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Research Article

A Study of Sympathetic Skin Response in persons with Type-2 Diabetes Mellitus

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Background: Impairment in Autonomic nervous system constitutes to one of the most serious and important complications in persons with Diabetes. Noninvasive Sympathetic Skin Response (SSR) test assesses the impairment of the sympathetic fibers of the peripheral nerves is widely used and valid markers of autonomic neuropathy. Considering the cost effectiveness of these tests, SSR testing would help us in understanding the prevalence of autonomic dysfunction in patients with Type 2 Diabetes Mellitus (T2DM). Method: 30 adults diagnosed with T2DM and 25 normal healthy adults who volunteered to participate were assessed for SSR in their foot and hand. SSR was assessed using Neurowerk EMG/NCV equipment capable of assessing SSR. Electrical current was used on the median nerve at the wrist to elicit SSR. Results: SSR was elicited in all participants. In persons with T2DM, mean SSR latency and SSR Amplitude for the hand were 1.587 ± 0.759 secs and 1499 ± 1411 microVolt respectively. The mean SSR Latency and SSR Amplitude for the foot were 2.478 ± 1.247 secs and 39.2 ± 901.07 micro Volts respectively. Characteristics of the SSR curves were discussed. Conclusion: In persons with T2DM, mean SSR latency of hand and foot were 1.587 ± 0.759 and 2.478 ± 1.247 seconds respectively. Mean SSR amplitude of hand and foot were 1499 ± 1411 and 939.2 ± 901.07 microVolts respectively. Mean values SSR Latency & Amplitude of persons with T2DM were significantly different from that of normal healthy adult.

Keywords: Sympathetic Skin Response, Automonic dysfunction, Diabetes mellitus.

Introduction

The Autonomic Nervous System (ANS) is implicated in patients with Type 2 Diabetes Mellitus (T2DM) [1]. Altered sympathetic skin response (SSR) is thought to result from the involvement of small sudomotor unmyelinated axons, influencing the skin response—a superior predictor of Diabetic Peripheral Neuropathy (DPN) [2, 3]. The SSR test evaluates the impairment of sympathetic fibers in peripheral nerves, employing a simple, noninvasive, and reproducible technique for this assessment [4]. While autonomic impairment was once deemed less significant, its connection to the mortality of diabetes patients has elevated it to one of the most distressing, serious, and pivotal components affecting individuals with diabetes [2, 5].

Despite its newfound importance, testing autonomic function has not gained traction among researchers in India, primarily due to the extensive infrastructure required. Consequently, there is limited prevalence data on autonomic function in diabetes. This study aims to assess and compare SSR in individuals with T2DM and a sample of normal, healthy subjects. The outcomes of this study will enhance our understanding of autonomic dysfunction in patients with Type 2 Diabetes Mellitus.

Methodology

After obtaining approval from the Institutional Ethics Committee, individuals diagnosed with T2DM and healthy participants volunteering for this study were enrolled. Study participants included adults diagnosed with T2DM at least 2 years ago, aged more than 40 years and of both sexes. However, individuals with a history of any metabolic disease other than T2DM, clinical manifestations of Neuro-musculoskeletal & cardiovascular disorders potentially interfering with SSR testing, engagement in alternative therapies such as Ayurveda, Siddha, Homeopathy for diabetes or other diseases, insulin therapy, contracture, tightness, and deformities in extremities (due to potential nerve entrapments causing interference with autonomic function testing), complications with foot ulcers and amputation, and those with implantable electronic/electrical devices were excluded.

Similarly, healthy individuals between the ages of 16 to 60 years of both sexes were considered as study participants. However, individuals with a history of surgery, pregnancy, a diagnosis of neuromusculoskeletal and cardiorespiratory disease, and those receiving medication for injury or disease were excluded from the study.

The NEUROWERK EMG/NCV device manufactured by SIGMA Medizin-Technik GmbH, Germany (Figure 1), was used to assess SSR in this study. Thirty adults with Type II DM and 25 healthy subjects who met the inclusion. All participants were assessed for Sympathetic Skin Response (SSR) using Neurowerk EMG/NCV devices capable of recording SSR. The SSR assessment method followed standard guidelines based on the approach of Shahani et al. [6]. SSR was assessed with participants lying supine on a couch in a room maintained at a temperature of 25°C. Disposable surface EMG electrodes were placed on the palm and dorsum of the hand, and the sole and dorsum of the foot. Recordings were obtained with a filter setting comprising a band pass of 0.5-1000 hertz, a sensitivity of 0.2-0.5 mV per division, and a sweep speed of 1 second per division. The stimulus was a short electrical pulse (0.2 msec duration and 15mA intensity) delivered to the median nerve at the right wrist every 60 seconds or longer to avoid habituation (Figure 2). The skin temperature at the test site was 32°C or higher. The test was considered abnormal if no response was detected after at least 10 stimulations. Hand and foot recordings were made sequentially with an interval of 10 minutes between recordings. A well-defined response was selected from 5 consecutive responses, and the peak-to-peak amplitude was measured. Abnormal SSR was considered when there was no response or the amplitude was less than 2 SD of the normal mean of Kim et al. [15].

