

Sural Radial Amplitude Ratio in Diabetic Patients

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Abstract

Background: The sural-radial amplitude ratio (SRAR) has been proven to be a good tool for diagnosis of early diabetic peripheral neuropathy.

Objective: To compare sural radial amplitude ratio between diabetic patients and healthy controls.

Methods: This age and sex matched case-control study was carried out in the Department of Neurology at Dhaka Medical College and Hospital, Dhaka from June, 2022 to May, 2024 over a period of 24 months. A total of 30 patients with diabetic and 30 healthy control of both genders and age ≥ 18 years were included in this study as case and control respectively. SPSS software version 22.0 was used to process and analyze the data. Chi-Square/Fisher's Exact test was used to compare categorical data and Unpaired t test was used to compare numerical data. Bivariate analysis was conducted for logistic regression analysis. Specimen's rho correlation was done to analyse the correlation between SRAR and related variables.

Result: Sural-radial amplitude ratio was found significantly lower in diabetic peripheral neuropathy patients (0.36 ± 0.22) than that of healthy controls (0.78 ± 0.35). Mean duration of diabetes mellitus of the peripheral neuropathy patients was 7.33 ± 5.01 years and mean HbA1c was 9.31 ± 1.43 . Non-significant negative correlation was found between sural-radial amplitude ratio and duration of DM ($r = -0.226$; $p = 0.231$) and significant negative correlation of sural-radial ratio with HbA1c ($r = -0.668$; $p < 0.001$) was revealed. Regression analysis showed duration of diabetes mellitus (DM) was 1.459 (95% CI: 0.640 to 3.329; $p = 0.317$) times and HbA1c $> 6\%$ was 3.5 (95% CI: 2.170 to 5.646; $p < 0.001$) fold increased risk of times more chance for decreased SRAR. Among them HbA1c $> 6\%$ was independent factor for decreased SRAR.

Conclusion: The sural-radial amplitude ratio in patients with diabetic was significantly lower than in healthy controls.

Keywords: Diabetic peripheral neuropathy, sural-radial amplitude ratio, HbA1c.

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Introduction

Diabetic peripheral neuropathy (DPN) is a prevailing and severe microvascular consequence of diabetes. The overall occurrence rate of DPN across a person's lifespan was 50% in the world.¹ The prevalence of diabetic peripheral neuropathy (DPN) ranges from 1.9% to 53.6%, and this varies depending on geographical location and time.² DPN is a prominent contributor to global impairment, significantly impacting quality of life through the presence of persistent pain, heightened vulnerability to falls, foot ulcers, and non-

traumatic amputation of the lower limbs.^{3,4} The incidence of Diabetic Peripheral Neuropathy (DPN) in Bangladesh is reported to be 38.14% according to a study.⁵

DPN risk variables encompass the length of diabetes, age, HbA1c levels, diabetic retinopathy, smoking, BMI, fasting plasma glucose (FPG), blood urea nitrogen (BUN), and diastolic blood pressure (DBP), among other factors.⁶

The development of DPN involves multiple factors related to metabolism and blood vessels. Hyperglycemia is a crucial metabolic component

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that is recognized for its ability to induce damage to axons and micro-vessels.⁷ Consequently, nerve damage may result in the development of foot ulcers, which can ultimately lead to the amputation of a lower limb.⁴

Timely detection and efficient management of the progression of DPN in its first phase is vital for averting severe DPN-related complications (such as ulceration, gangrene, and amputation) and the associated societal cost.⁶

The sural radial amplitude ratio is a novel electrophysiological predictor derived from the assessment of the sural and radial nerves. It offers a more efficient and time-saving alternative to the whole nerve conduction investigation.⁸

