Correlation Between Neuropathy Severity and Balance Performance in Individuals with Diabetic Neuropathy

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Abstract

Background: Diabetic neuropathy has peripheral nerve damage which can reduce proprioceptive function. This condition causes functional balance disorders which increases the risk of falls.This study aims to determine assosiation between Diabetic Neuropathy Symptoms (DNS) and Diabetic Neuropathy Examination (DNE) with Berg Balance Scale (BBS) in diabetic neuropathy patients.

Method: a cross-sectional design, in diabetic neuropathy outpatient in Adam Malik General Hospital .DNS and DNE were performed to diagnose diabetic neuropathy and BBS examination to assess functional balance. Data analysis using spearman correlation test.

Results: Demographic characteristics of 52 subjects were male, age range 51-60 years, history of 5-10 years DM and HbA1c> 6.5%. The median scores of DNS, DNE and BBS are respectively; 3 (2-4), 3 (0-8) and 56 (29-56). As many as 82.7% of subjects had a risk of falling lightly and 17.3% had a risk of moderate fall. DNS has a significant correlation with a decrease BBS ($p < 0.001$; r -0.4477). DNE has a significant correlation with a decrease BBS($p < 0.001$; r -0.606).

Conclusion: There is a significant correlation between DNS and DNE with a decrease BBS in diabetic neuropathy patients.

Introduction

Distal Peripheral Neuropathy is one of the most common long-term complications of diabetes mellitus.[1] Distal Peripheral Neuropathy starts in the distal region leading to proximal innervation in the lower extremities that disrupts the sensory system. This contributes significantly to human postural control, namely the somatosensory system. The lack of accurate proprioceptive information of the lower extremities in DPN patients has resulted in static and dynamic postural instability. Therefore, they have a high risk of falls and life-threatening consequences.[2,3] Meijer et al. (2003) mention the value of DNS (Diabetic Neuropathy Symptom) and DNE (Diabetic Neuropathy Examination) can distinguish between subjects with and without neuropathy in diabetic patients. Diabetic Neuropathy Symptom is used as a tool for diagnosing diabetic neuropathy that has been validated, fast and easy to do, with high predictive value. Diabetic Neuropathy Symptom has a high relationship to DNE.[4]

Distal Peripheral Neuropathy causes a decrease in proprioceptive and induces numbness in the lower extremities, which leads to balance disorders.[5] According to a study conducted by Timar et al. (2016), there was a significant relationship between diabetic neuropathy and balance disorders ($p < 0.001$; $r = 0.47$).[6] Poor postural balance is a strong intrinsic risk factor for falls. Regarding the importance of functional balance control and the risk of falling during daily activities, especially in patients with DPN, a more comprehensive clinical balance evaluation is needed.[7] Ghanavati et al (2012) mention it is stated that Berg Balance Scale (BBS) is an instrument that is available and can be run anywhere, validated, widespread, clinical scale that is easy to do and comprehensive to assess functional balance in patients with DPN as well as healthy people .[8]

Method

Study sample

The study sample was taken from patients with diabetic neuropathy in Adam Malik General Hospital Medan with consecutive sampling techniques. The research subjects consisted of 52 diabetes mellitus patients who had diabetic neuropathy with a score of diabetic neuropathy symptom score> 1. willing to take part in the study by signing a research informed consent sheet.

Study design

This study is a cross-sectional design without treatment. The diagnosis of diabetic neuropathy is based on examination of diabetic neurpathy symptoms consisting of 4 questions related to diabetic neuropathy symptoms and diabetic neurpathy examination consisting of 8 items with each; 2 items about muscle strength, 1 about reflexes, and 5 about sensations. To assess the risk of falls in patients using a Berg Balance Scale consisting of 14 items of balance components.

Statistical analysis

Data from the research were analyzed statistically using the SPSS Windows computer program (Statistical Product and Science Service) version 22.0. To analyze the relationship between research variables, in this case to determine the relationship between diabetic neuropathy symptoms with Berg Balance Scale and the relationship between diabetic neurpathy examination and Berg Balance Scale with spearman correlation test.

