UNIVERSITI SAINS MALAYSIA

PRELIMINARY STUDY OF SUBJECTIVE VISUAL VERTICAL (SVVT) TEST AND SUBJECTIVE VISUAL HORIZONTAL TEST (SVHT) AMONG NORMAL ADULTS

By

ADNAN BIN TAHIR

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SVVT	Subjective Visual Vertical Test
SVHT	Subjective Visual horizontal Test
MVVSS	Malay Version of Vertigo Symptom Scale

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ABSTRACT

A Preliminary study of subjective visual vertical test(SVVT) and subjectivevisual horizontal test (SVHT) among normal adults.

Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) are good, cheap and simple clinical tools to evaluate the function of utricle and saccule organ. In the study of 95 subjects were recruited 48 male and 47 females with three different age group of 20-30 (33 subjects), 30-40 (30 subjects) and 40-50 (32 subjects).All of them were asked to fill the MVVSS and few basic questions. There were assessed with SVVT and SVHT.For normal line, dotted line and arrow pattern, showed that there is no significant different in the tilt/degree of Subjective Visual Vertical Test (SVVT) and Subjective Visual Vertical Test (SVHT) between male and female.There are also no significant difference for three age groups at least from 20 to 50 years old and with a poor to fair association between SVVT and SVHT. This suggests that there is no gender bias and age bias at least for 20 to 50 years old in SVVT and SVHT.

Keyword: Subjective Visual Vertical Test (SVVT), Subjective Visual Vertical Test (SVHT), gender, age, view pattern.

Chapter 1

Introduction

A Preliminary Study of Subjective Visual Vertical (SVVT) Test and Subjective Visual Horizontal Test (SVHT) among Normal Adults

1.1 Background of Study

The understanding of balance system is based on the origin of the balance system that is so unique which capable to make human bodies equalize to the center of gravity using their feet. Hearing and balancing associate in the sense that their organ is connected each other's. Hearing: cochlear is one of the organs that contribute to auditory function, Balance: vestibule and semicircular canals is the peripheral organ of vestibular (balance) system. Semicircular canals have no auditory function although they are closely associated with the cochlea (Ross and Wilson, 2001).

Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) are assessments that we can do to rule out vestibular function status. The purposes of these tests are to detect abnormal subjective tilt. In normal persons, the ability to perceive verticality is quite good. This ability depends on input from visual, vestibular and somatosensory systems. It also depends on a functioning central nervous system. The SVVT and SVHT are quite different, but these assessments also clues clinicians into possible vestibular system impairments. SVVT and SVHT measures the patient's subjective perception of vertical and of horizontal. These tests are generally

performed in complete darkness and requires the patient to adjust a vertical line (usually via remote control) so the line is perceived to be straight up and down.

1.1.1 Anatomy and Physiology of Vestibular system

The inner ear or labyrinth consist of two main divisions, one called as an outer bony labyrinth and second division that encloses the outer bony labyrinth is called the inner membranous labyrinth. Bony labyrinth is a series of cavities in the petrous portion of temporal bone that divided into three areas: (1) Semicircular canals which then projected superiorly, horizontally and posteriorly in specific position and (2) the vestibule that contain receptor for balance system and (3) cochlea that contain receptor for auditory function.

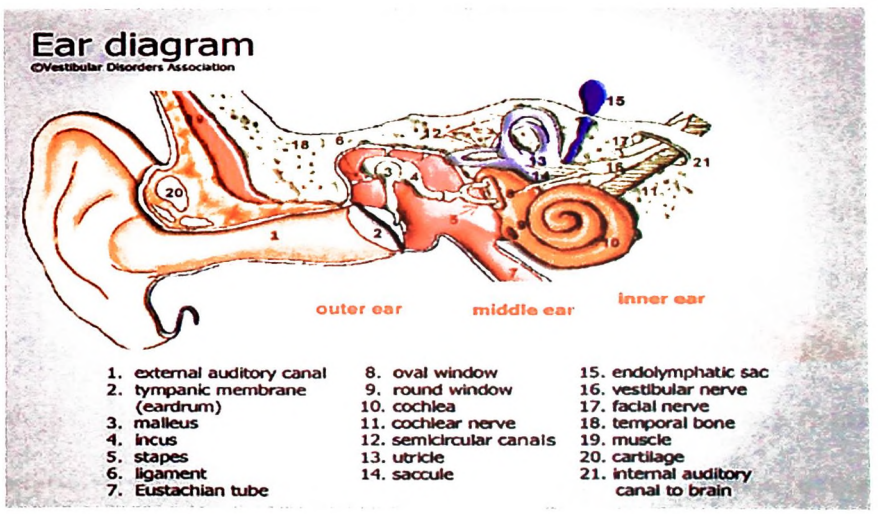

Figure 1.1: diagram of ear structure (www.vestibular.org)