The proliferation of novel diagnostic tests for DPN indicates a significant unmet demand for enhancing its diagnosis in practical settings. Certain tests are more suited for initial screening purposes, while others are more suitable for evaluation and further monitoring at specialized facilities.⁹ As a result, electrophysiological devices that operate automatically have been created for use in diabetes clinics by staff members who have received minimal training.⁸ The sural sensory/radial motor amplitude ratio (SRAR) is a highly sensitive and moderately specific measure used to identify patients with DPN (diabetic peripheral neuropathy).⁸ The threshold value may vary depending on the amount of variables. The suggested SRAR value is below 0.4, making it a sensitive, specific, and age-independent indicator for axonal neuropathy.¹⁰ While the nerve conduction study (NCS) is considered the most reliable method for identifying diabetic peripheral neuropathy diabetic patients, it does have several limitations. Sural radial amplitude ratio (SRAR) has the potential to be a new electrophysiological predictor that could have a strong correlation with standardized NCS.

Objectives of the study was to evaluate the significance of SRAR in individuals with diabetic patients

Methodology and Methods

Study design and participants

It was a sex-and age-matched case-control study carried out in the Department of Neurology,

Dhaka Medical College and Hospital, Dhaka from June, 2022 to May, 2024. A total of 30 patients with diabetic peripheral neuropathy and 30 healthy control of both genders and ≥ 18 years from Neurology and Medicine Department of Dhaka Medical College Hospital were included in this study as case and control respectively.

Diagnosed case of Diabetic patients with hypothyroidism, nutritional deficiency (B1, B6, B12), patient diagnosed with autoimmune disease, cancer patients with chemotherapy, patients with electro-physiologically diagnosed poly-neuropathy, radiculopathy, plexopathy, sciatic neuropathy, patients with isolated radial neuropathy were excluded.

Study Procedure

Data was collected after obtaining approval from Ethical Review Committee (ERC) of DMCH by a structured questionnaire. Diagnosis of peripheral neuropathy was assessed from the previous medical records, history and clinical examination. An informed written consent was taken from participants after describing the aim, purpose and procedure of the study. The questionnaire included socio-demographic characteristics, co-morbidities, duration of diabetic diagnosis, diabetes medication, complications, symptoms of neuropathy at initial diagnosis, duration of diagnosis of peripheral neuropathy and associated investigations. All participants were subjected to nerve conduction study.

Electrophysiological tests:

All nerve conduction studies were performed with NIHON KOHDEN Neuropack MEB-7102 mobile unit with a two channel evoked/EMG measuring system. The room temperature was maintained at 33-34°C. The identification of polyneuropathy was based on clinical examinations and electrophysiological studies. The reports were generated by a neurologist.

Sural Nerve Conduction Study (NCS):

Subjects were placed side-lying. The active electrode was placed in between the lateral malleolus and the heel and the reference electrode was placed in 3 cm more distally at

the lateral edge of the foot. Supramaximal stimuli were applied 12-14 cm in front to the active electrode and just lateral to the midline of the calf.

Superficial Radial NCS:

Subjects were seated or placed in a supine position. An active electrode was placed over the superficial radial nerve where it crosses the tendon of the extensor pollicis longus muscle. The reference electrode was placed 4 cm distally in between the first and second metacarpophalangeal joints and stimuli were applied 10 cm proximal to the active electrode over the radius. All tests were done by the same neurophysiologists trained in the same Department and following this protocol. All collected information was noted within the questionnaire. All velocities and amplitudes were categorized as 0= normal and 1= abnormal. Finally, the sural radial amplitude ratio (SRAR) was calculated by dividing sural by the radial sensory amplitudes; a value below 0.4 was considered as reduced ratio.

Statistical analysis

SPSS software version 22.0 was used to process and analyze the data. Chi- Square/Fisher's Exact test was used to compare categorical data and Unpaired t test was used to compare numerical data. Bivariate analysis was conducted for logistic regression analysis. For all analyses, p-value <0.05 will be considered statistically significant. Spearman's rho correlation was done to analyse the correlation between SRAR and related variables.

Ethical Consideration

The study was approved by the research review committee of the Department of Neurology of Dhaka Medical College and Hospital and got the ethical review committee of Dhaka Medical College for getting clearance. Patients and their relatives and healthy controls were informed in details about the study, its "merits and demerits" explained to them in easy and understandable language and then informed consent was taken. It was assured that all information and records would be kept confidential and the procedure would be helpful for both attending neurologist and healthy controls, as well as patients in making decisions for management.

