EVALUATION OF POSTURAL CONTROL AMONG DIABETES MELLITUS PATIENT USING GANS SOP TEST

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By

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CERTIFICATE

This is to certify that the dissertation entitle

“EVALUATION OF POSTURAL CONTROL AMONG DIABETES MELLITUS PATIENT USING GANS SOP TEST”

is the bona fide record of research work done by

NOR FARAWAHEEDA BINTI AB SHUKOR

During the period from September to May 2017 under my supervision.I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the degree of Bachelor of Health Sciences (Honours) (Audiology).

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LIST OF ABREVIATIONS

SOP	Sensory Organization Performance
DM	Diabetes Mellitus
DN	Diabetic Neuropathy
SCC	Semi Circular Canal
ABC Scale	Activities Specific Balance Confidence Scale

ABSTRAK

Keseimbangan dapat ditakrifkan sebagai kemampuan untuk mengekalkan pusat jisim badan melalui asas sokongan badan. Bagi keseimbangan badan yang normal, adalah penting untuk kita mempunyai tahap penglihatan yang baik, orentasi terhadap gravity, dan pelarasan postur yang berfungsi untuk mengekalkan postur dan kestabilan badan dalam pelbagai keadaan. Gaya berjalan dan keseimbangan pesakit diabetes telah diubah disebabkan keadaan ini. Ujian *Gans SOP* menggunakan bantal *Bal Ex* digunakan untuk menilai prestasi keseimbangan. Ujian ini merupakan kombinasi ujian *Romberg*, Ujian *Romberg yang diubahsuai*, ujian berdiri diatas bantal *Bal Ex* dan ujian *Fukuda*. Matlamat utama kajian ini adalah untuk menilai perubahan postur pesakit *Diabetes Mellitus* melalui ujian *Gans SOP* menggunakan bantal *Bal Ex*. Seramai 59 orang peserta berumur lingkungan 20 sehingga 60 tahun telah direkrut dan mereka dibahagikan kepada dua kumpulan iaitu kumpulan dewasa yang normal dan kumpulan yang mempunyai penyakit *Diabetes Mellitus*. Kesemua subjek diuji dengan menggunakan ujian *Gans SOP* yang merangkumi tujuh keadaan yang berbeza. Tahap badan bergoyang dan beralih telah direkodkan untuk setiap tujuh keadaan yang diuji. Keputusan yang diperolehi dianalisis menggunakan ujian *Mann Whitney*. Berdasarkan analisa, perbezaan yang signikan ($p<0.05$) ditemui dlaam tiga daripada tujuh keadaan. Namun, satu keputusan yang diperolehi dalam ujian menunjukkan kolerasi dengan faktor umur dimana ia menunjukkan bahawa faktor umur telah menyumbang kepada signifikasi keputusan ujian . Empat keadaan yang lain menunjukkan perbezaan yang tdak signifikan ($p>0.05$). Konklusinya, dapatan daripadaujina *Gans SOP* menggunakan bantal *Bal Ex* menunjukkan kumpulan pesakit *Diabetes Mellitus* mempunyai masalah keseimbangan lebih tinggi berbanding kumpulan

normal. Namun bergitu, faktor umur juga memberi kesan kepada keputusan yang diperolehi untuk kumpulan pesakit *Diabetes Mellitus*. Keseluruhannya, pesakit *Diabetes Mellitus* tetap mempunyai masalah keseimbangan badan lebih tinggi berbanding kumpulan dewasa yang normal samada dalam keadaan mata tertutp atau tidak.