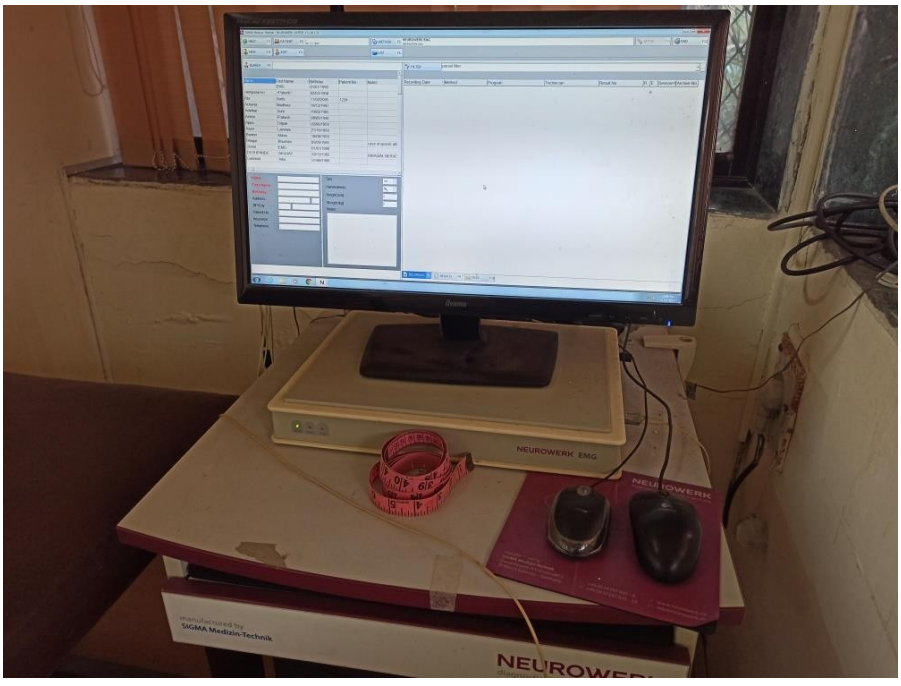

Figure 1. *NEUROWERK EMG/NCV devices manufactured by SIGMA Medizin-Technik GmbH, Germany*

Figure 2. *SSR testing procedure*

The data underwent normality testing using the Shapiro-Wilk Test, and all data passed this test. Descriptive statistics, including mean and standard deviation (SD), were employed. The "t" test was utilized to assess the significance between SSR of subjects with T2DM and a sample of normal healthy individuals.

Results

The average age of participants with T2DM was 60.07±5.35 years and included 18 male and 12 female participants. The average age of the healthy participants was 30±6.58 years and included 13 male and 12 female participants. SSR was triggered in all participants.

From Table 1, it can be seen that the mean SSR latency and SSR amplitude of healthy participants for the hand were 1.2±0.42 seconds and 2503±1424 microvolts, respectively. The mean SSR latency and SSR amplitude of healthy participants for the foot were 1.8±0.44 seconds and 1749± 1252 microvolts, respectively (Figure 5 & 6). The shape of the SSR curve obtained in healthy participant was triphasic in hand and biphasic in the foot (Figure 3).

From Table 1, it can be seen that the mean SSR latency and SSR amplitude of participants with T2DM for the hand were 1.587 ± 0.759 seconds and 1499 ±1411.06 microvolts, respectively. The mean SSR latency and SSR amplitude of participants with T2DM for the foot were 2.478±1.247 seconds and 939.2±901.07 microvolts, respectively (Figure 5 & 6). SSR curve obtained was triphasic or biphasic in hands and usually biphasic in foot. (Figure 4) When comparing the SSR latency and amplitude of hand and foot between participants with T2DM and healthy participants, it was found that there was statistical significance (Table 1).