Result

Patients with diabetes mellitus who received treatment at H. Adam Malik Hospital Medan in December 2018 until January 2019, there were 52 patients with diabetes mellitus with diabetic neuropathy who participated in the study.

Based on the characteristics of 52 research subjects, the age of all research subjects had a mean of 58 years ± 7.22 divided into the age range of 40 - 50 years as many as 10 subjects (19.2%) with the youngest age 44 years, age range 51 - 60 years as many as 22 subjects (42.3%), and age range 61 - 70 years as many as 20 subjects (38.5%) with the oldest age 69 years. History of diabetes mellitus all subjects had a median value of 6 years (1-15 years) divided into <5 years as many as 16 subjects (30.8%), 5-10 years as many as 33 subjects (63.4%), and> 10 years as many as 3 subjects (5.8%). The Hba1c level of all research subjects had a median value of 8.15% (6.1-12.9%) divided into <6.5% by 2 subjects (3.8%) and ,5 6.5% as many as 50 subjects (96 , 2%). For complete data about the characteristics of the subject of this study are presented in table 1 below.

Table 1. Demographic Characteristics of Research Subjects (n = 52)

Characteristics	Frequency n=52	Percentage (%)
Age,average ± SD (years)	58± 7,22	
- ≥ 40-50 years old	10	19,2
- ≥ 51-60 years old	22	42,3
- ≥ 61-70 years old	20	38,5
Sex		
- Male	32	61,5
- Female	20	38,5
Hystory of diabetes mellitus (years), median	6(1-15)	
- < 5 years	16	30,8
- 5 – 10 years	33	63,4
- >10 years	3	5,8
Hba1c level (%), median	8,15 (6,1-12,9)	
- < 6,5 %	2	3,8
- ≥ 6,5 %	50	96,2

Descriptive analysis of the characteristics of the score of Symptom Diabetic Neuropathy, Diabetic Neuropathy Examination and Berg Balance Scale in this study used a median value with minimum and maximum values. This is because the distribution of data regarding DNS, DNE and BBS scores is not normally distributed. Based on the characteristics of the Diabetic Neuropathy Symptom, Diabetic Neuropathy Examination and Berg Balance Scale scores in the 52 study subjects who participated in this study, it was found that the overall score of the Diabetic Neuropathy Symptom had a median value of 3 (2-4). The overall Diabetic Neuropathy Examination score has a median value of 3 (0-8) while the proportion of diabetic neuropathy with a score of Diabetic Neuropathy Examination> 3 has 20 subjects (38.5%) with a median value of 6 (4-8) and Diabetic scores Neuropathy Examination ≤ 3 as many as 32 subjects (61.5%) with a median value of 2 (0-3). The whole Berg Balance Scale score has a median value of 56 (29-56). The proportion of the risk of falls based on the Berg Balance Scale score is divided into the risk of mild fall as many as 43 subjects (82.7%) with a median value of 56 (42-56) and the risk of moderate fall as many as 9 subjects (17.3%) with a median value of 38 (29-48). This can be seen in table 2 below.

Table 2. Characteristics of DNS, DNE and BBS (n = 52)

Variable	Median (minimum-maximum)	N (52)	Percentage (%)
DNS score (all subject)	3(2-4)		
DNS score(all subject)	3(0-8)		
- >3	6(4-8)	20	38,5
- ≤3	2(0-3)	32	61,5
BBS score(all subject)	56(29-56)		
- Mild risk of fall	56(42-56)	43	82,7
- Moderate risk of fall	38(29-48)	9	17,3

In this study the statistical analysis used was the Spearman correlation test due to abnormal data distribution. Based on the spearman correlation test on 52 research samples, it was found that there was a significant relationship between DNS scores and BBS with a p value of <0.001. The correlation r value obtained is -0.447 showing the direction of the negative correlation with the strength of the medium correlation. the relationship between DNE scores and BBS is significant with a p value of <0.001. The correlation r value obtained at -0.606 shows the direction of the negative correlation with the strength of a strong correlation. This can be seen in table 3 below.