ABSTRACT

Balance is the ability to maintain the body's center of mass over its base of support. Normal body's balance system essential for us to have normal vision while we are moving, orientation with respect to gravity, and postural adjustment to maintain posture and stability in various conditions. As we know, Diabetes Mellitus can cause many effect to our body system include balance problem. Gait characteristics and balance are altered in diabetic patients. The Gans SOP Test using Bal ex Foam is used to evaluate balance performance. It is combination of the Romberg, Modified Romberg, standing on the form and Stepping Fukuda Tests.The aim to evaluate the postural changes of patient with Diabetic Mellitus using Gans SOP Test. A total of 59 subjects with age range 20 to 60 were recruited for this study and were divided into two group of normal and group of Diabetes Mellitus patient. Subjects were tested with Gans SOP test which consist of seven conditions. The degree of sway and turning was recorded for each condition tested. Statistical analysis using Mann Whitney test showed significant difference with $p<0.05$ were found in three out of seven condition tested. However the result have correlation with the age factor which show that age are one of the contribution factor that cause the results to be significant. The other 4 condition showed no significant difference. In conclusion, the finding of Gans SOP test are found that Diabetes Mellitus patient showed more sway compare to the normal group. However, in this test, the contribution of age also maybe one of the factor that cause the Diabetes Mellitus group have significant sway compare to the normal group. Overall, the patient with Diabetes Mellitus still have more degree of swaying compare to the normal group regardless with eyes open or closed.

CHAPTER 1

BACKGROUND OF STUDY

1.0 Introduction

1.0.1 Diabetes Mellitus

Diabetes is one of the well known diseases around us today. According to the Ministry of Health Malaysia in 2015, The prevalence of individuals with known diabetes was at 8.3%. There was also a general increasing trend with age, starting from 0.7% within the age group of 20-24 years old, reaching a peak of 27.9% at age group 70-74 years. Meanwhile, the prevalence of undiagnosed diabetes was 9.2%. There was also a general increasing trend with age, starting from 5.5% at age group 18-19 years, reaching a peak of 13.6% at age group 65-69 year olds (MOH, 2015).

Diabetes Mellitus as general is a metabolic diseases in which the body are unable or have inability to produce enough insulin level which then cause elevated blood glucose. WHO (1999), define Diabetes Mellitus a metabolic disorder of multiple aetiology characterized by chronic hyperglyceamic with disturbance of carbohydrate, fat and protein metabolism resulting from deficit in insulin secretion, insulin action, or both. According to American Diabetes Association (2017), Diabetes Mellitus are classified into four type that is type 1, type 2 , gestational diabetes and ‘other specific type’ which is due to the other causes for example, monogenic diabetes syndromes , diseases of the exocrine pancreas, and drug or chemical-induced diabetes. Diabetes Mellitus may present with many symptoms that are varied among peoples. It can be thirst, blurring of vision, increased frequency of urination and also weight loss. It also can develop ketoacidosis or a non-ketotic hyperosmolar state which then can lead to stupor, coma, and in absence of effective treatment, it can be fatal.

Diabetes Mellitus can cause many damage to our body system and also our body function. Long term Diabetes can lead to several organ failure. Cade (2008) as cited from Diabetologia (1991) state that Diabetes is a disease that is strongly associated with both microvascular and macrovascular complications, including retinopathy, nephropathy, and neuropathy (microvascular) and ischemic heart disease, peripheral vascular disease, and cerebrovascular disease (macrovascular), resulting in organ and tissue damage in approximately one third to one half of people with diabetes.

1.0.2 Postural Control

Postural control is a complex skill based on the interaction of dynamic sensorimotor processes The two main functional goals of postural behaviour are postural orientation and postural equilibrium (Horak, 2006). Postural control is defined as the act of maintaining, achieving or restoring a state of balance during any posture or activity (Pollock et al., 2000). Postural control strategies may be either predictive or reactive, and may involve either a fixed-support or a change-in-support response (Pollock et al., 2000). Postural orientation involves the active alignment of the trunk and head with respect to gravity, support surfaces, the visual surround and internal references (Horak, 2006). Sensory information from somatosensory, vestibular and visual systems is integrated, and the relative weights placed on each of these inputs are dependent on the goals of the movement task and the environmental context (Horax, 2006). It is our ability in controlling the body position in space for our body for stability and also our orientation. For example, the ability to move from sitting to standing; to take a step, to respond to a slip or trip, to predict and avoid obstacles, to carry a glass of water without spilling it, even when walking across a rolling boat, and to orient your body to a speeding soccer ball, all require excellent postural control. Postural control emerges from the interaction of individual capabilities, task requirements, and environmental constraints or affordances. Damage to any of the underlying systems will result in different, context-specific instabilities. The effective rehabilitation of balance to improve mobility and to prevent falls requires a better understanding of the multiple mechanisms underlying postural control (Horax, 2006).

