International Journal of Research and Review
Vol. 9; Issue: 2; February 2022
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

The Relationship of Nerve Conduction Velocity (NCV) Amplitude with Controlled and Uncontrolled Diabetes Mellitus based on HBA1C in Peripherals Polyneuropathy Patients in Sanglah Hospital

Ni Made Kurnia Dwi Jayanthi[1], Komang Arimbawa[1], Ni Made Dwita Pratiwi[1]

[1]Department of Neurology, Faculty of Medicine, Udayana University, Denpasar, Bali, Indonesia.

Corresponding Author: Ni Made Dwita Pratiwi

DOI: https://doi.org/10.52403/ijrr.20220244

ABSTRACT

Background: Complications microangiopathy in the field of nerves resulting from diabetes mellitus is diabetic neuropathy. Patients with diabetes mellitus with blood glucose levels that are not regulated well have a 25.6% risk of developing neuropathy. Neuropathy can be diagnosed clinically, the presence of complaints such as numbness, tingling, or burning in the distal extremity, but almost half of patients are asymptomatic, other methods to determine the presence of neuropathy are questionnaires and electrodiagnostic examinations which are the gold standard. The purpose of this study was to find the relationship between the amplitude of nerve conduction velocity (NCV) with controlled and uncontrolled diabetes mellitus based on HBA1c in patients with peripheral diabetic polyneuropathy at Sanglah Hospital.
Method: This study was conducted with a case-control analytic design at Sanglah Hospital by taking data retrospectively where patient data were directly taken from January 2021-October 31 2021
Results: There were 40 research subjects where 20 subjects with controlled DM and 20 subjects with uncontrolled DM, 62.5% men, with an age range of 50-60 years, BMI obesity, duration of diagnosis > 3 years where the results obtained were peripheral polyneuropathy conditions. with the results of NCV only found a significant difference in CMAP N Median with p 0.026 and in SNAP with p = 0.035 in SNAP
Conclusion: All patients have the result of decreased function of NCV with the highest risk if it is not controlled with HBA1C levels < 7%, there will be the greatest decrease in NCV motor and sensory N. radialis.

Keywords: diabetes mellitus, CMAP, HBA1C, NCV, SNAP

INTRODUCTION

Changes in the lifestyle of modern society and rapid urbanization today have resulted an increase in various non-communicable metabolic diseases. Lack of physical activity, consumption of instant food and high levels of stress are often encountered in daily life. One of the metabolic diseases that have a risk of complications that can reduce the quality of life of the sufferer is diabetes mellitus.

Diabetes mellitus is a metabolic disorder of various etiologies, accompanied by chronic hyperglycemia due to impaired insulin secretion or insulin action, or both. Diabetes mellitus is classified into four types, namely diabetes mellitus type 1, type 2, gestational diabetes and other types of diabetes mellitus. Type 1 diabetes mellitus is caused by reduced insulin secretion due to pancreatic beta cell damage which is based on an autoimmune process (Pratono, 2008). Long-term complications of diabetes mellitus include macroangiopathy and microangiopathy (Gibbons, 2013; Barbosa, 2016; Garter, 2008).

Complications of microangiopathy in the field of nerves are neuropathy, with the most manifestation being distal symmetric polyneuropathy (DSP) (Gibbons, 2013). Diabetic neuropathy is arm-dependent, clinically showing symptoms of stocking and glove distribution both sensory and motor also found to be a decrease in tendon reflexes (Gibbons, 2013 & Shapiro, 2013). The pathological processes involved include excessive glycolysis, an increase in the polyol pathway, an increase in the hexosamine pathway, and the formation of AGEs (advanced glycation end products) that cause the formation of oxidative stress (Callaghan, 2012). One of them can be monitored by checking HbA1C (Gibbons, 2013).

Neuropathy is a functional disorder in the peripheral nervous system caused by various factors (Shapiro, 2013). Its prevalence is more than 2% of the general population. Diabetes mellitus is the most common cause of neuropathy (Callaghan, 2012). Patients with diabetes mellitus with poorly regulated blood glucose levels have a 25.6% risk of developing neuropathy (DiBonaventura, 2013). The high incidence of neuropathy increases the health budget (Pernomo H, et al, 2003). The total cost incurred by the United States government for the treatment of diabetic peripheral neuropathy annually reaches 760 million dollars. Approximately 85% of the annual fee is used for the treatment of long-term complications such as lower limb amputation, foot ulceration, cellulitis, and osteomyelitis.12 amount of lower limb amputations has been carried out more than 80.

