OUTCOMES AND FACTORS IMPACTING COCHLEA IMPLANTATION AMONGST ADULTS IN OMAN

BY

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ABSTRACT

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 most rehabilitation centers. However, there are underlying factors which differ from location to location. In patients report from different demographic data, a clear difference is usually seen when they underwent such implantation either due to the post implantation procedures or patient's pre-implantation condition. Hence this research considers conducting the study to find out the post-cochlear implantation satisfaction and speech recognition outcomes of postlingual Omani adult and adolescent users in other to identify the underlying factors that affect these outcomes. An Arabic version (back-to-back translated) of Satisfaction with Amplification in Daily Life (SADL) Questionnaire, aided audiometry, and speech audiometry (with/ without visual clues) were used to assess cochlear implantation outcomes in an Omani demographics. In the study, participants' mean score of speech perception test with visual clues was 75%, whereas their mean score on speech perception test without visual clues was 36.9%. Subsequently, all participants with the exception of one were satisfied as obtained from the SADL questionnaire. Furthermore, this research was able to obtain a significant correlation between the results of speech perception tests with visual clues and the overall score of SADL questionnaire ($r=0.522$) with a significance at $\alpha \leq 0.05$. It further indicates that an improvement from the participant's receptive communication skills makes them more satisfied. Although, the results produced in this research are extensive, limited onsite participant from key rehabilitation center imposed some limitation on the sample size in this study.

خلاصة البحث

ورد في العديد من المجلات التي لها علاقة بالرعاية الطبية والرعاية الصحية عن موثوقية زراعة القوقعة الصناعية في إعادة التأهيل السمعي ويرى أن يتم تنفيذها على نطاق واسع في معظم مراكز إعادة التأهيل. ومع ذلك ، فإن هناك عوامل أساسية والتي تختلف من مكان لآخر. في المرضى المعلن عنهم في البيانات الديموغرافية المختلفة ، عادة ما يكون هناك فرق واضح عندما يخضعوا لعملية الزرع ويعود هذا إما لإجراءات ما بعد الزرع أو حالة ما قبل الزرع . ومن هنا فإن هذا البحث يدرس إجراء الدراسة لمعرفة مدى رضا مرحلة ما بعد زراعة القوقعة ونتائج التعرف علو عبارات للمستخدمين البالغين والمراهقين العمانيين في مرحلة ما بعد النطق من أجل تحديد العوامل الأساسية التي تؤثر لو هذه النتايج . وقد م استخدام نسخة باللغة العربية (مترجمة تبادليا) من الاستمتاع بالتضخيم في الحياة اليومية (SADL) الاستبيان ، قياس السمع باستخدام المساعدة ، وقياس السمع الكلام (مع/ بدون أدلة بصرية) لتقييم نتائج زرع القوقعة في التركيبة السكانية العمانية. في الدراسة، كان متوسط درجة إختبار الإدراك الكلامي "للمشاركين" مع الدلائل لبصرية 75% ، في حين أن متوسط درجة إختبار الإدراك الكلامي دون دلائل بصرية كان 36.9% . وبالتالي ، كان جميع المشاركين باستثناء واحدا كانوا راضيين حيث تم الحصول على هذه النتيجة من استبيان SADL . وعلاوة على ذلك ، فإن هذا البحث ادرا على الحصول على ارتباط كبير وملحوظ بين نتائج اختبارات إدراك الكلام مع الدلائل البصرية والنتيجة الكلية لاستبيان SADL (=0.522) مع دلالة عند $\alpha \leq 0.05$. و يشير أيضا إلى أن تحسين مهارات التواصل لدى المشتركين مما يجعلهم أكثر رضا . على الرغم من أن نتائج هذا البحث شاملة ، فإن المشارك في الموقع المحدد من مركز إعادة التأهيل الرئيسي يفرض بعض القيود على حجم العينة في هذه الدراسة.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Health Science.