1.0.3 Diabetes Mellitus and Poor Postural Control

Postural instability is one of the complications associated with diabetes mellitus (Bonnet, 2009). Type 2 diabetic patients often exhibit impaired balance and gait dynamics, and are at a greater risk of falling. Many individuals who fall develop a fear of falling, resulting in a further limitation of activity, reduced mobility and physical fitness (Morrison, 2012). Allet et.al(2010) stated that peripheral neuropathy (PN) seems to be a primary factor leading to sensory and motor deficits, which often result in balance impairments. Besides, several parts of the central nervous system (CNS), which consists of the spinal cord and the brain, take part in controlling posture (Mokhtar, 2013). Central nervous system complications resulting from DM is a problem that have been know for long times. According to Mokhtar (2013) also, diabetic neuropathy involves not only the peripheral nervous system, but also the central nervous system. CNS degeneration is a well known pathology in diabetic patients in the long term (Shabry, 2007). It is assumed that these problem are causes by the altered body metabolic reaction cause by diabetes mellitus. These changes may contribute to postural impairment in diabetic patients (Mokhtar, 2013).

However, study by Maz et. al. (2013), shows that diabetic neuropathy not only reasons of poor postural control among patient with Diabetes Mellitus. This study assess the influence of diabetic neuropathy (DN) on balance and functional strength in patients with diabetes mellitus type 2. Subjects with DM2 had greater anterior-posterior displacement in the unstable platform with eyes closed condition compared with those without DM2, whereas no difference in medial-lateral displacement was observed between these groups. Maz et. al.(2013) concluded through their study that Subjects with DM2, with or without DN, showed deficits in postural control and functional strength compared with healthy individuals of the same age group.

1.1 Research Statement

In Malaysia, there are no research available to study the relationship of Diabetes Mellitus and body postural control. Thus, we will evaluate the body postural control among Diabetic Mellitus patient using Gans SOP Test.

1.2 Objective

1.2.1 General Objective

To evaluate the body postural control of patient with Diabetic Mellitus using Gans SOP Test.

1.2.2 Specific Objective

1) To determine the balance problem of patient with Diabetes Mellitus.

2) To determine the postural control of Diabetes Mellitus patient with Gans SOP Test.

3) To compare the postural control of patient with Diabetes Mellitus with normal adult using result of Gans SOP Test.

1.3 Hypothesis

1.3.1 Null Hypothesis, Ho

There is no significant difference in Diabetes Mellitus patient and the result of Gans SOP Test

Alternative Hypothesis, HA

There is significant difference in Diabetes Mellitus patient and the result of Gans SOP Test.

1.3.2 Null Hypothesis, Ho

There is no significant differences in findings of Gans SOP Test between normal people and people with Diabetes Mellitus

Alterative Hypothesis, HA

There is no significant differences in findings of Gans SOP Test between normal people and people with Diabetes Mellitus.

CHAPTER 2

LITERATURE REVIEW

2.0 Human Body's Balance System

According to Shumway (2001), balance is the ability to maintain the body's center of mass over its base of support. Balance is important in our life as we use our balance system 24 hours per day. With a proper function of body's balance system, we can see moving object or see clearly while we are moving, determine the direction and also the speed of a movement, identify orientation with respect to gravity, and make automatic postural adjustment to maintain posture and stability in various conditions and activities (Watson et al.,2016). The integration of our visual from the eyes, our vestibular organ, and somatosensory components are used to maintain our body's postural balance and to make sure we can control our body postural control. Postural control represents a complex interplay between the sensory systems which involves perceiving environmental stimuli, responding to alterations, and maintaining the body's center of gravity within the base of support (Shaffer & Harrison, 2007).