Vestibule plays important role for vestibular system or balance system, vestibule is the central cavity of bony labyrinth with two suspended sacs called (1) saccule and (2) utricle. Saccule continuous with cochlea whereas the utricle is continuous with the

semicircular canals, the important of these sacs is that they both contain receptor for balance system that responds to gravity and changes in the position of the head this unique receptor called maculae.

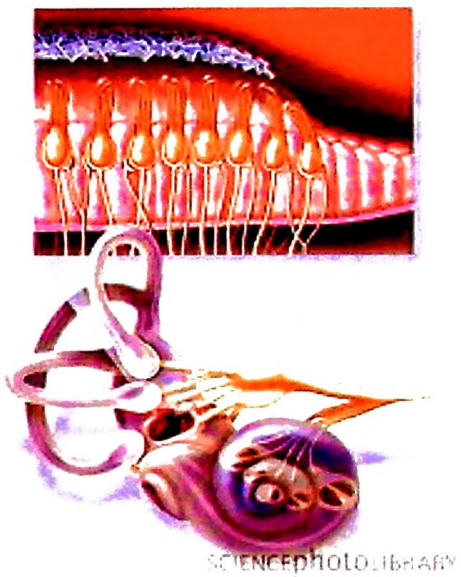

Figure 1.2: diagram of hair cell of ear (www.treatvertigonow.com)

Another important part in bony labyrinth that contribute to the balance system is the semicircular canals, this three canals lying in the plane of space and the membranous semicircular ducts line each canal and communicate with the utricle. The expanded end of each canal is called ampulla and it is house of balance receptors in a region called the crista ampullaris these receptors will respond to angular movement of the head. The semicircular canals lies posterior, anterior and lateral which then make up of their name of posterior semicircular canals, anterior semicircular canals and lateral semicircular canals.

The second division of the inner ear is the membranous labyrinth as mention earlier, the portion of the membranous labyrinth that lies inside the bony semicircular canals are called the semicircular ducts with connected with the utricle. Propagate toward the central of vestibular system from peripheral vestibular system is the vestibularcochlear (VIII) nerve which then branched into many parts. The branches consist of ampullary, utricular and saccular nerves and these nerves contain sensory neurons and motor neuron that synapses with the receptor for balance.

