had a significant correlation with the results of speech perception tests with visual clues (r = 0.522), and it is significant at α ≤0 05. This indicates that improving the participant's receptive communication skills, especially with visual cues, makes them more satisfied. Moreover, the overall score of the Arabic version SADL questionnaire had a significant negative correlation with aided audiometry average (dB HL) (r = 0.443-) and it is significant at α ≤0 05. This indicates that improving the participant's access to external sound, makes them more satisfied. Satisfaction affects device retention since a satisfied hearing device user is usually using his device consistently [10]. Therefore, more Omani cochlear implant user will use their cochlear implant consistently.

First, the study's most significant limitation was the refusal of some patients to participate in this study. Nine of those post-lingual adolescents and adults who are found to match the research inclusion criteria did not participate in this study due to many reasons. For example, some of them refused to participate in this study because of their medical condition, such as pregnancy or study commitments. However, gender heterogeneity was limited in the study because it contains 12 males and nine females.

Live voice is less reliable than recorded voice, but it is convenient and may decrease administration time in speech audiometry [17]. This is because the fast action of an audiometer's volume unit meter cannot examine less intense constant information, which is necessary for speech performance in suprathreshold recognition testing [17]. There are also some disadvantages in using mono/disyllabic Arabic words in the speech perception tests. For instance, some words might not represent a genuinely open set and can be overused. Moreover, the word recognition score can be affected by the clients' familiarity with the language [17]. Additionally, using sentences or phrases in speech perception tests can expect real-world performance with high face validity [17].

Conclusion

All participants except one person of post-lingual adolescents and adults cochlear implant users in Oman are satisfied with their cochlear implant aural intervention. Their mean score on the speech perception test with visual clues was 75%, whereas their mean score on the speech perception test without visual clues was 36.9%. Such positive findings prove the feasibility of cochlear implantation in Oman as an aural intervention and qualify cochlear implants as an appropriate option for a post-lingual patient with severe to profound sensorineural hearing loss. However, the speech materials should be improved in Oman, and the CD player should conduct the speech stimuli in order to get standard speech perception results. Besides, the speech audiometry should be done preimplantation as a parameter for candidacy and a baseline to examine the improvement following all clients' implantation, especially for post-lingual clients.

This study also showed the importance of using subjective measures, such as SADL, to assess cochlear implant outcomes. Therefore, these subjective outcomes measures should be routinely used. For assessment of a cochlear implant, other quality of life questionnaires may also be included, and it is better to have an Arabic version of these questionnaires in the audiology clinic.

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Conflict of Interest

This article is a part from my thesis which was done at International Islamic University Malaysia (IIUM). This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Appendix 1

Figure

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