Balance is something complex that is achieved and maintained by the complex set and interaction of sensorimotor control system that include input from several sources that are, vision (the eyes which is our sight), proprioception (touch) and also the vestibular system which control the motion, equilibrium and also spatial orientation by integration of that sensory input and motor output to the eye and body muscles. (Watson et al., 2016). The inner ears organs (vestibular organ) which consists of cupula, utricle, and also three semicircular canals (horizontal, anterior, and also posterior canal). Interactions between proprioceptive and vestibular inputs contributing to the generation of balance corrections may vary across muscles depending on the availability of sensory information at centre initiating and modulating muscle synergies, and the efficacy with which the muscle action can prevent a fall (Allum & Honegger, 1998). Nasher, 1982 as quote in Khattar and Hathiram, 2012, said it is to be understood that the central nervous system usually relies on one of the three above mentioned inpiuts for the information of orientation and, in normal healthy adults, it is the sometosensory inputs which are primarily relied upon. In case of inadequate input/inability of one input to provide the necessary information, the other inputs take over to overcome this inadequacy. Finally in cases of any conflict of input, the central nervous system relies on the vestibular system to decide the orientation of the body.

2.1 Sensory Input

Maintaining balance depends on information received by the brain from three peripheral sources that are eyes, muscles and joints, and vestibular organs. All three of these information sources send signals to the brain in the form of nerve impulses from special nerve endings called sensory receptors. It has been suggested that the information carried by individual sensory channels is combined and a ‘weight’ is assigned to the various input sources depending upon the current functional state of a particular sensory system, the postural task itself, and the context in which task is being performed(Ernst, 2002).. During this process the most reliable inputs are given more emphasis i.e. upweighted by the CNS, and the less reliable sensory inputs are given less emphasis i.e. downweighted (Ernst, 2002).

Sensory input from the three system are very important in order the input of surround can be deliver to the brain to be process. The eyes (vision) will catch one's surround environment while standing or walking. For example, when someone walking while looking at certain place or building, the body balance system would process the visual input by making the surrounding building appear vertically aligned and each storefront passed first moves into and then beyond the range of peripheral vision. Proprioceptive information from the skin, muscles, and joints involves sensory receptors that are sensitive to stretch or pressure in the surrounding tissues. For example, when walking, the pressure at the ones' soles will help in maintaining ones' balance. Sensory information about motion, equilibrium, and spatial orientation is provided by the vestibular apparatus, which in each ear includes the utricle, saccule, and three semicircular canals. These organs will be stimulate depending on different situation of our body act. The utricle and saccule detect gravity (information in a vertical orientation) and linear movement. The semicircular canals, which detect rotational movement, are located at right angles to each other and are filled with a fluid called endolymph.

2.2 Input from the Eyes.

Vision plays a significant role in balance. Your eyes give you a picture of the world and where you are in relation to other things in it. Approximately 20 percent of the nerve fibers in the eyes interact with the vestibular system.