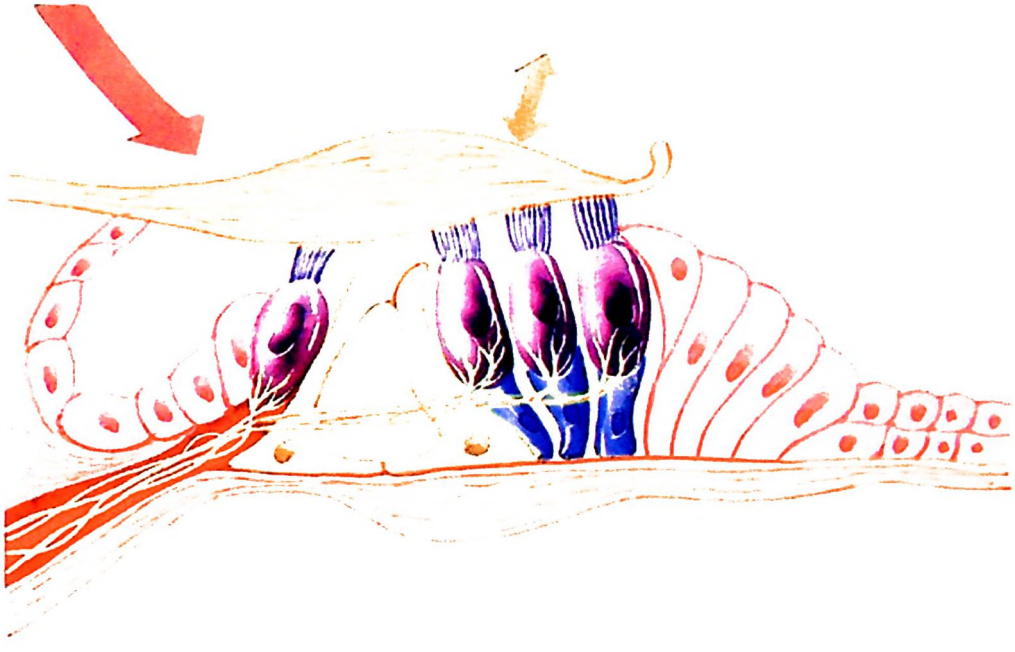

Figure 1.3: Diagram of Inner and Outer hair cells (www.vestibular.org)

There are two types of balance in generals, one is called static equilibrium (balance) and another one is called dynamic equilibrium (balance). The static equilibrium is mainly the maintenance of the body position and head position relative to the force of gravity. Dynamic equilibrium is the maintenance of body and head position in response to rotational acceleration or deceleration. Collectively, the receptor organs for balance are called the vestibular apparatus which include the saccule, utricle and semicircular ducts.

1.1.2 Equilibrium or balance system

The semicircular canals and vestibule are concerned with balance. Any change of position of the head causes movement in the perilymph and endolymh, which bends the hair cells and stimulates the sensory nerve endings in the utricle, saccule and ampullae. The resultant nerve impulses are transmitted by the vestibulocochlear nerve. The vestibular branch passes first to the vestibular nucleus, then to the cerebellum.

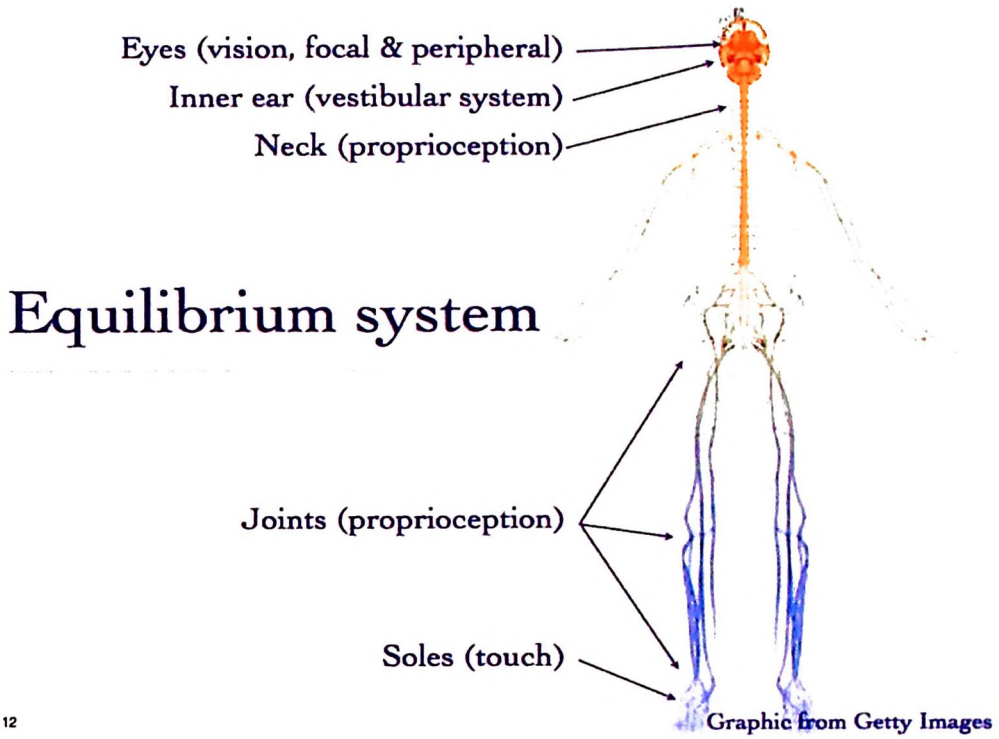

Figure 1.4: an illustration of postural control of balance system

(www.neuroanthropology.net)

The cerebellum also receives nerve impulses from the eyes and proprioceptors (sensory receptors) in the skeletal muscles and joints. Impulses from these three sources are coordinated and efferent nerves impulses pass to the cerebrum and to skeletal muscles. This results in awareness of body position, maintenance of upright posture and fixing of the eyes on the same point, independently of head movements (Ross and Wilson, 2001).