Diabetic peripheral neuropathy indirectly also causes the decrease in productivity, especially in the productive age population due to high employee absenteeism and other complications, although the literature on this matter is still scanty (Hex, 2012). In Indonesia the analysis of the costs incurred in outpatient DM patients each year an average of Rp. 902,928 per person and Rp. 9,104,077 per person for inpatients (Fitri, 2015). Good control of blood glucose levels, seen from the HbA1C examination, can reduce the incidence of neuropathy in people with diabetes mellitus (Smith, 2005). Early diagnosis and screening for neuropathy in patients with diabetes is essential. both subjectively and objectively for early treatment and prevention in order to prevent further morbidity and mortality in people with diabetes mellitus (Ottobuckpwska, 2015). Neuropathy can be diagnosed clinically, the presence of complaints of numbness, tingling, or burning in the distal extremity, but almost half of patients are asymptomatic, other methods to determine the presence of neuropathy are questionnaires and electrodiagnostic examinations which are the gold standard (Fateh, 2016). The purpose of this study was to determine the relationship between the amplitude of nerve conduction velocity (NCV) with controlled and uncontrolled diabetes mellitus based on HbA1C in patients with peripheral diabetic polyneuropathy at Sanglah Hospital. Neuropathy can be diagnosed clinically, the presence of complaints of numbness, tingling, or burning in the distal extremity, but almost half of patients are asymptomatic, other methods to determine the presence of neuropathy are questionnaires and electrodiagnostic examinations which are the gold standard (Fateh, 2016). The purpose of this study was to determine the relationship between the amplitude of nerve conduction velocity (NCV) with controlled and uncontrolled diabetes mellitus based on HbA1C in patients with peripheral diabetic polyneuropathy at Sanglah Hospital.

METHODS AND PROCEDURES

This study was conducted with a case-control analytic design to determine the relationship between the amplitude of nerve conduction velocity (NCV) with controlled and uncontrolled diabetes mellitus based on HbA1C in patients with peripheral diabetic polyneuropathy at

Sanglah Hospital by taking data retrospectively where patient data was directly taken from January 1 2021-31 October 2021, DM patients who have had the Amplitodo NCV examination at the Denpasar Hospital with the results of the HbA1C examination also obtained.

Table 1. Normal Value of Motor Nerve Conduction Speed (Sukarini, 2015)

Variable		NCV (m/sec)
motor	N. Median	67.16 ± 6.73
	N. Ulnaris	66.65 ± 7.36
	N. Radialis	59.34 ± 10.01
	N. Tibialis	53.95±6.65
	N. Peroneal	54.67 ± 8.25
Sensory	N. Median	65.16 ± 10.29
	N. Ulnaris	63.44 ± 9.79
	N. Radialis	70.44 ± 10.33
	N. Suralis	59.06 ± 9.12

The inclusion criteria in this study were: (1) All patients with diabetes mellitus who have peripheral diabetic polyneuropathy at Sanglah Hospital and have examined the NCV amplitude in January-October 2021. (2) Complete medical record data with HbA1C examination results and NCV amplitude results. The exclusion criteria were as follows: (1) Patients with obesity, (2) History of chronic kidney and liver disease, (3) History of HIV/Morbus Hansen, (4) History of malignancy, (5) History of stroke, (6) History of surgical trauma, (7) History of exposure to toxins and use of other drugs, (8) Patients with entrapment neuropathy, (9) Patients with moderate to severe depression. Normal values for NCV CMAP and SNAP are found in table 1

The sampling technique was carried out by consecutive non-random sampling method, that is, all subjects who came and met the eligibility criteria were included in the study until the required number of samples was met.