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LIST OF SYMBOLS

dB	Decibel
dB HL	Decibel
Hz	Hertz
α	Alpha
r	Correlation coefficient

LIST OF ABBREVIATIONS

ASHA	American Speech-Language-Hearing Association
CT	computed tomography
EAS	electric-acoustic stimulation
FDA	Food and Drug Administration
MRI	Magnetic resonance imaging
MED-EL	Cochlear Company
QOL	related quality of life
RObj	Research Objectives
SADL	Satisfaction with Amplification in Daily Life
SPL	sound pressure level
UK	United Kindom
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Oman is a beautiful country that is located on the south-eastern coast of the Arabian Peninsula. It has an estimated population of 5.1 million people, and it has become one of the top countries worldwide, thanks to its rapid socio-economic growth and healthcare investment that utilizes health resources (Al Khabori and Khandekar, 2004). The Ministry of Health of Oman considers the evaluation and management of hearing loss as a major health challenge that should be addressed. According to a report conducted by Turton and Smith (2013), an average of 10 million people in the United Kingdom (UK) have deafness or some other sort of hearing impairment (representing 1 out of 6 individuals in the United Kingdom). On the other hand, Al Khabori and Khandekar (2004) reported the prevalence of hearing loss in both ears as 55/1000 in Oman. Al Khabori and Khandekar have also found that middle ear diseases represent 25% of the total hearing loss etiologies. They have found that the highest cause of hearing loss was presbycusis due to a non-infectious disease in Oman. Thus, one could infer from this why the Ministry of Health prioritized hearing impairment in its health plan.

Omani Ministry of Health initiated a universal hearing screening policy for neonates to become one of the national child health care programs in 2001 (Khandekar, Khabori, Mohammed, & Gupta, 2006). After applying this policy, the detection and management of hearing impairment became earlier amongst young children. Then, many of those children with hearing impairment are moved to Al-

Nahdha Hospital, the tertiary hospital in the capital of Oman, Muscat, for further aural rehabilitation plans that may require cochlear implantation. Al-Nahdha Hospital also happens to be the only public hospital that performs cochlear implantation in Oman.

1.2 STATEMENT OF THE PROBLEM

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 (Huinck, Mylanus, & Snik, 2019). According to Lachowska, Pastuszka, Glinka, & Niemczyk (2014), even with the availability of the most powerful hearing aids, these clients might also suffer from some hearing difficulties with their residual hearing. 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 (Lachowska et al., 2014). 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 (Wilson, 2008).

As part of the Ministry of Health initiatives in Oman today, a team of cochlear specialists at Al-Nahdha Hospital has decided to provide cochlear implants as an aural rehabilitation intervention for adults and children. Al-Harthy, a senior specialist at Al-Nahdha Hospital, estimated that over 200 patients received cochlear implantation in Oman. However, some post-lingual adults and adolescents, who had cochlear implants at Al-Nahdha Hospital, indicated that they had found some difficulty

following up with a conversation. Those were noted to have become inconsistent cochlear implant users (S. Al-Harthy, personal communication, 2014).

Many factors may affect the outcomes of cochlear implantation. For instance, postoperative speech understanding, which is one of the effects of cochlear implantation in adults, may be impacted by the extent of deafness and the period of use for the cochlear implant (Beyea et al., 2016; Sladen & Zappler, 2015). Moreover, the competence of the auditory and spoken language before cochlear implantation, personal motivation, family attitudes, and client's expectations are considered as other factors that can affect cochlear implantation outcomes (Niparko, 2009). The satisfaction of cochlear implant users can impact the use of cochlear implants. According to Buarque et al. (2014), a limited number of studies are conducted to address this satisfaction. Furthermore, there is also little or no data on cochlear implantation outcomes and cochlear implant users' satisfaction in Oman in the literature (Al Khabori & Khandekar, 2004). Therefore, estimating the satisfaction and outcomes after cochlear implantation of Omani cochlear users can further help assess Oman's health services.

One should note that Cochlear implantation is a costly aural intervention. Therefore, determining the outcomes of cochlear implantation in Oman may help improve the health services offered to Omani patients since measuring the outcomes of any healthcare intervention is vital in improving health services. Outcome measurement can also refine the intervention of delivery and obtain feedback on the effectiveness of any intervention. Furthermore, it is useful to measure clients' satisfaction to indicate the effectiveness of the cochlear implantation program in Oman. Besides, measuring the effectiveness of cochlear implantation may provide

evidence for the Ministry of Health in Oman to continue supporting its cochlear implant program.

This study would also help in providing the outcomes of cochlear implantation in post-lingually deafened Omani adolescents and adults and would aim to:

i) find out the speech outcomes of post-lingual adults and adolescents who had their cochlear implantation surgery in Al-Nahdha Hospital,

ii) identify potential factors that may impact these outcomes, and

iii) assess the satisfaction of cochlear implant users in Oman.

1.3 RESEARCH OBJECTIVES

The objective of this research is to determine:

1- The findings of post-lingual adults and adolescents after cochlear implantation in Oman.

2- The factors that can affect these outcomes.

3- The satisfaction of post-lingual Omani clients after cochlear implantation.

