COMPARING THE HEARING THRESHOLD BETWEEN POSTERIOR AURICULAR MUSCLE RESPONSE (PAMR) AND PURE TONE AUDIOMETRY (PTA) IN IMPAIRED HEARING INDIVIDUALS

By

DR AIFAA BINTI ABDUL MANAN

Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Medicine (Otorhinolarnyngology-Head and Neck Surgery)

UNIVERSITI SAINS MALAYSIA
2015

ACKNOWLEDGEMENT

Thanks to Allah, the Most Merciful and Most Grateful and with His blessings has allowed me to complete this study without much difficulty. I would like to express my deepest gratitude and appreciation to my supervisors, Dr Nik Adilah binti Nik Othman, Dr Mohd Normani bin Zakaria and Prof Madya Dr Rosdan Salim who has inspired me and giving me unrelentless support and guidance in completing this dissertation. Their constructive criticism and valuable guidance has helped me through the hassle and obstacles during field works and writing up the study.

My sincere appreciation to Prof Baharuddin Abdullah, the Head of Department ORL-HNS, USM for his invaluable advises and support throughout the year. Special thanks to Mrs Rosninda, the audiologist, for her patience and hard work. I am also indebted to all my fellow colleagues and all staffs of Otorhinolaryngology , School of Medical Science and unit of Audiology Unit Hospital USM, past and present; for rendering generous support and willing assistance in contributing to this study.

My warmest thanks also go to Dr Najib Majdi bin Yaacob, lecturer from Biostatistic department for helping me with the statistical analysis.

Finally, I have received enormous continuous support, understanding and patience from my beloved husband, Dr Mohd Sufian Ardi, our child; Muhammad Al Fateh, my parents and the rest of my family for their fullest love and unconditional support, understanding and cooperation throughout my postgraduate study. Without their support, this study would not have been successful and memorable.

TABLE OF CONTENTS

CONTENTS **PAGE**

CHAPTER 2: OBJECTIVES OF STUDY

CHAPTER 3: METHODOLOGY

LIST OF ABBREVIATIONS

AABR	Automated auditory brainstem response
ABR	Auditory brainstem response
AEP	Auditory evoked potential
BAER	Brainstem auditory evoked response
BOA	Behavioural observation audiometry
CHL	Conductive hearing loss
CM	Cochlear microphonic
dB	Decibel
dB HL	Decibel hearing loss
dB nHL	Decibel normal hearing loss
DT	Distraction test
EAC	External auditory canal
Hz	Hertz
kHz	Kilo Hertz
MHL	Mixed hearing loss
OAEs	Otoacoustic emissions
OHCs	Outer hair cells
P-audio	Play audiometry
PAM	Posterior auricular muscle
PAMR	Posterior auricular muscle response
PTA	Pure tone audiometry

SD	Standard deviation
SNHL	Sensorineural hearing loss
USM	Universiti Sains Malaysia
VRA	Visual reinforcement audiometry
VEMP	Vestibular evoked potential
WHO	World Health Organization

LIST OF FIGURES **PAGE**

LIST OF TABLES **PAGE**

ABSTRAK

BAHASA MALAYSIA VERSION

TAJUK KAJIAN:

MEMBANDINGKAN NILAI AMBANG PENDENGARAN DALAM KALANGAN SUBJEK DEWASA YANG MEMPUNYAI PENDENGARAN ABNORMAL MENGGUNAKAN UJIAN RESPON OTOT BELAKANG TELINGA (PAMR) DENGAN UJIAN AUDOMETRI NADA TULEN (PTA)

PAMR adalah merupakan ujian objektif elektrofisiologi untuk menentukan ambang pendengaran. Ia adalah merupakan respons otot koklea yang dirangsang dengan menggunakan nada bunyi klik atau nada bunyi pecah dan respon PAMR ini diukur sebagai perbezaan rangsangan di antara otot belakang telinga and cuping telinga.

OBJEKTIF

Tujuan kajian ini dijalankan adalah untuk menentukan dan membandingkan nilai ambang pendengaran seseorang dewasa yang mempunyai kehilangan pendengaran jenis sensori dan kehilangan pendengaran jenis konduktif dengan menggunakan ujian PTA dan PAMR.

