

**EARLY DETECTION OF EXTENDED HIGH  
FREQUENCY SENSORINEURAL HEARING  
LOSS IN CHRONIC SUPPURATIVE OTITIS  
MEDIA USING EXTENDED HIGH FREQUENCY  
PURE TONE AUDIOMETRY**

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**DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF MASTER  
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## TABLE OF CONTENTS

	<b>PAGE</b>
TITLE	1
ACKNOWLEDEGEMENT	2
TABLE OF CONTENTS	3
ABSTRAK (BAHASA MELAYU)	5
ABSTRACT (ENGLISH)	7
<b>CHAPTER 1:</b>	
<b>INTRODUCTION</b>	<b>9</b>
1.1	10
Introduction and literature review	
<b>CHAPTER 2:</b>	
<b>OBJECTIVES OF THE STUDY</b>	<b>15</b>
2.1	16
General objective	
2.2	16
Specific objectives	
<b>CHAPTER 3:</b>	
<b>MANUSCRIPT</b>	<b>17</b>
3.1	18
Title page	
3.2	19
Abstract	
3.3	21
Introduction	
3.4	26
Material and Method	
3.5	29
Results	
3.6	36
Discussion	

3.7	Conclusion	41
3.8	References	42
3.9	Guidelines/Instructions to Authors of selected journal	48
<b>CHAPTER 4:</b>	<b>STUDY PROTOCOL</b>	<b>53</b>
4.1	Study proposal submitted for ethical approval	54
4.2	Gantt chart	67
4.3	Ethical approval letter	68
4.4	Patient information and consent form	71
<b>CHAPTER 5:</b>	<b>APPENDICES</b>	<b>95</b>
5.1	Additional tables/graphs	96
5.2	Proforma	100
5.3	Raw data on SPSS soft copy	101

## **ABSTRAK (BAHASA MELAYU)**

**Objektif:** Kaitan antara penyakit telinga bernanah kronik (CSOM) dan kepekakan jenis sensorineural (SNHL) masih lagi dalam perbahasan. Kewujudan ujian audiometri frekuensi tinggi tambahan nada tulen (extended high frequency pure tone audiometry), membolehkan pengesanan awal penyakit kepekakan frekuensi tinggi tambahan jenis sensorineural. Tujuan kajian ini adalah untuk mengesan prevalen masalah kepekakan frekuensi tinggi tambahan jenis sensorineural dalam penyakit telinga bernanah kronik dan kaitan antara jangkamasa penyakit telinga bernanah kronik dengan masalah kepekakan frekuensi tinggi tambahan jenis sensorineural.

**Reka bentuk:** Seratus dua puluh telinga bernanah kronik (CSOM) dan seratus dua puluh telinga normal untuk kumpulan kawalan, yang tidak pernah mengalami masalah telinga sebelum ini telah dipilih untuk kajian ini. Semua peserta berumur antara 11-50 tahun, yang mempunyai ujian pendengaran konduksi tulang pada ambang normal (frekuensi 250Hz, 500Hz, 1kHz, 2kHz, 4kHz and 8kHz) akan menjalani pemeriksaan otoskopi, pemeriksaan menggunakan mikroskop dan ujian audiometri frekuensi tinggi tambahan nada tulen. Ujian audiometri frekuensi tinggi tambahan nada tulen ini di buat di dalam kabin kalis bunyi, yang berada di bilik dirawat bunyi pada frekuensi 9kHz, 10kHz, 11.2kHz, 12.5kHz, 14kHz and 16kHz. Purata ambang konduksi tulang pada semua frekuensi akan diambil sebagai tahap kepekakan peserta. Ambang bunyi pada atau melebihi 25dB, akan dikira sebagai kepekakan pendengaran jenis sensorineural, mengikut kriteria Organisasi Kesihatan Dunia (WHO). Tahap kepekakan frekuensi tinggi tambahan jenis sensorineural adalah normal, ringan, sederhana,

sederhana ke teruk, teruk, mendalam. Data dianalisis menggunakan perisian SPSS versi 22 dan STATA versi 11.0.