Visual stabilization of posture is known to improve when the distance to target fixation decreases. This scenario, attributed to increased angular size of retinal slip induced by body sway. At near distance, however, the eyes converge and efferent or afferent oculomotor signals could also be involved in posture stabilization (Kapoula & Thuan Le, 2006). Guerraz & Bronstein(2008) as cited in Gaerlan (2010) stated that the afferent motion perception consists of two visual systems: focal and ambient. The focal system also known as central vision, specializes in object motion perception and object recognition; whereas, ambient or peripheral vision is sensitive to movement scene and is thought to dominate both perception of self-motion and postural control. The retinal slip, a part of the afferent motion perception, is related to a person's displacement by the central nervous system (CNS), and is used as feedback for compensatory sway. For example, when someone walks along a road with building at both side, the eyes catch the image when the light strikes the rods and cones, they send the impulse to the brain that provide visual cues identifying how a person is oriented relative to other object. Thus, the person will appear vertically aligned. The vestibular system interacts with the proprioceptive system coupled with corollary discharge of a motor plan, allowing the brain to distinguish actively compared to from passive head movements(Angelaki & Cullen, 2008). According to Gaerlan (2010), both visual and proprioceptive systems interact with the vestibular system throughout the central vestibular pathways and are essential for gaze and postural control. The somatosensory system contributes to maintain normal quiet stance and to safely accomplish the majority of activities of daily living.

Berencsi, Ishihara, & Inanaka (2005) has conducted a study to access the role of central and peripheral vision in the control of body posture. The result of the study suggest that peripheral rather than the central vision plays more significant and important role in maintaining stable while in quite standing condition. According to Berencsi, Ishihara, & Inanaka (2005), it is because visual stimulation of the peripheral visual field was found to decrease postural sway in the direction of observing the visual stimulus to which head and gaze were oriented rather than in the direction of the trunk ,it seems reasonable to conclude that peripheral vision operates in a viewer-centered frame of reference characterized by the position of the head and gaze rather than in a body-centered frame of reference characterized by the anatomical planes of the body and may contribute to the control of posture in the direction of heading.

2.3 Input From The Muscles And Joints

During multisensory integration, it has been proposed that the central nervous system (CNS) assigns a weight to each sensory input through a process called sensory reweighting (Kabbaligere, 2017). Proprioceptive information from the skin, muscles, and joints involves sensory receptors that are sensitive to stretch or pressure in the surrounding tissues. Horax (1997) as cited in Horstmann (2015) stated that to maintain balance and prevent falling, the center of mass must remain within the base of support which is achieved through a complex process of position adjustments by muscles acting across joints and controlled by the central nervous system. The sensory input includes visual feedback and feedback from the vestibular organ, stretch and velocity sensitive receptors in joints, muscles, tendons and ligament structures, and cutaneous receptors such as pressure receptors on the foot sole (Grönqvist, 2001). For examples, when someone standing while leaning forward, an increase in pressure felt at the fornt part of feet soles. With other movement of other body muscle, sensory receptors respond by sending the impulse to the brain. This, will help our brain to determine our body posture and determine where our body in space. Cues from the ankles indicate the body's movement or sway relative to both the standing surface (floor or ground) and the quality of that surface (for example, hard, soft, slippery, or uneven).

Other muscles that play important part in posture is neck muscle. Proprioceptive input from the neck is important for maintenance of upright standing (Liang, 2013). Muscle spindles and Golgi tendon organs of neck musculature provide important information on head orientation for postural control (Brandt, 2001). Proprioceptive cues from the neck indicate the direction in which the head is turned.

2.4 Input From The Vestibular System

Sensory information about motion, equilibrium, and spatial orientation is provided by the vestibular apparatus, which in each ear includes the utricle, saccule, and three semicircular canals. The vestibular system, which is a contributor to our balance system and our sense of spatial orientation, is the sensory system that provides the dominant input about movement and equilibrioception (Writer & Arora, 2012). The vestibular snese provides information related to movement and head position and is important for the development of balance, coordination, eye control, attention, being secure with movement and some aspect of language development (Writer & Arora,2012).

These receptors contained within the vestibular apparatus are sensitive to any changes in head position or movement direction. These receptors provide information regarding linear acceleration. For example, being able to sense forward and backward, as well as upward and downward, movement and angular acceleration, which enables us to detect rotation of the head while keeping the eyes still. The vestibular apparatus exerts direct control over the eyes so they can directly compensate for head movements.