The research data will be analyzed statistically with the help of the Windows Statistical Package for the Social Sciences (SPSS) version 23 program. Data analysis was carried out in the following stages: (1) Descriptive analysis was used to describe the characteristics of the sample, HbA1C, age, gender, age. diagnosed with DM, education, BMI, types of antidiabetic drugs, and the results of the amplitude examination. Quantitative data is expressed in the mean (mean + SD) if the distribution is normal, the median (minimum-maximum) if the data is not normally distributed and qualitative data as the frequency (%). (2) The relationship between controlled and uncontrolled DM variables with the amplitude of the NCV value was used Chi-Square test, the level of significance was expressed by p and Relative Risk (RR) with 95% Confident Interval (CI). The results are said to be statistically significant if $P < 0.05$.

RESULTS

Table 2. Characteristics of research subjects

Variable		DM controlled HBA1C 7% n=20	DM is not controlled HBA1C > 7% n=20	p-value
Age	60 years	8 (40%)	9 (45%)	
	> 60 years old	12 (60%)	11 (55%)	
	Average ± SD	55.34±9.94	53.45±9.39	0.789**
Gender	Man	13 (65%)	12 (60%)	0.567*
	Woman	7 (35%)	8 (40%)	
Long time diagnosed with Diabetes Mellitus	3 years	6 (30%)	7 (35%)	0.678*
	> 3 years	14 (70%)	13 (65%)	
Types of diabetic drugs	insulin	6 (30%)	4 (20%)	
	Glimepiride	3 (15%)	2 (10%)	
	metformin	5 (25%)	3 (15%)	
	2 kinds of combination	3 (15%)	4 (20%)	
	> 2 types of combination drugs	3 (15%)	7 (35%)	
Education	Not until high school	5 (25%)	6 (30%)	
	senior High School	8 (40%)	7 (35%)	
	College	7 (35%)	7 (35%)	
BMI (kg/m2)	Normal	8 (40%)	6 (30%)	
	Overweight – obesity	12 (60%)	14 (70%)	
	Average ± SD	25.78 ±3.90	27.44±4.41	0.160**

** Chi-Square test (p<0.05) **Independent t test (p<0.05)*

In this study, there were 40 subjects, of which 20 patients had controlled and uncontrolled DM based on the results of the HbA1C examination. DM results are controlled if HbA1C is below 7 and uncontrolled if above 7. This study was carried out in November 2021 by taking patient data from January 1, 2021-October 31, 2021, DM patients who have had Amplitodo NCV examinations at Denpasar Hospital. HbA1C test. The characteristics of the research subjects are found in table 2.

In this study, the average value of NCV Compound Muscle Action Potential (CMAP) motor in the hand area includes the median nerve, ulnar nerve, and radial nerve while in the leg area includes the peroneal nerve, posterior tibial nerve, sural nerve and the mean NCV value. Sensory Nerve Action Potential (SNAP) in the hand area includes the median nerve, ulnar nerve, and radial nerve. in the sural nerve area is shown in table 3

Table 3. Differences in mean NCV (CMAP) values of patients with controlled and uncontrolled DM

NCV	Average (SD) m/millisecond		95% CI	p-value
	DM controlled HBA1C 7%	DM is not controlled HBA1C > 7%		
motor				
N. Median	53.53±5.67	45.53±8.87	0.32-8.74	0.026
N. Ulnaris	48.80 ± 7.27	42.80 ± 5.45	-3.58-17.18	0.180
N. Radialis	50.65 ± 3.45	48.65±6.55	-2.33-12.45	0.067
N. Peroneal	42.64 ± 5.66	33.64 ± 14.44	-2.73-21.53	0.112
posterior tibial nerve	37.93±11.36	33.93 ± 13.33	-5.38-14.08	0.365
Sensory				
N. Median	29.67 ± 20.45	27.20±17.64	-11.83-16.76	0.726
N. Ulnaris	41.40 ± 14.15	34.40 ± 18.15	-6.38-20.24	0.295
N. Radialis	30.23±19.45	21.32 ± 12.45	-8.34-16.45	0.035†
N. Suralis	21.07±19.06	18.07 ± 17.53	-10.37-17.03	0.622

**Independent t test (p<0.05) Significant*

DISCUSSION

This study was conducted with a case-control analytic design to determine the relationship between the amplitude of nerve conduction velocity (NCV) with controlled and uncontrolled diabetes mellitus based on HbA1C in patients with peripheral diabetic polyneuropathy at Sanglah Hospital. In this study, patients with diabetes mellitus were diagnosed based on anamnesis, physical examination and laboratory support for HBA1C and ENMG examination to determine NCV. For patients who meet the inclusion criteria, will be put into two groups of controlled and uncontrolled diabetes. NCV examination was performed on the median, ulnar, peroneal, posterior tibial, and sural nerves.