Seterusnya, nilai ambang pendengaran PTA dan PAMR bagi kedua-dua kumpulan hilang pendengaran ini dibandingkan bagi mendapatkan faktor pembetulan.

KAEDAH KAJIAN

Kajian ini merupakan kajian keratan rentas yang dijalankan di Klinik Audiologi, Hospital USM bermula dari 1hb Jun 2013 sehingga 31hb Mei 2014. Sebanyak 38 dewasa (n = 76 telinga) yang memenuhi kriteria dan berumur antara 18 hingga 60 tahun telah dipilih.

Kemudian, subjek-subjek ini diperiksa menggunakan otoskop, ujian tympanogram dan ujian PTA. Ujian pereputan nada dilakukan untuk pesakit dengan kehilangan pendengaran sensorineural untuk menunjukkan kehilangan pendengaran retrokoklear. Pesakit dengan ujian pereputan nada normal akan meneruskan PAMR.

Seterusnya, ujian PAMR dilakukan dengan meletakkan elektrod positif pada cuping telinga, elektrod negatif pada bahagian otot belakang telinga dan elektrod rujukan pada bahagian dahi. Kemudian, ujian PAMR ini dilakukan pada frekuensi 500, 1000, 2000 dan 4000 Hz dengan menggunakan bunyi nada pecah. Subjek diarahkan melihat pada arah 70^0 ke tepi mata mengikut arah rangsangan bunyi yang dibagi dan graf dirakamkan.

KEPUTUSAN

Nilai ambang PAMR adalah lebih tinggi berbanding dengan nilai ambang PTA. Oleh kerana terdapat perbezaan di antara nilai ambang PAMR dan PTA, faktor pembetulan dapat ditentukan. Faktor-faktor pembetulan menurun dengan peningkatan frekuensi. Dalam pesakit hilang pendengaran jenis sensori, faktor pembetulan adalah 26.29, 19.00, 16.00, 13.00 untuk 500, 1000, 2000 dan 4000 Hz . Dalam pesakit hilang pendengaran jenis konduktif, faktor pembetulan adalah 20.29, 18.68, 14.12, 12.06 untuk 500, 1000, 2000 dan 4000 Hz .

KESIMPULAN

PAMR boleh digunakan sebagai salah satu ujian objektif bagi menentukan nilai ambang pendengaran seseorang dengan terbuktinya semua subjek dalam kajian ini menunjukkan graf PAMR direkod apabila mata subjek mengiring ke tepi mengikut rangsangan bunyi. Walau bagaimanapun, disebabkan terdapat perbezaan di antara nilai ambang pendengaran PAMR dibandingkan dengan PTA, faktor pembetulan telah ditentukan dan faktor pembetulan ini hendaklah ditambah pada nilai ambang pendengaran PAMR seseorang bagi menentukan nilai ambang pendengaran PTAnya.

ABSTRACT

ENGLISH VERSION

TITLE: COMPARING THE HEARING THRESHOLD BETWEEN POSTERIOR AURICULAR MUSCLE RESPONSE (PAMR) AND PURE TONE AUDIOMETRY (PTA) IN IMPAIRED HEARING INDIVIDUALS

Posterior Auricular Muscle Response (PAMR) is an objective electrophysiological test to determine hearing thresholds. It is a cochlear myogenic response evoked by a click or tone burst stimuli and the response is measured as potential difference between posterior auricular muscle and rear of ear pinna.

OBJECTIVE

The aim of this study is to estimate and to compare the mean hearing thresholds in cochlear hearing loss and CHL using PAMR and PTA. Then, the hearing thresholds of PAMR and PTA in cochlear hearing loss and CHL patient are compared in order to determine the correction factors.

METHOD

This is a cross sectional study conducted at Audiology Clinic, Hospital USM starting from 1st June 2013 until 31st May 2014. It comprised of 76 volunteered subjects and aged ranging between 18 to 60 years.