Table No. 1	T2DM Mean (SD)	Normal Participants Mean (SD)	P-Value	Significance
SSRH Latency	1.587 (0.759)	1.168 (0.421)	0.0173	S
SSRH Amp	1499 (1411.06)	2503 (1424.05)	0.0116	S
SSRF Latency	2.478 (1.247)	1.796 (0.0437)	0.0126	S
SSRF Amp	939.2 (901.07)	1749 (1252.10)	0.0096	S

Table 1. ***Comparative analysis of SSR of Hand and Foot in persons with T2DM and healthy participants***

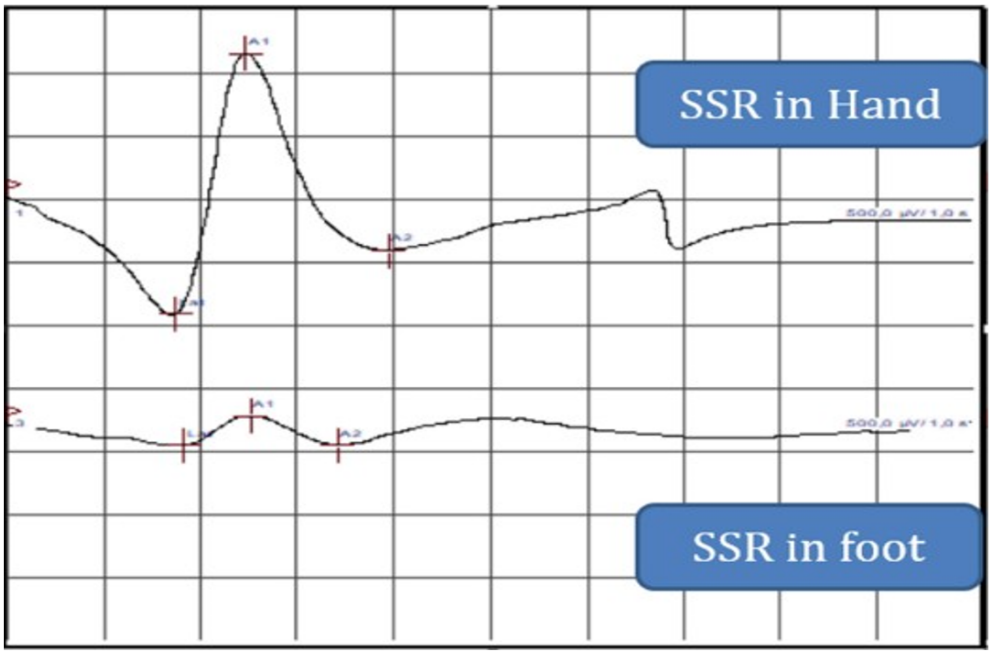

Figure 3. ***Characteristics of SSR response in Healthy participants***

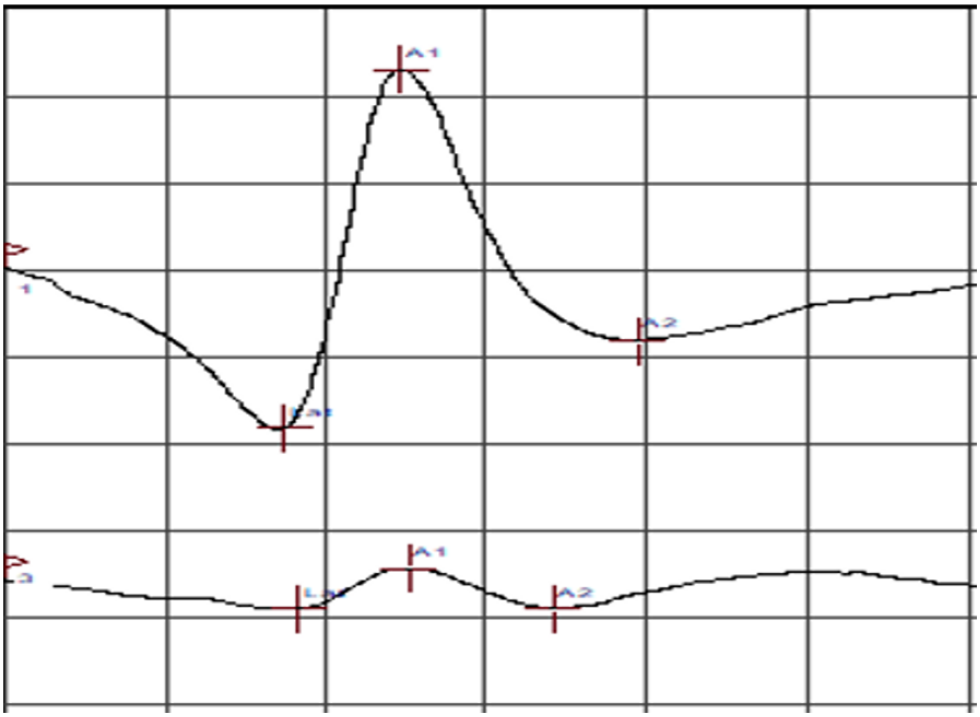

Figure 4. ***Characteristics of SSR response in participants with T2DM***

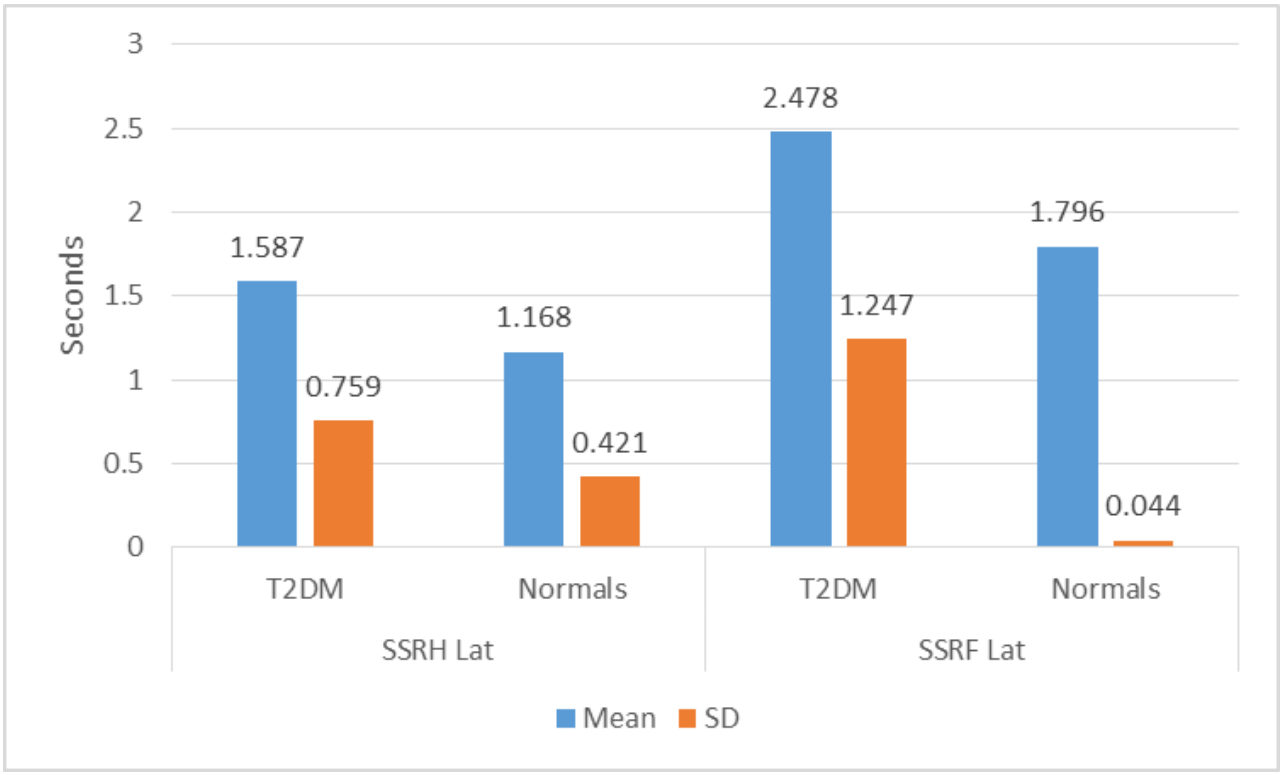

Figure 5. ***Comparative analysis of SSR Latency of Hand and Foot in persons with T2DM and healthy participants***