1.1.3 Vestibular Disorder

The vestibular system includes the part of the inner ear and brain that help control balance and eye movements. If the system is damaged by disease, aging, or injury vestibular disorder may arise. The symptoms may include vertigo, dizziness, and imbalance. The vestibular system as mention earlier that its associates with the cochlear that functionally for auditory, so as a result a symptom of hearing loss may arise when vestibular disorder present. Common vestibular disorder is nausea or vomiting, ear pain, ear fullness headaches motion sickness, anxiety and much more. It has been said that vertigo is the most common symptom for the indication of vestibular disorder to present. Vertigo is quite common to be wrongly said as dizziness but both are totally different.

1.1.4 Vertigo

Vertigo is defined as a subjective sense of imbalance and includes unsteadiness as well as a sensation of rotation. Vertiginous symptoms may arise from defects in the labyrinth, the visual system, or the lesion lies within the labyrinth or its central connections. (AG Kerr, 2005) Vertigo has been said to be the greatest "heartsink" symptom in medicine. That certainly is a possibility but every specialty has its similar conditions, and vertigo is no worse than low back ache or nocturnal cramps, it has been said that labyrinthine vertigo can change, in seconds. There is no agreed definition of the term vertigo but the one preferred by the author is "a subjective sense of imbalance" and in general, this can be considered synonymous with dizziness.

Common sign and symptom of vertigo are spinning or whirling sensation; an illusion of movement of self or the world, lightheaded, floating, or rocking sensation and

sensation of being heavily weighted or pulled in one direction. In the sense of balance the patient may complaint of imbalance, stumbling, difficulty walking straight or turning a corner, clumsiness or difficulty with coordination, or difficulty maintaining straight posture; tendency to look downward to confirm the location of the ground.

The head also may held in tilted position and have tendency to touch or hold onto something when standing, or to touch or hold the head while seated. Others than that patient may have sensitivity to changes in walking surfaces or footwear, muscle joint pain (due to difficulty balancing) and difficulty finding stability in crowds or in large open spaces. Vertigo is virtually always accompanied by nystagmus, which is the ocular compensation for the unreal sensation of spinning.

1.1.5 Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT)

Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) is one of assessment that we can do to rule out vestibular function status. The purpose of this test is to detect abnormal subjective tilt. In normal persons, the ability to perceive verticality is quite good. This ability is dependent on input from visual, vestibular and somatosensory systems. It also depends on a functioning central nervous system. (Yelnik, Lebreton et al. 2002)

The otolith organ of the vestibular system which is saccule and utricle contribute into sense of gravity which is prior to tilt the head vertically in person whose have normal vestibular system. The disturbance within the otolith organ whether the organ itself or the

nerves will also disturb the ability for human to altered the head vertically. Otolith organs: schemativ of the utricle (horizontal) and saccule (vertical). These sensory organs in the inner ear primarily respond to linear acceleration such as due to orientation to gravity. Utricular lesions may shift the subjective vertical. (Timothy C. Hain, MD 2009)

The inner ear may falsely suggest that the head is tilted while the eyes and somatosensory systems suggest that one is upright. Thus there is a sensory conflict. There can be an interaction between vision and the otoliths in that an otolith imbalance may transiently cause the eyes to counter-roll, which literally tilts ones vision. Visual influences on verticality may be measured by putting a frame around a bar. Alterations of the angle that the frame makes with vertical may disturb a person's judgments of verticality of a bar. One may eliminate the visual component to vertical by putting a person in a dark room, and asking them to orient an illuminated bar. (Timothy C. Hain, MD 2009)

1.2 Problem Statement

SVVT and SVT are among the vestibular tests that are not really used among the clinician in Malaysia. . This is due to less study done using these tests and the equipment limitation. Where there are only a few center that have this equipment. Normative value is really essential before it can be used especially for a specific and new population. Both tests are good and reliable test in order to access the function of vestibular organ function. Till now, none of studies done are to understand the uses and the normative values of those tests in Malaysia. This preliminary study will provide a

normative value for SVVT and SVHT among Malaysian community. This normative value will be used in the future as a reference for all the clinicians.

1.3 Research Objectives

1.3.1 General Objective

The objective of this study is to determine the normative value of Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) among normal adults.