Results

This case-control study was carried out in the Department of Neurology at Dhaka Medical College and Hospital, Dhaka from June, 2022 to May, 2024 over a period of 24 months to compare the sural radial amplitude ratio between diabetic peripheral neuropathy patients and healthy controls. Results are as follows:

Table I

Distribution of the study subjects according to age group (N = 60)

Age (years)	Diabetic patients (n=30)	Control (n=30)	p-value
≤20	2 (6.7)	3 (10.0)	0.826
21 – 30	5 (16.7)	9 (30.0)	
31 – 40	10 (33.3)	7 (23.3)	
41 – 50	6 (20.0)	5 (16.7)	
51 – 60	4 (13.3)	4 (13.3)	
>60	3 (10.0)	2 (6.7)	
Mean ± SD	42.17±13.30	38.70±14.55	0.340

Mean age of the diabetic patients was 42.17 ± 13.30 years and mean age of the healthy controls was 38.70 ± 14.55 years. There was no significance difference in age between case and control groups.

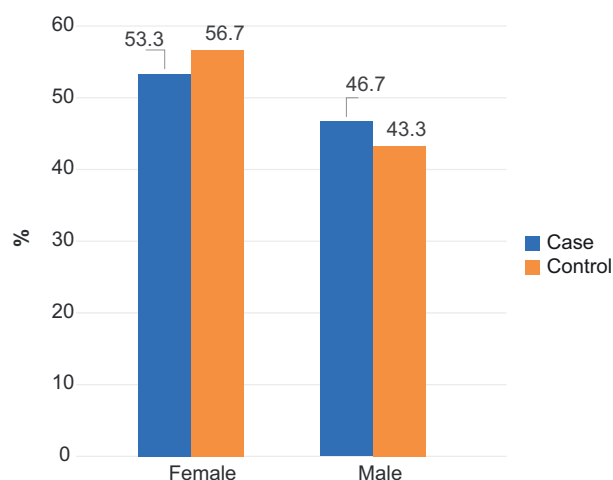


Figure-1: *Distribution of study subjects according to gender (N=60)*

p value was obtained from Chi-Square test. Case=Diabetic patients, Control= non diabetic patients

The majority of respondents (53.3%; 56.7%) were female in case and control male to female ratio was 1:1.4 in the case and 1:1.3 in the control group. There was no significant ($p=0.795$) difference between genders of both groups.

Figure 2 states that 6 (20%) and 1 (3.3%) study subjects were businessmen, 4 (13.3%) and 4 (13.3%) were service holders, 13 (43.3%) and 15 (50%) were housewives, 1 (3.3%) and 5 (16.7%) were students and 6 (20%) and 5 (16.7%) were in others in their occupation. No significant ($p=0.166$) difference was observed in occupations of both case and control.

In this study, mean $\pm$ SD duration of diabetes was 7.33 ± 5.01 years. Majority (76.7%) of the study subjects were suffering from DM for less than 10 years in cases and the mean HbA1c was 9.31 ± 1.43 and $>6\%$ in 27 (90%) cases and ≤ 6 in 3 (10%) cases.

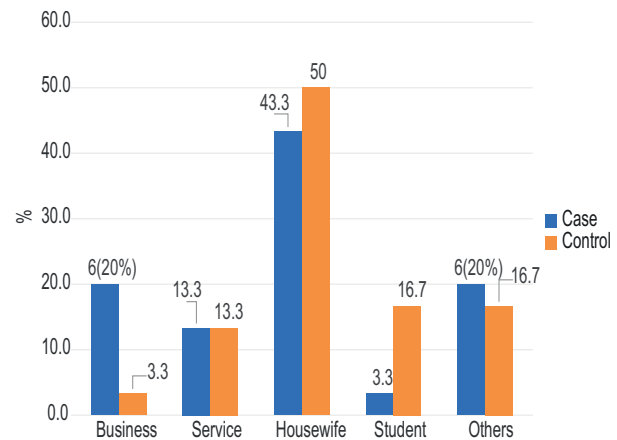


Figure-2: Distribution of the study subjects according to occupation (n=60)

p value was obtained from Chi-Square test. Case= Diabetic patients, Control= non diabetic patients