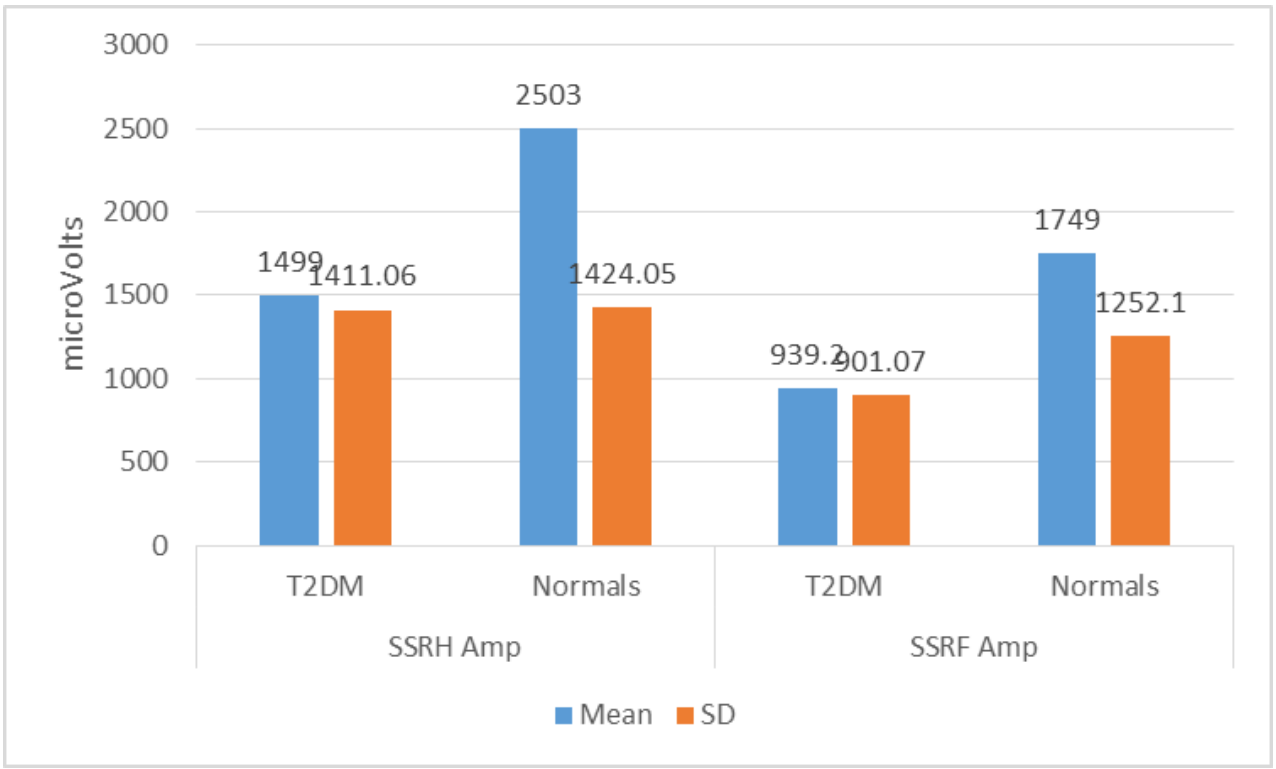

Figure 6. ***Comparative analysis of SSR Amplitude of Hand and Foot in persons with T2DM and healthy participants***

Discussion

The primary objective of this study was to evaluate SSR in individuals with T2DM and compare the responses to those of normal healthy adults. The results indicate the success of the SSR assessment method in eliciting responses from all participants, suggesting that electrical stimulation is a simple and effective means of triggering SSR [6]. In individuals with T2DM, the latency from the hand was found to be shorter than from the foot [6-8]. Similarly, the amplitude was significantly higher from the hand than from the foot [8, 9], and the shape of the SSR curve obtained was triphasic or biphasic in hands, usually biphasic in the foot [10, 11]. The electrical stimulation-elicited response (SSR) had to travel a longer distance to reach the pick-up electrode in the foot than in the hand, explaining the difference in the amplitude of the SSR.

The SSR values observed in this study were comparable to those reported by various authors in non-Indian populations [12, 13]. This result is further supported by the findings of the study conducted by Sung et al. [12]. The characteristics of the SSR curve were consistent with observations in the literature (Figure 4) [10, 11]. The comparative analysis demonstrated a significant difference in SSR values between individuals with T2DM and normal healthy participants (Table No. 1), indicating a delay in the conduction of the sudomotor sympathetic pathway.

Additionally, all subjects included were non-neuropathic, as indicated by their DNE scores. This suggests that even in the absence of clinical signs of neuropathy, there are changes in the SSR values assessed in individuals with T2DM compared to the values of SSR in normal healthy participants. Thus, we believe SSR measurement serves as an objective indicator of conduction in multineural pathways and can detect subclinical involvement of the sympathetic nervous system in diabetics who do not manifest clinical symptoms or signs of neuropathy [14]. However, confirmation through further studies with robust designs is necessary.

Conclusion

Based on the study results, it can be inferred that the method employed in this study is successful in eliciting SSR. The mean and SD of Latency and amplitude of SSR values in individuals with T2DM measured in Hand and Foot respectively were obtained. The mean values of SSR latency and amplitude in persons with T2DM were significantly different from those of normal, healthy adults.

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