1.4 RESEARCH METHODOLOGY

This study aims to obtain the post-cochlear implantation satisfaction and speech recognition outcomes from post-lingual adult and adolescent users in Oman and identify the factors that might influence Oman's outcomes. Therefore, the appropriate methodology of this research would be:

1. To measure and determine postimplant speech recognition outcomes of Omani post-lingual clients with cochlear implantation.

2. To measure their preimplant average of pure-tone threshold in the better ear versus a postimplant average of sound field aided audiometry.
3. To measure the satisfaction of Omani post-lingual clients with cochlear implantation through administering the SADL questionnaire.
4. To measure the correlation between SADL questionnaire results and postimplant speech audiometry results of Omani post-lingual clients with cochlear implantation.
5. To measure the correlation between SADL questionnaire results and a postimplant average of sound field aided audiometry of Omani post-lingual clients with cochlear implantation.
6. To measure the correlation between the postimplant averages of sound field aided audiometry and postimplant speech audiometry results of Omani post-lingual clients with cochlear implantation.
7. To measure the correlation between the duration of cochlear implant use and postimplant speech audiometry results.
8. To measure the correlation between Implantation age and postimplant speech audiometry results

1.5 RESEARCH SCOPE

The scope of this research is limited to ascertaining post-cochlear implantation speech recognition outcomes of post-lingual adult and adolescent users in Oman by considering whether these clients are satisfied after cochlear implantation or not. It is also limited to measuring and validating whether cochlear implants' duration and the

duration of deafness can affect the outcomes of post-cochlear implantation speech recognition for those clients.

1.6 THESIS ORGANIZATION

This thesis contains five chapters. Chapter one presents a conceptual layout of the whole dissertation. It starts with a brief motivation, problem statement, research scope and objectives, and a brief methodology. In chapter two, a concise literature review is presented and thoroughly discussed. The research methodology employed in achieving the three research objectives has been fully discussed in chapter three. The results of the study are analysed and discussed in chapter four. Finally, chapter five comprises the concluding remarks, limitations, future works, and recommendations to other forthcoming researchers.

1.7 DEFINITIONS OF TERMS

1.7.1 Post-lingual hearing loss

The hearing loss which is acquired after the complete acquisition of language skills.

1.7.2 Prelingual hearing loss

The hearing loss which is acquired before the spoken language is gained.

1.7.3 Duration of deafness

The period from the onset of severe to profound hearing loss to the cochlear implant operation.

1.7.4 Implantation age

The age of a client when he/she got the cochlear implant operation.

1.7.5 Sound field audiometry

An audiological test examines the client's hearing level by using acoustic stimuli presented through one loudspeaker or more in a test room.

1.8 THE SUMMARY OF THE CHAPTER

This chapter has given and discussed the study background. It has also explained the significance of the health resource optimal utilization to provide better care for a community with hearing impairments. Furthermore, the problem statement was covered in this chapter, and it was set to determine post-lingual adults and adolescents' outcomes with cochlear implantation and the factors that affect these outcomes. This chapter also provided the research objectives. It also presented the proposed methodology to achieve these objectives. The scope of the study then highlighted the limitations of this study. Finally, a brief definition of the critical terms was given in this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This research aims to determine the satisfaction and speech recognition outcomes of post-cochlear implantation in post-lingual adult and adolescent users in Oman and to identify the factors that could affect these results. Accordingly, it is crucial to check out both the definition and importance of the constitution of human hearing and hearing impairment's pathophysiology. The analysis will demonstrate the significance and benefits to patients of cochlear implants.

2.2 The Human Auditory System

The auditory system is generally responsible for converting pressure variations generated by sound waves that approach the ear into nerve signals decoded in the brain. The human ear can be divided into three parts: the outer ear, the middle ear, and the inner ear.

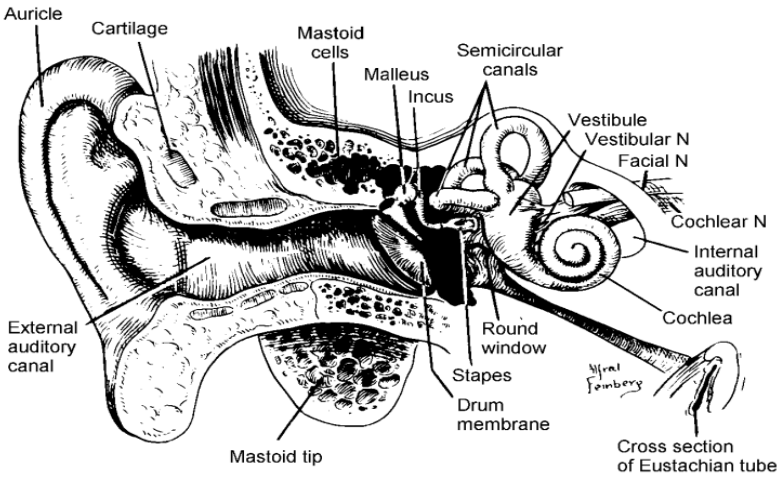

Figure 2.1 The Human Auditory System (Alberti, 2001)