Table-II

Distribution of study subjects according to duration of diabetes and HbA1c (n=30)

Attributes	Frequency (%)	Mean $\pm$ SD	Median (IQR)
Duration (Years)			
<10	23 (76.7)	7.33 ± 5.01 (1 - 26)	6.50 (3-10)
≥ 10	7 (23.3)		
HbA1c (%)			
≤ 6	3 (10)	9.31 ± 1.43 (7.30 -12.20)	9.0 (8.25-10.20)
>6	27 (90)		

Data were expressed as frequency, percentage and Mean $\pm$ SD, median (IQR)

Table-III

Sural radial amplitude ratio and comparison of electrophysiological finding between case and control (N=60)

SRAR	Case (n=30)	Control (n=30)	p value
≤ 0.4	23 (76.7%)	1 (3.3%)	<0.001
>0.4	7 (23.7%)	29 (96.7%)	
Sensory Nerve Conduction Study			
Sural sensory amplitude	12.43 ± 6.48	25.17 ± 19.62	0.001
Radial sensory amplitude	37.19 ± 17.21	29.49 ± 14.99	0.070
Sural-radial ratio	0.36 ± 0.22	0.78 ± 0.35	<0.001

Data were expressed as frequency and percentage. p value was obtained from Chi-Square test. Case=Diabetic patients, Control= non diabetic patients

We observed that the SRAR was ≤ 0.4 in 23 (76.7%) cases and 1 (3.3%) control and >0.4 in 7 (23.7%) cases and 29 (96.7%) controls. There was a significantly ($p < 0.001$) difference in the SRAR between the case and the control group. Sural-radial amplitude ratio was significantly lower in diabetic peripheral neuropathy patients (0.36 ± 0.22) than that of healthy controls (0.78 ± 0.35).

Table-IV

Bivariate regression analysis of sural radial amplitude ratio and different variable in cases (n=30)

Diagnostic indices	OR	95% CI	p value
Age ≥ 50 years	1.0	0.576 to 1.099	1.000 ^{ns}
Female	0.874	0.316 to 2.418	0.795 ^{ns}
Duration of DM ≥ 10 years	1.459	0.640 to 3.329	0.317 ^{ns}
HbA1C $>6\%$	3.5	2.170 to 5.646	<0.001

Regression analysis was performed to calculate OR (odds ratio). p value was obtained from Chi-Square test

Regression analysis showed duration of diabetes mellitus (DM) was 1.459 (95% CI: 0.640 to 3.329; $p=0.317$) times and HbA1c $>6\%$ was 3.5 (95% CI: 2.170 to 5.646; $p < 0.001$) times more risk for decreased SRAR. Among these HbA1c $>6\%$ was independent risk factor for decreased SRAR.

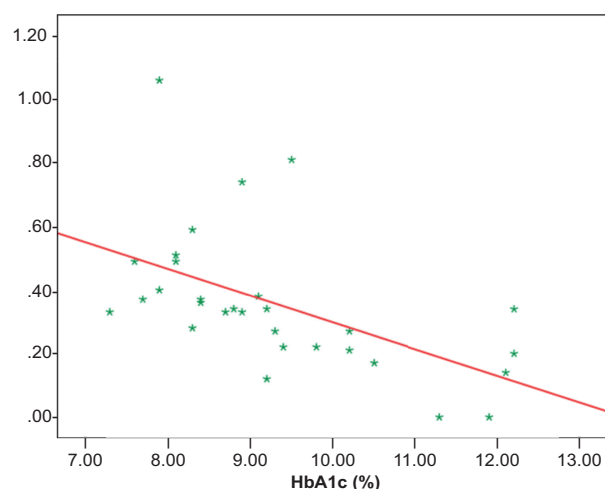


Figure 3: Correlation of sural-radial amplitude ratio with duration of DM

Spearman's rho correlation was done. There was non-significant negative correlation was found between sural-radial ratio and duration of DM ($r = -0.226$; $p = 0.231$)