**Keputusan:** Prevalen masalah kepekakan frekuensi tinggi tambahan jenis sensorineural dalam penyakit telinga bernanah kronik adalah 78.3% dan dalam kumpulan kawalan adalah 26.2%. Penyakit telinga bernanah kronik, umur peserta dan jangka masa penyakit mempunyai kaitan yang amat tinggi dengan kepekakan frekuensi tinggi tambahan jenis sensorineural ( $p < 0.001$ ). Keputusan menunjukkan bahawa semakin lama jangka masa penyakit telinga bernanah kronik, semakin teruk tahap kepekakan frekuensi tinggi tambahan jenis sensorineural.

**Kesimpulan:** Ujian audiometri frekuensi tinggi tambahan nada tulen sangat berguna dalam mengesan masalah kepekakan frekuensi tinggi tambahan jenis sensorineural dalam penyakit telinga bernanah kronik. Ujian ini patut dilakukan secara kerap dalam penyakit telinga bernanah kronik untuk mengelakkan kepekakan jenis sensorineural kekal dan seterusnya dapat memulakan langkah pencegahan awal.

## **ABSTRACT (ENGLISH)**

**Objective :** The relationship between chronic suppurative otitis media with sensorineural hearing loss is still debatable. The availability of extended high frequency pure tone audiometry evaluation makes the detection of extended high frequency sensorineural hearing loss possible at much earlier stage. Thus, the aim for this study is to look for the prevalence of extended high frequency sensorineural hearing loss in chronic suppurative otitis media and the association between duration of the disease with extended high frequency sensorineural hearing loss.

**Design :** One hundred and twenty chronic suppurative otitis media ears and one hundred and twenty normal ears for control group who never have history of ear problem before were enrolled in this study. All participants age 11 till 50 years old, who previously had a normal bone conduction threshold using conventional pure tone audiometry (frequency 250Hz, 500Hz, 1kHz, 2kHz, 4kHz and 8kHz) underwent examination using otoscopy, microscope and extended high frequency pure tone audiometry evaluation. Extended high frequency pure tone audiometry evaluation at frequency 9kHz, 10kHz, 11.2kHz, 12.5kHz, 14kHz and 16kHz were done in a sound proof cabin, which is located in a sound treated room. The average hearing threshold of all extended high frequencies will be taken as degree of hearing loss. Any hearing threshold at 25dB or more were taken as present of extended high frequency sensorineural hearing loss, following World Health Organization degree of hearing loss. The degree of extended high frequency sensorineural hearing loss will be graded into normal, mild, moderate, moderately severe, severe and profound. Data were analyzed using SPSS version 22 and STATA version 11.0.

**Result :** Prevalence of extended high frequency sensorineural hearing loss in chronic suppurative otitis media group were 78.3% and in control group were 26.2%. There was a highly significant association between chronic suppurative otitis media, patient's age and duration of the disease with extended frequency sensorineural hearing loss (p-value < 0.001). Result also showed the longer the duration of chronic suppurative otitis media, the more severe the degree of extended high frequency sensorineural hearing loss.

**Conclusion:** Extended high frequency audiometry test is very useful in detecting early extended high frequency sensorineural hearing loss in chronic suppurative otitis media. This test should be regularly done in chronic suppurative otitis media cases to prevent further worsening of the irreversible sensorineural hearing loss and early prevention can be taken.

**Keywords:** Extended high frequency sensorineural hearing loss; pure tone audiometry; chronic suppurative otitis media;

# Chapter 1

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## INTRODUCTION

## 1.1 INTRODUCTON AND LITERATURE REVIEW

Chronic suppurative otitis media is defined as chronic inflammation of middle ear and mastoid cavity with presence of persistent or recurrent otorrhea through a perforated tympanic membrane (Orji 2013). In some textbooks, it is defined as chronic inflammation of the middle ear and mastoid mucosa in which the tympanic membrane is not intact either due to perforation or tympanostomy tube and presence of ear discharge (Dhingra 2014). The duration of chronic suppurative otitis media is debatable in which that World Health Organization defines chronic suppurative otitis media as tympanic membrane perforation with otorrhea for at least two weeks while other literatures suggest for more than six weeks duration, as the word chronic implies (Verheoff et al. 2006). Chronic suppurative otitis media which occurs in the early age has the potential to develop and persist into adulthood accounting for recurrent episodes of chronic discharging ears that can last for many years if poorly managed (Orji 2013).