In this study, there were 40 DM patients where 20 DM patients were controlled and 20 DM patients were not controlled. Subjects with DM sufferers are known to be more male than female, namely 62.5%, accordance with previous research, as reported by Li et al., 2015 which examined the prevalence of diabetes in China, which based on this study showed the prevalence of men was higher than women. The similar thing was also reported by Forouhi and Wareham, 2014 which stated that there was a slight difference in the number of people with diabetes by gender, where males were more numerous than females. In general, the difference between the ratio of men to women with diabetes differs between countries. Biological, cultural, lifestyle, environmental, and socioeconomic conditions affect differences in predisposition between men and women to develop diabetes. Psychosocial factors also have a role in increasing the risk of diabetes mellitus, in general, psychosocial factors have a greater influence on women than men. In addition, the most common risk factor for diabetes is obesity, which is more common in women (Kautzky-Willer et al, 2015). The results of statistical analysis did not find a gender difference in the two groups with p = 0.567 where in general

psychosocial factors have a greater influence on women than men. In addition, the most common risk factor for diabetes is obesity, which is more common in women (Kautzky-Willer et al, 2015). The results of statistical analysis did not find a gender difference in the two groups with p = 0.567 where in general psychosocial factors have a greater influence on women than men. In addition, the most common risk factor for diabetes is obesity, which is more common in women (Kautzky-Willer et al, 2015). The results of statistical analysis did not find a gender difference in the two groups with p = 0.567

The mean age of subjects with diabetes mellitus in the controlled group was 55.34±9.94 and 53.45±9.39 in the uncontrolled group, ranging from 40 years to 75 years. This is in accordance with the statement of Ryden et al, 2007 where the prevalence of diabetes for both men and women increase with age, from less than 5% (in patients under 60), to 10-20% (in patients between the ages of 60 to 69 years). The similar thing was also reported by Li et al, 2015 which stated that the prevalence of diabetes mellitus increased along with increasing age, where based on this study the prevalence of diabetes was highest between the age range of 55-64 years. In this study, there was a non-significant difference between the mean age of diabetes duration less than five years with a duration of more than equal to five years with p value = 0.789.

In this study, it was found that the duration of suffering from DM in both groups was not related to p = 0.678, this indicates that the duration of suffering from DM does not affect the control of DM itself, this is different from Putri's study, 2020 where the risk factors for long suffering from DM and non-adherence to taking medication Poor glycemic control status in type 2 DM patients was found to be significantly associated with p = 0.02. The reason for the difference between these studies is that the level of awareness in research subjects about the importance of routine treatment and the duration of suffering from DM has not been fully realized.

The results of the BMI showed that both the controlled and uncontrolled DM group were known to have BMI in obesity with a mean of 25.78 ±3.90 for the control group and 27.44±4.41 for the uncontrolled group. The early stages of type 2 diabetes are characterized by insulin resistance, leading to elevated post-prandial glucose levels. Usually occurs in adults, where people with this type of diabetes are generally obese and less active (Ryden et al, 2007). This is in accordance with the research of Li et al, 2015 where both men and women, there was an increase in the prevalence of diabetes in accordance with the increase in body mass index. Based on research by Li et al, 2015 BMI is divided into three categories, namely 18kg/m2 and <25kg/m2 are said to be normal, 25kg/m2 and <28kg/m2 are said to be overweight, and ≥28kg/m2 are said to be obese. In this study, the prevalence of diabetes in each BMI group was 3.4%; 6.7%, and 12%. In this study, there were no significant differences in BMI in the group with a duration of less than five years compared to the group with a duration of more than five years, with p value = 0.16. Until now, the authors have not found a study that compares the average BMI of diabetics between a duration of less than five years and a duration of more than five years. According to the authors, this is in accordance with the explanation above that an increase in BMI is associated with the occurrence of diabetes. The mean BMI value in this study was higher in diabetics with a duration of less than five years, where the age of diabetics was relatively younger than the group with a duration of more than five years. Based on research by Hegazi et al., 2015 which examined the epidemiology and risk factors of diabetes in Egypt, it showed an increasing number of obese people in Egypt. This is partly due to the pattern of today's society. The development of personal transportation