1.3.2 Specific Objective

- To compare the outcome SVVT and SVHT among 3 different age group.
- To compare outcome SVVT and SVHT among gender difference.

1.4 Hypothesis

1.4.1 Null hypothesis, H_o:

- There is no significant difference between normative value of SVVT and SVHT
- There is no significant difference outcome SVVT and SVHT among 3 different age groups
- There is no significant difference outcome SVVT and SVHT among gender difference.

1.4.2 Alternative hypothesis, H_a:

- There is significant difference between normative value of SVVT and SVHT
- There is significant difference outcome SVVT and SVHT among 3 different age groups
- There is significant difference outcome SVVT and SVHT among gender difference.

1.5 Significance of study

This study will provide a normative value for normal adult of SVVT and SVHT that can be used by the clinician in the future. This study also provides a clear picture of understanding SVVT and SVHT in evaluation of the vestibular organ function. This also provides more understanding and detail information on one of the new vestibular test in order to evaluate patient with vestibular disorder and also will enhance the usefulness of this new test in assessing vestibular disorder.

CHAPTER 2

LITERATURE REVIEW

Subjective Visual Vertical Test (SVVT) is found to be a good clinical test to assess the function of vestibular organ. Unfortunately, less study done related on it and less study done to evaluate the normative values for this test. In clinical field this is really essential in order to make sure we do have a proper reference and normal range as interpretation guideline. Between these two tests most of the articles only focus on the vertical aspect of the test and not in the horizontal part.

A study showed that Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) significantly related in dizziness symptom. The research results demonstrate that SVVT and SVHT correlated with clinical dizziness symptoms in patients with acute unilateral vestibular neuritis. Therefore, SVVT and SVHT would be useful tools for the evaluation of clinical manifestations of unilateral vestibular neuritis. (Min KK et al 2007)

Base on reviewed journal, the degree of the tilt bar line can be deviant for normal person; Persons with vestibular lesions may orient the bar tilted as much as 10 degrees compare to normal person with good balance perception (Garcia and Jauregui-Renaud, 2003; Vibert, Hausler et al. 1999)

The SVVT is quite different, but this assessment also clues clinicians into possible vestibular system impairments. SVVT measures the patient's subjective perception of vertical (or horizontal). This test is generally performed in complete darkness and requires the patient to adjust a vertical line (usually via remote control) so the line is perceived to be straight up and down. Individuals with normal peripheral vestibular function can generally set this line within 2–3 degrees to the right and left of true vertical (Bohmer& Mast, 1999; Zwergal et al., 2009).

In one of the reviewed journal that compare SVVT in young healthy individuals between affected group, the SVVT was < 2 degree for static and on-axis rotation, and shifted up to 11 degree during unilateral centrifugation (Akin FW et al, 2011). Yet again in already mentioned in previous study that the centrifugation can affect the SVVT result. In this study by Akin FW, it's only focus on the vertical of the test and the straight line.

In a study its mention that, the offsets of the SVVT line greater than 3 degrees to either side are considered abnormal, and are generally associated with peripheral vestibular system dysfunction (specifically the utricle) or unilateral brainstem lesions. In individuals with uncompensated loss of unilateral peripheral vestibular system function, the line is often set towards the lesion side, with offsets of as much as 15–20 degrees (Bohmer& Mast, 1999; Zwergal et al., 2009)

A study by Jovanovic has proven its statistically significant bigger SVVT tilt in the subjects aged over 45 years than in the younger subjects. The arithmetic mean of the tilt to the left or tilt to the right in the group younger than 45 years was 0.42 degrees during the static test and 0.49 degrees during the dynamic test. The arithmetic mean for the group older than 45 years was 0.67 during the static test and 0.68 during the dynamic test. (Jovanovic S et al, 2008). Jovanovic focus his study on the different age groups and only based on the vertical line of this test, in detail this test can either be horizontal and not only in the aspect of adjusting a line, what happen is the line become a dotted line but still has not mentioned in previous study.

In a recent study of the Subjective Visual Vertical Test (SVVT) and Subjective Visual Horizontal Test (SVHT) will be affected by the direction of the preset angle, so this should be randomized. (Pagarkar et al, 2008), since we used SYNAPSYS Subjective vertical 1.3.0 it's has been computerized that the preset angle is random each time for the new tested subject.