Prevalent of chronic suppurative otitis media varies globally depending mainly on the sociodemographic factors. Lowest prevalence is found in highly developed industrial countries such as United Kingdom and United States of America, with prevalence of less than 1%. Intermediate prevalence ranging from 1%-6% reported in the South Pacific Islands, Korea, India, and Saudi Arabia. The highest prevalence of chronic suppurative otitis media, ranging from 7%-46% are reported among children in Inuit's of Alaska, Canada and Greenland, America Indians, and Australian Aborigines (Bluestone 1998; Verhoeff et al. 2006; Monasta et al. 2012). Meanwhile in the southeast Asian region, countries like Thailand, Malaysia, Philippines and Vietnam are defined as countries with high prevalence of chronic suppurative otitis media (Mahadevan et al. 2012).

In general, chronic suppurative otitis media commonly affects children during the first five years of life. Children with history of recurrent acute otitis media, parental history of

chronic suppurative otitis media, overcrowding (for example, large families with several siblings and large day care centres), poor hygiene, poor nutrition and children with craniofacial anomalies have significant risk that attributed to high rates of chronic suppurative otitis media (Verheoff et al. 2006; Mahadevan et al. 2012). Hearing loss is the most common sequel of chronic suppurative otitis media. Hearing loss of even 15dB HL can create hearing disability in children and consequently impairment in their mental growth (Absalan et al. 2013). It has a long-term effect on early communication, language development, auditory processing, psychosocial and cognitive development, educational progress and achievement (Monasta et al. 2012).

Hearing loss can be classified into conductive hearing loss, sensorineural hearing loss and mixed hearing loss, which is the combination of both conductive and sensorineural hearing loss. Conductive hearing loss can be caused by either disease of external or middle ear. Individual with conductive hearing loss, will demonstrate a pattern of pure tone audiometry of an air bone gap of 10 dB or more and the bone conductive threshold will be normal (Audiology 2011). On the other hand, sensorineural hearing loss can be caused by either cochlear or retro cochlear lesion and majority of permanent hearing loss are sensorineural type. This sensorineural hearing loss is commonly seen in elderly with presbycusis, noise induced hearing loss, post viral infection or tumour such as acoustic neuroma. The air bone gap of 10 dB or less with an average bone conduction threshold greater than 25 dB is the pure tone audiometry features of sensorineural hearing loss (Audiology 2011).

The exact pathogenesis for sensorineural hearing loss to occur in chronic suppurative otitis media is still unclear. The release of deleterious toxin, inflammatory mediators during the otitis media episode are thought to cause the sensorineural hearing loss in chronic suppurative otitis media. Few studies reported increased incidence of sensorineural hearing loss was due to

cochlear biochemical changes created through the round window (Paparella et al 1984; Redaelli 2005).

The possible route for toxin to reach the inner ear is through the round window membrane. The biochemical changes occur mainly due to alteration of middle layer of round window membrane during inflammatory process that permits diffusion of toxin into the cochlea resulting in destruction of organ of Corti (English and Northern 1973; Paparella et al. 1984). Hence, finding of increased damage at higher frequency due to passage of toxins around the round window membrane are the most probable hypotheses (Da Costa et al. 2009)

The usage of ototoxic ear drop was also thought to cause sensorineural hearing loss mainly due to the ototoxic drug diffuses through the round window membrane. Thus, damaging the inner hair cell. This postulation was proved by Wright and Meyerhoff (1984), Ikeda and Morizono (2000), and Kaplan et al. (2004) in their study using neomycin, ciprofloxacin and steroid based ear drop. However, there were also studies that against this postulation. As reported by Ozagar et al. (1997) and Claros et al. (2000), which suggested that gentamicin, ciprofloxacin and steroid ear drop were not statistically significant in causing the hearing loss. Recently Ahmed Singer et al. (2018) proposed that the history of topical ear drop (topical quinolones, topical aminoglycosides and mixture of both) usage did not correlate with incidence of sensorineural hearing loss in chronic suppurative otitis media.

The degree of hearing loss is described in decibel (dB), a unit of intensity of loudness. According to World health organization, the degree of hearing loss can be classified into normal, mild, moderate, moderately severe, severe and profound hearing loss depending on the intensity of loudness or decibel (WHO 1980). World Health Organization sets the range for individual's hearing threshold is in between 0-24 dB, 25-40 dB, 41-55 dB, 56-70 dB, 71-90 dB

and more than 91 dB for normal, mild, moderate, moderately severe, severe and profound respectively.