facilities and the development of technology, accompanied by extreme weather causes a decrease in daily physical activity. This condition causes an increase in the number of obese people at a younger age. accompanied by extreme weather causes a decrease in daily physical activity, increase in the number of obese people at a younger age. accompanied by extreme weather causes a decrease in daily physical activity and number of obese people at a younger age.

In this study, it was found that motor and sensory NCV decreased compared to normal values in tables 5 and 6 both in the diabetes group with a duration of less than five years or more than equal to five years. This is in accordance with the research of Garg et al, 2013 where the study compared the motor and sensory NCV of the median nerve between the diabetes group and the control group. Based on this study, it was found that the motor and sensory NCV of the diabetes group was lower than that of the control group. The same thing was also reported by Yadav et al, 2015 which compared the motor and sensory NCV of the median nerve, as well as the sensory nerve of the sural in the control group, the diabetes group with good sugar control, and the diabetes group with uncontrolled sugar levels.

The study of Shekharappa et al, 2011 which compared ulnar nerve motor NCV in three groups, found a lower mean NCV value in the uncontrolled diabetes group compared to the controlled diabetes group and the control group. According to the authors of this study, this is in accordance with previous studies because there has been a process of nerve fiber damage, which according to Dunnigan et al., 2013 that mild demyelination contributes to the pathophysiology of nerve damage in diabetic neuropathy sufferers. Based on the information in table 3 in chapter 2, it has been explained that one of the signs of demyelinating lesions is a decrease in NCV. This is supported by research conducted by in this study, the average NCV value was lower in the sural, median, and medial sensory nerves. and tibial motor. This is in accordance with the research of Kakrani et al, 2014 which stated that the tibial nerve and sural nerve were more commonly disturbed. According to the authors, this is in accordance with the explanation that the most common form of diabetic neuropathy is DSPN, where according to Callaghan et al., 2012 complaints of tingling, numbness, pain usually start from the feet. In this study, there were no significant differences in the mean changes in NCV values for ulnar nerve motor, median nerve sensory, ulnar nerve sensory, peroneal nerve motoric; Posterior tibial nerve motor and sensory nerve sural between patients with controlled and uncontrolled diabetes mellitus, while for the mean median nerve motor NCV, there were significant differences in radial nerve motor and sensory results.

Based on this study, when compared between controlled and uncontrolled diabetes mellitus, a lower nerve conduction velocity was found in all the nerves examined. This accordance with research conducted by Charles et al, (2010) which showed a negative relationship between duration and speed of nerve conduction both ulnar, peroneal, and sural. This supported by a study by Garg et al., 2013 which showed a decrease in the mean motor and sensory NCV values of the median nerve with increasing duration of diabetes.

The weakness of this study is the availability of NCV examinations which are not routinely performed on patients with diabetes mellitus who come without complaints, so that the results of the study have seen peripheral polyneuropathy and slowed NCV. This study uses subjects in certain populations and carried out in certain places, the results of this study cannot describe in the same conditions in different populations and places.

CONCLUSION

Patients with uncontrolled or controlled diabetes mellitus both experience

a decrease in overall nerve conduction speed. The result of NCV SNAP mostly on radial nerve, while the CMAP result mostly of the median nerve. The results of this study can be used as a reference that all patients with diabetes mellitus have the same risk of developing polyneuropathy and increase the decrease in the NCV value if the patient is not controlled.

Informed Consent and Patient Details

The authors declare that this research does not contain any personal information that could lead to the identification of the patient(s) and/or volunteers.

Funding

This work did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Committee Approval

This study has obtained ethical clearance issued by the Research Ethic Commission of Faculty of Medicine, Udayana University, Sanglah General Hospital, Denpasar.

Conflict Of Interest

There are no conflicts of interest to declare by any of the authors of this study.