All patients were examined using otoscopy, tympanometry and then PTA. Tone decay test was done for patient with sensorineural hearing loss to exclude retrocochlear hearing loss. Subject with normal tone decay test will proceed with PAMR. Finally, the PAMR were performed by placing the positive electrode at the ear lobule, negative electrode at the posterior auricular muscle while the reference electrode was placed at the forehead. This PAMR were measured at frequencies 500, 1000, 2000 and 4000 Hz using tone burst stimuli and the subject was asked to make 70° lateral eye turned to side of stimulus when the stimulus was being presented and the waves recorded.

RESULT

The PAMR thresholds noted were higher compared to the PTA thresholds. As there were differences in hearing thresholds between PAMR and PTA, the correction factors were determined. The correction factors decreased with increased in frequencies. In cochlear hearing loss patients, the correction factors were 26.29, 19.00, 16.00, 13.00 for 500, 1000, 2000 and 4000 Hz respectively. In CHL patients, the correction factors were 20.29, 18.68, 14.12, 12.06 for 500, 1000, 2000 and 4000 Hz respectively.

CONCLUSION

PAMR can be used as one of objective tests to determine hearing thresholds since all the subjects had recordable PAMR waves with eye turned position. However, because of difference in PAMR thresholds compared to PTA, the correction factors should be applied to PAMR threshold in order to estimate PTA thresholds.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The most common form of sensory impairment all over the world is hearing loss. The World Health Organization (WHO) estimated that in 2008 more than 360 million people have disabling hearing loss which represents 5.3% of the world population. Eighty per cent of these people living in low- or middle-income countries. The highest prevalence of hearing impairment in both adult and children are in South East Asia and sub-Saharan Africa. This can be explained by the high rates of infections such as chronic otitis media, meningitis, excessive noise, ototoxic drugs and ageing populations in developing countries (Duthey, 2013).

Hearing impairment affects all age group. From 2003 till 2004, 29 million Americans which represent 16.1% of the adults had speech frequency hearing loss. In the youngest age group from 20 to 29 years old, 8.5% exhibited hearing loss and the prevalence seems to be increasing among this age group(Agrawal *et al.*, 2008).

Hearing loss is an important public health concern with economic and society burden. Hearing impairment in infant and children will cause delay in education and communication development(Davis *et al.*, 2001). The impact of hearing impairment in childhood is devastating. Poor language development cause negative impact on literacy skills, academic achievements and subsequently income and socioeconomic status.

Therefore, the main aim is for early diagnosis of hearing loss and hearing rehabilitation can be established(Proops and Acharya, 2009).

Majority of the hearing loss and ear diseases are avoidable and reversible if proper screening and management could be carried out at initial stage of identification. World Health Organization (WHO), has set up a program for the Prevention of Deafness and Hearing Impairment aiming at the development of technology, educating proper or appropriate hearing care and protection, improving the services in order to prevent deafness and hearing impairment. The prevention program includes primary, secondary and tertiary prevention. In primary prevention, the aim is to prevent any risk factors that could impair the hearing status and condition of the ear itself. The secondary prevention aim is to prevent an already impaired hearing status from progressing to a disability. Lastly, the tertiary prevention aims at preventing disability progressing to a handicap and at the same time providing rehabilitation to the patients.(Hinchcliffe, 1997)

1.2 Anatomy of the ear

The ear can be divided into three parts; the external ear, the middle ear and the inner ear. The external and middle ears are concerned primarily with the transmission of sound. The inner ear functions both as the organ of hearing and as part of the balance system of the body.

1.2.1 The external ear

The external ear consists of pinna, external auditory canal (EAC) and tympanic membrane. Pinna is also known as auricle. It is composed of thin plate of yellow cartilage which is covered with skin except its lobule. It is connected to surrounding parts by ligaments and muscles. There are various elevations and depressions on lateral aspects of pinna as seen below (Figure 1.1):-