Table 3. Assosiation between DNS and DNE with BBS

	Berg Balance Scale
DNS score	r=-0,447 p=<0,001 n=52
DNE score	r=-0,606 p=<0,001 n=52

Discussion

The average age characteristics of diabetic neuropathy patients are relevant to previous studies conducted by Brown et al. (2015) which mention the average age of diabetic neuropathy patients at the age of 57 years.[9] Other relevant research also states that the age range of suffering from diabetic neuropathy is most experienced in the age range of 51 - 59 years of 52, 7%.[10]Age factors physiologically affect changes in vascular conditions associated with atherosclerosis. Atherosclerosis will result in blood flow being blocked, so that it will have an impact on tissue hypoxia which will affect nerve cell function. Decreasing nerve cell function can reduce foot sensation.[11]
The sex characteristics of most diabetic neuropathy patients were 32 subjects (61.5%). The results of this study are relevant to a previous study conducted by Brown et al. (2015) which states that diabetic neuropathy patients are more experienced by men (68%) compared to women (32%).[9]Unmodified risk factors for microvascular complications of diabetes include old age, genetics (polymorphism of the aldose reductase gene), increased duration of diabetes, and height. Higher diabetics are more prone to diabetic neuropathy because they have longer peripheral nerves. Because men are generally higher than women, more men who experience diabetic neuropathy are compared with women.[12,13]

In this study, a history of diabetes mellitus in patients with diabetic neuropathy had a median value of 6 years (1-15 years) with the longest history of suffering from diabetes mellitus, the most 5 - 10 years as many as 33 subjects (63.4%). The results of this study are relevant to previous research by Trisnawati (2014) which states that 64.6% of patients with diabetic neuropathy have long periods of suffering from DM ≥ 5 years. Duration of diabetes mellitus ≥ 5 years significantly has a risk of developing diabetic neuropathy 3.95 times higher than DM patients with long-term diabetes <5 years.[14]Diabetic neuropathy is the most common complication in people with type 2 diabetes, the incidence increases according to the duration of suffering from diabetes, especially after suffering for 5 years. The length of time diagnosed with DM is also related to a decrease in pancreatic beta cell function, causing complications that generally occur in patients with 5 to 10 years of illness.[15]The duration of suffering from diabetes is closely related to diabetic neuropathy. The condition of chronic hyperglycemia causes a decrease in insulin secretion or decreased sensitivity of insulin. Excess glucose will enter the Polyol pathway, so glucose turns into sorbitol. Sorbitol formed will cause intracellular osmotic stress on nerve cells so that it can cause nerve cell damage. In reducing high intracellular glucose, the aldose reductase enzyme reduces the amount of glucose that enters the Polyol pathway, but this also causes a reduction in gluthathione which then increases the production

of the Advanced Glycation End Product so that in the end it will still cause oxidative stress on nerve cells. The longer a person suffers from DM, the process will continue longer and continue to cause further damage to cells, especially nerves.[16]

The Hba1c level of diabetic neuropathy patients had a median value of 8.15% (6.1-12.9%) with the most is the Hba1c category ≥ 6.5% as many as 50 subjects (96.2%). The Hba1c results are close to previous studies conducted by Meijer (2003) which stated that Hba1c levels in DM patients with diabetic neuropathy were 8.7% ± 1.4.[4]The proportion of HbA1c ,5 6.5% in this study was higher than the results of the Trisnawati (2014) study which stated that the proportion of HbA1c levels was high in patients with more diabetic neuropathy, namely 72.1% compared to normal HbA1c levels. This shows that most blood glucose levels in patients with diabetic neuropathy are not well controlled.[14]Measurement of HbA1c levels is one method used to monitor glucose control in patients with DM. The HbA1c assessment can assess the effectiveness of therapy by monitoring long-term blood glucose regulation. The HbA1c value is proportional plasma glucose concentration within 4 weeks to 3 months. Control of blood sugar judged by HbA1c levels has been associated with progressivity from DM complications, one of which is Neuropathy.[17]