The vestibular system of the inner ear is designed to detect linear acceleration (maculae) and angular acceleration (cristae) (Swenson,2006). Both types of organs include a thickened epithelium with the cilia of their hair cells being embedded in a gelatinous covering. The organs are divided by,

i) Macule which is located in utricle and saccule. Inside this organs, there are calcium carbonate crystal called otoliths. This crystal mainly affected by the gravity which will distort the hair cells inside the macule. Acccording to Swenson (2006), they will lag behind if the head is accelerated in a linear direction. There are hair cells that are polarized in many different directions in each macula. Therefore, the macula can detect the orientation of the head in relation to gravity and the direction of linear acceleration.

ii) The cristae located in the semicircular ducts (SCC). SCC consist of three different canals which are the horizontal canal, posterior canal and also anterior canal. According to Swenson(2006), In the case of the semicircular ducts, a dilated "ampula" is associated with each. The ampula contains a flame-shaped christae which consist of gelatinous cap (cupula) protrudes into the canal. Movement of the endolymph through the canal results in a deflection of the christae thereby deflecting the hairs (Swenson, 2006). These cristae will be polarized and inhibit according to which way did they move as the fluid will move which will excite all the hair cell and when in opposite direction will inhibit all of them.

Angular acceleration of the head (i.e., rotation, lateral flexion or nodding) will cause fluid to tend to lag behind the movement of the head in relation to the canal that moves with the head, there will be relative movement of the fluid. This relative movement will be greatest if the head movement is directly in the plane of the semicircular duct. Therefore, the christae signal angular acceleration (Swenson, 2006).

The semicircular canals, which detect rotational movement, are located at right angles to each other and are filled with a fluid called endolymph. When the head rotates in the direction sensed by a particular canal, the endolymphatic fluid within it lags behind because of inertia, and exerts pressure against the canal's sensory receptor (Shumway, 2001). The receptor then sends impulses to the brain about movement from the specific canal that is stimulated. When the vestibular organs on both sides of the head are functioning properly, they send symmetrical impulses to the brain saying that impulses originating from the right side are consistent with impulses originating from the left side (Shumway, 2001).

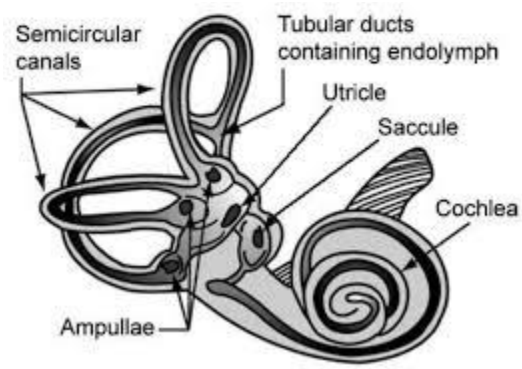

Figure 2.1: The Vestibular Organ

. This is crucial in sports where tracking moving objects or an opponent with head and eye movement is a constant necessity. With head movement, receptors in the vestibular apparatus transmit neural information to the cerebellum and the vestibular nuclei located in the brain stem. When the brain receives the message, often reinforced by visual feedback, it sends a signal to the muscles; this tells them to react to the loss of balance. Even standing still is an exercise in dynamic equilibrium. A person is swaying very slightly all the time to all four sides, and balance is maintained by alternate contraction and relaxation of the leg muscles (Lee & Vance, n.d)

2.5 Diabetes Mellitus and Balance Problem.

As we know, Diabetes Mellitus can cause many effect to our system. One of the problems is balance problem that most of the patient with Diabetes Mellitus have. Among the four types of Diabetes Mellitus that have been state, Type 2 Diabetes Mellitus are most associated with the balance problems. Gait characteristics and balance are altered in diabetic patients. Diabetes mellitus (DM) is a chronic systemic disease that leads to peripheral and central neuropathy, retinopathy, poor glycemic control, and impairments in locomotors functions (Tender et al., 2015 as cited from Volpato, 2005). Apart from these impairments, DM medications and/or polypharmacy may damage the balance maintenance systems, besides being a strong predictor of self-referred functional limitations, worse performance in lower limb functions, and falls (Tender et al. as cited from Morrison (2010) & Schwartz (2002)). Damage to large spindle afferent fibres may be the main culprit for the disequilibrium.