Worldwide, around 60% of chronic suppurative otitis media causes hearing loss (Mahadevan et al. 2012). It is commonly conductive type of hearing loss due to tympanic membrane perforation that subsequently causes the impairment of mechanical conduction of sound wave towards the cochlea. However, sensorineural type of hearing loss is also detected in chronic suppurative otitis media patient but the aetiology is still unknown (Da Costa 2009; Islam 2010). The incidence of sensorineural hearing loss in chronic suppurative otitis media varies ranging from 9%-43% and some reported that the age and duration of chronic suppurative otitis media determine the severity of sensorineural hearing loss in chronic suppurative otitis media (Khairi et al. 2013; Manpreet and Dinesh 2015).

In clinical practice, the standard subjective hearing assessment is the conventional pure tone audiometry evaluation measuring frequency of 250 Hz till 8 kHz. In sensorineural type of hearing loss, the higher frequency tone is affected first due to the cochleotopic gradient of susceptibility and is expressed functionally as a high frequency hearing loss, which extends to include progressively lower frequencies as the cochlear damage becomes more extensive (Gleeson and Michael 2008). Extended high frequency pure tone audiometry allows to reveal the earliest shifts of functions of the inner ear in both the patients with initial forms/stages of hearing disorders and in the patients with progressive hearing loss of a various origin, which cannot be detected by the conventional audiometry (Kholmatov et al. 2011).

In this study, the extended high frequency pure tone audiogram was used to determine the average hearing threshold. In sensorineural hearing loss, initial cochlear damage occurs at basal end of cochlea particularly at the outer hair cell, the area where higher frequency sound is encoded (Sulaiman et al. 2014). The location of round window, which is at the cochlear base

causing the higher frequency threshold to be affected earlier as compared to lower frequency threshold whenever toxin passing through the round window. The affected higher frequency threshold is not routinely tested in the conventional pure tone audiometry. Thus, extended high frequency pure tone audiometry is potentially valuable in detecting early impairment in auditory system before irreversible deficit is incurred (Fausti et al. 1990).

Although few previous studies done has shown the correlation between chronic suppurative otitis media and sensorineural hearing loss, most of the studies used the conventional pure tone audiometry but not the extended high frequency pure tone audiometry. Furthermore, there is no previous study to correlate the duration of the disease and the severity of hearing loss done using extended high frequency pure tone audiometry. Therefore, this study is significant and rationale in determining the correlation between these factors.

In this study, the prevalence of extended high frequency sensorineural hearing loss in chronic suppurative otitis media and the association between extended high frequency sensorineural hearing loss and chronic suppurative otitis media were determined. Apart from that, the duration of chronic suppurative otitis media and participants' age with severity of extended high frequency sensorineural hearing loss were also concluded.

## Chapter 2

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# OBJECTIVES OF THE STUDY

## **2. OBJECTIVES**

### **2.1 General objective:**

To study extended high frequency sensorineural hearing loss in participants with chronic suppurative otitis media.

### **2.2 Specific objectives:**

1. To determine the prevalence of extended high frequency sensorineural hearing loss in chronic suppurative otitis media participants and normal participants.
2. To determine the association between extended high frequency sensorineural hearing loss and chronic suppurative otitis media patient.
3. To determine the association between the duration of chronic suppurative otitis media and severity of extended high frequency sensorineural hearing loss.

# Chapter 3

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MANUSCRIPT

### 3.1 Title Page

# **EARLY DETECTION OF EXTENDED HIGH FREQUENCY SENSORINEURAL HEARING LOSS IN CHRONIC SUPPURATIVE OTITIS MEDIA USING EXTENDED HIGH FREQUENCY PURE TONE AUDIOMETRY**

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Financial disclosure/conflict of interest :

None of the authors received any financial support for this study

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### 3.2 ABSTRACT

**Objective :** The relationship between chronic suppurative otitis media with sensorineural hearing loss is still debatable. The availability of extended high frequency pure tone audiometry evaluation makes the detection of extended high frequency sensorineural hearing loss possible at much earlier stage. Thus, the aim for this study is to look for the prevalence of extended high frequency sensorineural hearing loss in chronic suppurative otitis media and the association between duration of the disease with extended high frequency sensorineural hearing loss.

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**Conclusion:** Extended high frequency audiometry test is very useful in detecting early extended high frequency sensorineural hearing loss in chronic suppurative otitis media. This test should be regularly done in chronic suppurative otitis media cases to prevent further worsening of the irreversible sensorineural hearing loss and early prevention can be taken.

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