The outer ear consists of the auricle and the external auditory meatus (Figure2.1). The tympanic membrane is located at the end of the external auditory meatus. The middle ear is the air-filled cavity behind the tympanic membrane, and it is connected to the pharynx by the Eustachian tube. The inner air is situated medial to the middle ear. The ossicular chain (malleus, incus, and stapes) connects the tympanic membrane to the oval window. The inner ear, or cochlea, has the sensory organs of hearing and balance. The inner ear contains the vestibule, the snail-shaped cochlea, and the three semicircular canals. The cochlea is the part of the inner ear, which is involved in the ear's auditory function. It has the auditory sensory organ (organ of Corti). The organ of Corti has the hair cells, which are the sensory receptors for hearing. These hair cells are connected to the nerve cells, which make up the eighth cranial nerve (vestibulocochlear nerve). The eighth cranial nerve enters the internal auditory meatus to reach the brainstem. In the brainstem, the auditory parts go to the cochlear nuclei, whereas the nerve's vestibular portions go to the vestibular nuclei.

The conductive system consists of the outer and middle ear since their function is to deliver the sound waves to the inner ear. The sensorineural system includes the cochlea and vestibulocochlear nerve as they involve three functions: the physiological response to sound, the nerve cell activation, and the converting of the sensory response into a neural signal (Gelfand, 2001).

Auditory activation involves the following serial events. The outer ear collects and channels sound energy toward the comparatively small surface of the tympanic membrane. After the sound enters the ear, the oscillation of the tympanic membrane, due to sound waves, causes vibrations in the middle ear three ossicles. These vibrations are transmitted from the middle ear to the cochlear fluid by moving the stapes footplate in the oval window. The middle ear system acts as a mechanical transformer to overcome the mismatch of impedances between air and the cochlear fluid.

There are three ways to achieve the function of the middle ear transformer (Bailey, Johnson, & Newlands, 2006). These mechanisms are the broad area of the tympanic membrane compared with the oval window, the curved tympanic membrane buckling effect, and the ossicles' lever-action. The vibratory motion of the cochlear fluid stimulates the hair cells of the organ of Corti. Hair cells stimuli activate auditory neurons that carry the signals to the nervous system. These signals (neural codes) are processed in the cortical auditory center.

2.3 Hearing Impairment

According to the National Institute on Disability and Rehabilitation Research Hearing, impairment refers to a functional limitation to hear a regular conversation (Meyer,

2011). Hearing loss could be categorized into four primary dimensions: degree, onset, etiology, and time course (Tye-Murray, 2014). The World Health Organisation (WHO) census around 466 million people (432 million adults and 34 million children) worldwide have a hearing impairment that affects their daily life, and more than 900 million people are expected to have a hearing impairment by 2050 (WHO, 2018).

2.3.1 Degree of Hearing Impairment

The pure-tone average refers to the average of hearing levels at a set of specified frequencies: typically: 500, 1000, and 2000 Hz may determine the degree of hearing impairment (Tye-Murray, 2014). The severity of hearing loss is determined by the degree of hearing loss (American Speech-Language-Hearing Association, 2015). A person with a hearing threshold of 25 decibels (dB) or higher in both ears is considered to have normal hearing. Hearing impairment can be considered mild, moderate, moderate-to-severe, or profound based on the pure-tone average, as shown in Table 2.1 (Tye-Murray, 2014). The American Speech-Language-Hearing Association (ASHA) has another hearing loss classification system, and Table 2.2 shows the degree of hearing loss used by ASHA (American Speech-Language-Hearing Association, 2015). According to WHO, hearing impairment becomes disabling when the better ear's hearing impairment level exceeds more than 40 dB in adults and more than 30 dB in children (WHO, 2018). Hard hearing refers to having a mild, moderate, or moderately severe hearing loss (Tye-Murray, 2014). A person can be called deaf when he/she has either profound or sometimes severe hearing loss.