Older adult with Diabetes Mellitus has significant association with the fear of falling compare to the non-diabetic group. Studies conducted by Souza Moreiraa et al. (2017) studies about the factor of Fof (Fear of Failing) between two adult groups (normal vs Diabetic patient). Fear of falling (FoF), defined as low perceived self-efficacy or confidence at avoiding falls during essential, nonhazardous activities of daily living (Tinetti et al., 1990 as cited in Souza Moreiraa et al., 2017).

Study from Brach, 2008 shows the association between Diabetes Mellitus and also the gait problem. This study access the gait function of 558 older adult subject by using the GaitMat II. GaitMat II is an automated gait analysis system based on the opening and closing of pressure-sensitive switches, which are represented on the computer screen as footprints when the participant walks on the walkway. Result from this study, when compared with individuals without diabetes, individuals with diabetes walked more slowly, took shorter steps with a greater step width, and spent more time in stance and double support (Brach,2008). The findings in this large sample of older adults support the findings of previous studies on diabetes and gait in adults primarily less than 65 years of age. However, the association was partially explained by health status variables, cognition, mood, lower-extremity circulation and sensation, visual impairment, lower-extremity strength, physical activity, and BMI. The result of this study support the earlier study by Muller(1994), that stated individuals with diabetes also have been shown to have less ankle mobility, ankle moment, and ankle power during walking compared with individuals without diabetes. These studies show significant result about gait function of diabetic patient.

Thus, looking from this previous studies, we know that Diabetes Mellitus can cause balance problem not only because of the Diabetes Mellitus itself but because of the failure of several organ and function of the body system which then cause the Diabetes Mellitus patient have problem in their body balance.

2.6 Vestibular Assessment

Vestibular assessment is very important in assessing patient's balance status. It consist of several test that help determine if there is something wrong with the vestibular (balance) portion of the inner ear. Vestibular assessment that available now days can assess patients' balance problem whether it come from the vestibular organ / peripheral part of body or the central part involving the upper brain processing. According to ASHA(2017), doctors use information from a person's medical history and findings from a physical examination as a basis for ordering diagnostic tests to assess the vestibular system function and to rule out alternative causes of symptoms.

Lara Alleta,2009 studies about the Gait alterations of diabetic patients while walking on different surfaces. According to this study, walking in real life conditions revealed gait difficulties in patients with type 2 diabetes before neuropathy was clinically detectable. The strategies used by patients while changing from a flat, tarred walkway to a more challenging surface (grass or stones) were similar between patients with and without sensory loss (Alleta,2009). Thus, clinicians should therefore be aware that diabetic individuals' gait capacity decreases and fall risk increases in an early stage of the disease.

2.6.1 Gans SOP.

Many vestibular assessments have been develops for the past year to assess the balance and also vestibular function of the patient that has balance problem. Most of them can help in diagnosing and the balance problem that a person has and futher management can be done .

One of them is Gans Sensory Organization Performance Test (Gans SOP). This test had been standardized to patient from 3 years to 79 years old age with weight 159kg. Gans SOP include of Romberg test, modified Romberg test and Fukuda test. Balance testing can be done to the people with nausea, vomiting, rapid or involuntary eye movement or known as nystagmus or having gait abnormalities (ASHA, n.d). Gans SOP Test is best used to look at overall patterns of balance performance through it's a combination of the Romberg, CTSIB and Stepping Fukuda Tests. Although no test of balance function can provide a specific diagnosis, there are well-established patterns of functional impairment that have been found to correlate with various vestibular function tests.