This study is relevant to previous research conducted by Meijer (2003) which states the average DNS score in diabetic neuropathy patients is 2.29 ± 1.23. The Diabetic Neuropathy Symptom score is a validated predictive assessment system consisting of 4 questions regarding complaints related to symptoms of diabetic neurpatiies such as numbness, tingling, burning pain or stabbing, and instability when walking. Based on these scores if the value> 1 is said the subject has diabetic neuropathy .The Diabetic Neuropathy Examination score is a validated scoring system based on physical examination which includes examination of motor, reflex and sensory strength (proprioceptive and ecsteroceptive). Positive results as diabetic neuropathy if score> 3.[4]According to Tesfaye et al. (2010) mentioning the definition for diabetic neuropathy is divided into possible which is only based on the presence of symptoms, probable is the result of a combination of symptoms and physical examination of neuropathy, confirmation is a symptom and sign of neurpati which is evidenced by abnormal nerve conduction and subclinical is a condition with no symptoms or signs of neuropathy, but abnormal nerve conduction is found.[18]

The results of this study are close to the results of previous studies conducted by Vaz et al. (2013) stating that the average BBS score in patients with diabetic neuropathy is 48.6 ± 7.2 with a risk of mild falls. Based on Shumway-Cook et al, in the range of 56 to 54, any 1 point decrease in BBS is associated with a 3% to 4% risk of falling. In the range of 54 to 46, each drops 1 point referring to a 6% to 8% increase in risk of falling, and <36 points of risk fall near 100%. Therefore, changes in 1 point in the BBS can produce very different percentages because it depends on the total score and, accordingly, represents a different risk of falling.[19]The results of this study have relevance to previous research conducted by Timar et al (2016) which states that there is a significant relationship between diabetic neuropathy with a decrease in BBS score with p value <0.001 and correlation r value of - 0.475 which shows a negative correlation with medium correlation strength.[6]Diabetic neuropathy causes somatosensory and proprioceptive information disorders. The somatosensory and proprioceptive system that regulates balance consists of mechanoreceptors in muscles, joints and skin. In the presence of neuropathy, there is a decrease in foot sensitivity so that the mechanoreceptor information from the sole of the foot decreases and ultimately results in a balance disorder.[20]

The results of this study approach the previous research was conducted by Ghanavati et al (2012) which states that there is a significant relationship between DNE scores and BBS with a value of <0.001 and a correlation r value of -0.77 which shows a strong correlation. So it can be concluded that the DNS and DN scores are used to confirm the diagnosis of diabetic neuropathy.[21]Other research results on postural control and functional balance in neuropathic patients also show that the higher neuropathy score the functional balance score will decrease.[22] According to Asad et al. (2010), mentioning the scoring systems for diagnosing diabetic neuropathy.[23]

In Distal Peripheral Neuropathy (DPN) damage to motor and sensory nerve fibers can occur. Sensory nerves, anatomically, physiologically and functionally can be distinguished into at least three types of nerve fibers, namely fibers Aα, Aδ, and C. Fiber damage will interfere with the delivery of vibration sensations, position perception, and touch sensations.[24]Impulses from position sensation, vibration, pressure, discrimination, and located in the skin, muscles, tendons, and Vater-Pacini corpuscles, then will be delivered through lower extremity and funikuluskuneatus (upper extremity) to the nucleus of the brain and the second neuron through the medial lemniscus to the thalamus and the third neuron to the sensory center in the central nervous system.[25]

Conclusion

There is a significant relationship between diabetic neuropathy symptoms and diabetic neurpathy examination with decreased berg balance scale in diabetic neuropathy patients.

Suggestion

Future studies can further analyze the factors that affect balance, especially in patients with diabetic neuropathy. The use of the gold standard diagnostic test needs to be done to get better results.

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