Acknowledgement: None

REFERENCES

1. Callaghan, BC, Cheng, HT, Stables, CL, Smith, AL, and Feldman, EL University Of North Sumatera 114 2012. Diabetic neuropathy: clinical manifestations and current treatments. Lancet Neurol. 11:521 – 534
2. Charles, M., Soedamah-Muthu, SS, Tesfaye, S., Fuller, JH, Arezzo, JC, Chaturvedi, N., et al. 2010. Low peripheral nerve conduction velocities and amplitudes are strongly related to diabetic microvascular complications in type 1 diabetes. Diabetes Care. 33:2648–2653
3. Dunnigan, SK, Ebadi, H., Breiner, A., Katzberg, HD, Lovblom, LE, Perkins, BA, et al. 2013. Conduction slowing in diabetic sensorimotor polyneuropathy. Diabetes Care. 36:3684–3690.
4. Fateh, HR, Madani, SP, Heshmat, R., and Larijani, B. Correlation of Michigan neuropathy screening instrument, United Kingdom screening test, and electrodiagnosis for early detection of diabetic peripheral neuropathy. Journal of diabetes and metabolic disorders. 15(8):1–5.
5. Forouhi, NG, and Wareham, NJ 2014. Epidemiology of diabetes. Medicine. 42(12):698–702.
6. Garg, R., Kumar, A., and Dhar, U. 2013. A study of median nerve conduction velocities in diabetes mellitus type 2 in neurologically asymptomatic patients. International Journal of Health Sciences and Research. 3(5):42–49.
7. Harper, RA, and Shock, JP 2009. Lenses. In: Riordan-Eva, P. and Whitcher, JP (editor). General Ophthalmology 17th edition. Jakarta : EGC. pp. 169–177 .
8. Hegazi, R., El-Gamal, M., Abdel-Hady, N., and Hamdy, O. 2015. Epidemiology of and risk factors for type 2 diabetes in Egypt. Annals of Global Health. 81(6):814–820.
9. Kakrani, AL, Gokhale, VS, Vohra, KV, and Chaudhary, N. 2014. Clinical and nerve conduction study correlation in patients of diabetic neuropathy. Journal of the association of physicians of India. 62:24–27.
10. Li, S., Guo, S., He, F., Zhang, M., He, J., Yan, Y., et al. 2015. Prevalence of diabetes mellitus and impaired fasting glucose, associated with risk factor in rural Kazakh adults in Xianjiang, China. int. J. Environ. res. Public Health. 12:554–565.
11. Poernomo, H., Basuki, M., and Widjaja, D. 2003. Practical Guide to Electrodiagnostics. Surabaya: Airlangga University Press.
12. Rydén, L., Standl, E., Bartnik, M., Berghe, GV Betteridge, J., de Boer, MJ, et al. 2007. Guidelines on diabetes, pre-diabetes, and cardiovascular disease: executive summary. European Heart Journal. 28:88–136.

13. Shekharappa, KR, Srinivasa, AK, Vedavathi, KJ, and Venkatesh, G. 2011. A study on the utility of nerve conduction studies in type 2 diabetes mellitus. Journal of Clinical and Diagnostic Research. 5(3):529–531.
14. Sukarini, P., Widyadharma, PE, Purna-Putra, IGN, and Purwa-Samatra, DPG 2015. Normal Value of Nerve Conduction Speed at Sanglah Hospital Denpasar. Mirror of the World of Medicine. 42(3): 176 – 179.
15. Yadav, N., Shete, A., Yadav, P., Yadav, N., and Khan, ST 2015. Study of Nerve Conduction Velocity in Type II Diabetes Mellitus. Natl J Integr Res Med. 6(4):36–43.

How to cite this article: Ni Made Kurnia Dwi Jayanthi, Komang Arimbawa, Ni Made Dwita Pratiwi. The relationship of nerve conduction velocity (NCV) amplitude with controlled and uncontrolled diabetes mellitus based on HBA1C in peripherals polyneuropathy patients in Sanglah Hospital. *International Journal of Research and Review*. 2022; 9(2): 332-339. DOI: *https://doi.org/10.52403/ijrr.20220244*

******