2.7 Activities Specific Balance Confidence Scale

Although fall-related physical morbidities are significant, arguments have been made that the psychological consequences associated with falling, such as developing a fear of falling and/or losing balance confidence, are of equal or greater concern due to their subsequent influence on reduced quality of life and self-imposed avoidance of activities. (Yardley, 2002). Among the psychological consequences of falling, Miller et al,2001 found balance confidence, the belief individuals have in their ability to perform daily activities without losing their balance, to have a greater influence on mobility and participation in daily and social activities than fear of falling among individuals with a lower-limb amputation. Balance confidence as such is important to assess among those in this population (Miller et 2001 as cited in Miller 2002).

Balance confidence is an important determinant of social role participation (Anaby, 2009). Because confidence is a modifiable factor according to the tenets of Social Cognitive Theory, treatment strategies to address reduced or low levels of balance confidence are necessary given that optimal participation is considered a key goal of rehabilitation.

According to Moore & Ellis, 2008 the ABC Scale, is by far the most widely used measure to assess balance confidence. This scale was developed to assess balance confidence in high functioning older adults.It is a 16-item scale requiring respondents to self-rate their balance confidence from 0% to 100% in performing activities of daily living. Averaging the ratings derives total scores, and higher scores reflect higher levels of balance confidence. The ABC Scale has been used with various populations and has psychometric evidence supporting its use with older adults, individuals with lower-limb amputations, and stroke (Sakakibara et al., 2011as cited in Rasch 2007)

CHAPTER3:

METHODOLOGY & MATERIALS

3.0 Research Design

This is cross sectional study design to evaluate the postural control among Diabetic Mellitus patient by using Gans Sensory Organization Performance Test.

3.1 Participant

3.1.1 Sample size

The sample size was calculated by using MedCalc software (Version 2.1, 2011) and based on study by De Oliveira et al. (2011). By taking mean difference = 22.9, SD1=15, SD2=36, α value = 0.05, power of study = 80%. The minimum sample size required is 23 for each group. However, by considering 10% drop out, the minimum sample size required is 25 for each group (a total of 50 subject).

3.1.2 Inclusion Criteria

Diabetes Mellitus patients

i) Age between 20 to 60 years old

ii) Diagnosed diabetic mellitus <10 years

iii. No hip or knee injury

iv. No history of osteoarthritis

v. No vision problem

Normal Adult

i) Age between 20 to 60 years old

ii) Healthy with no vestibular disorder

iii. No, any serious and chronic medical illness

iv. No hip or knee injury

v. No history of osteoarthritis

vi. No vision problem

3.1.3 Exclusion Criteria

Participant who doesn't want to participate in the study

Patient with the vascular and musculoskeletal problem.

3.1.4 Instruments

- Bal Ex Foam

  Bal Ex Foam was used in this study. This foam is developed by the team of Medical Doctor of Hospital Universiti Sains Malaysia. The foam was marked to standardize to patient ranging from 3 to 79 years old age. The materials used for this foam is high quality standard foam to support high body weight during the test. The dimension of this foam also beneficial even for the tall patient with a widened base of support. It was designed to have high quality and density. Thus, this foam is an ideal foam to be used in the

Standardized Clinical Test of Sensory Integrations of Balance (CTSIB) or for therapy purpose.

Figure 3.1: Bal Ex foam

Figure 3.2: Bal Ex foam

Figure 3.3: Bal Ex foam (side view)

- History Form (Appendix D)

- Malay Version Modified Vertigo Symptom Scale (MVMVSS) (Appendix B)

MVMVSS is the Malay version of Modified Vertigo Symptom Scale 14 items in this questionnaire. During the translation process, all the translator try to kept as close as the original version of semantic and technical error of the items. There are several words from the questions were changed or modified but the meaning is consistent and very close with the original one. This adaptation is important in order to adapt with the Malay language and culture. The questionnaire was validated by 10 health persons that from difference background such as the professional worker, health student and also public.