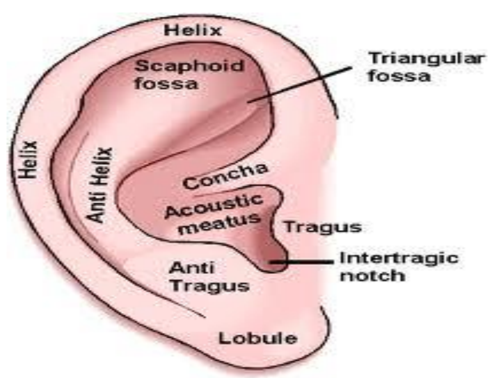

Figure 1.1: Pinna (Adapted from http://sonoworld.com/images/FetusItemImages/article-images/face_and_neck/ear_anu_patil_images/ear_anatomy.gif)

The EAC extends from concha of auricle to tympanic membrane. It measures about 2.4 cm length. It is divided into two parts which are cartilaginous part and bony part. The EAC ends at the tympanic membrane. The tympanic membrane is a thin and forms a translucent partition between the EAC and middle ear. It consists of 2 parts; pars tensa and pars flaccida.

1.2.2 The middle ear

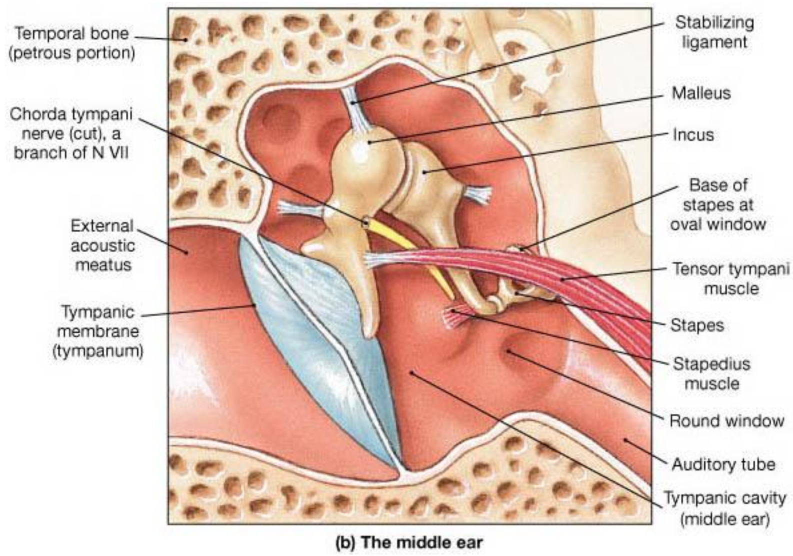

Figure 1.2: Structures in the middle ear (adapted from http://droualb.faculty.mjc.edu/Lecture%20Notes/Unit%205/special_senses%20Spring%20 2007%20with%20figures.htm)

Middle ear is a narrow air-filled space situated in the petrous part of temporal bone between the external ear and internal ear. This region includes eustachian tube, tympanic cavity and mastoid air cells system (Figure 1.2). The tympanic cavity can be described as a six-sided box with four walls, a roof and a floor. It contains three ossicles; malleus, incus and stapes, two muscles (stapedius and tensor tympani muscle) and two nerves (chorda tympani nerve and tympanic plexus of nerves).

The roof of the cavity is formed by thin plate of bone. The floor separates the cavity from the bulb of the internal jugular vein. The anterior wall has two openings. The upper portion lies the canal for the tensor tympani muscle, the lower portion is the auditory tube. The posterior wall is wider above than below and has its opening to mastoid antrum via aditus at superior region. Fossa incudis is a depression below aditus. It houses the short process of incus. Just below it is the pyramid. It is a conical bony projection located in between the junction of medial and posterior wall. It has an opening at the apex, for stapedius tendon and nerve.

Lateral to the pyramid is the posterior cannaliculus, which is an opening for chorda tympani to enter the middle ear cavity. Deep to the pyramid is a depression, the sinus tympani. Facial recess is lateral to sinus tympani and bounded laterally by chorda tympani, medially by pyramid and vertical part of facial nerve and superiorly by fossa incudis. Facial recess is an important surgical landmark because we can go through it into the middle ear without disturbing posterior meatal wall. Sinus tympani is one of hidden area for cholesteatoma.

The lateral wall formed mainly by the tympanic membrane and attic. The medial wall of middle ear cavity separates the tympanic cavity from inner ear. Its surface has several prominent features and two openings. Promontory is a rounded elevation occupying the