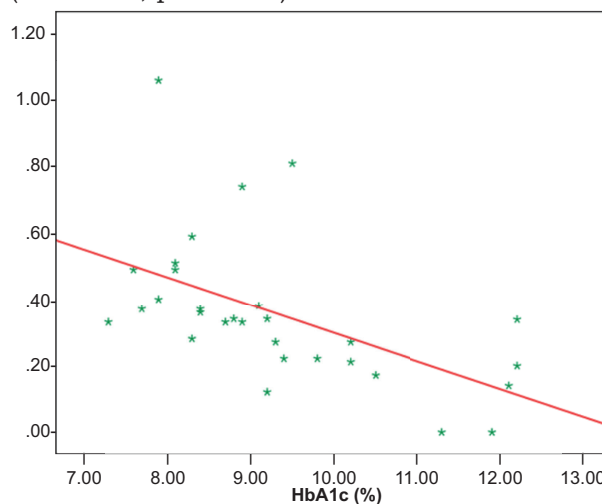


Figure 4: Correlation of the sural-radial amplitude ratio with HbA1c

Spearman's rho correlation was performed. There was significant negative correlation between sural-radial amplitude ratio and HbA1c ($r = -0.668$; $p = <0.001$)

Discussion

Early detection of diabetic peripheral neuropathy (DPN) is challenging due to its gradual development and the absence of symptoms in the earliest stages in patients. Electrophysiological tests, particularly nerve conduction studies, are useful for detecting subclinical alterations in early DPN.

No significant differences were found in age, gender, or occupation between the case and control groups. Similar findings were reported by Vilaca et al. (2020),¹¹ but there was a significant difference in age between the diabetic peripheral neuropathy and healthy control groups.¹² Males were more predominant than females observed in another study, which corresponds to our findings.^{11,12}

The sural sensory amplitude was significantly lower in patients with diabetic peripheral neuropathy (12.43 ± 6.48) compared to healthy controls (25.17 ± 19.62). In a study by Pastore et al. (1999); the sural nerve amplitude was 21.42 ± 9.09 in diabetic neuropathy patients

and 29.52 ± 6.22 in healthy controls.¹³

On the other hand, the radial sensory amplitude was higher in diabetic peripheral neuropathy patients (37.19 ± 17.21) than in healthy controls (29.49 ± 14.99). Pastore et al. (1999) also found that the radial nerve amplitude was 35.30 ± 17.35 in diabetic neuropathy patients and 49.83 ± 20.65 in healthy controls.¹³

Furthermore, the sural-radial ratio was significantly lower in diabetic peripheral neuropathy patients (0.36 ± 0.22) than healthy controls (0.78 ± 0.35). The sural-radial amplitude ratio was 0.29 ± 0.20 in diabetic neuropathy patients and 0.58 ± 0.12 in healthy controls in a previous study.¹³

Regression analysis showed that a duration of diabetes mellitus (DM) associated with was 1.459 fold increased risk and an HbA1c >6% was associated with 3.5 fold increased risk for a decreased SRAR. This study has several limitations like it was single centered study with small sample size. Accuracy tests was not conducted.

Conclusion

The sural-radial amplitude ratio is lower in diabetic peripheral neuropathy patients compared to healthy control. Further large studies may explore the accuracy of the SRAR test among diabetic and non-diabetic patients.

Declarations

Ethics approval and consent to participate

Before data collection, both verbal and written informed consent was taken from patients.

Consent for publication

All authors have approved this manuscript for publication.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Conflict of interests

The authors declare that they have no competing interests.

Ethical Approval

Ethical clearance was obtained from Ethical Review Committee of Dhaka Medical College, Dhaka.

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