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Galvanic skin response: A marker of autonomic dysfunction in type 2 diabetes mellitus patients

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Abstract---Introduction: Stress and sedentary lifestyles frequently result in chronic health issues such as diabetes; a metabolic disorder that impacts the neural system as a result of changes in multiple metabolic pathways. Long-term diabetes mellitus causes neuropathy, which affects the autonomic nervous system. The study was initiated based on indications that sweat glands innervated by the autonomic nervous system would be impacted in individuals with type 2 diabetes mellitus who also had neuropathy symptoms. The purpose of this study was to examine galvanic skin resistance (GSR) in patients with type 2 diabetes mellitus and healthy individuals. Material & Methods: A total of 60 subjects between the ages of 25- 60 years were included in the study. 60 healthy individuals in the same age group with no history of diabetes mellitus and neuropathy served as controls, while/participants with diabetes mellitus and a history of neuropathic symptoms served as cases. Galvanic skin resistance (GSR) was recorded using Physio-Pac 4 channel digital polygraph at the department of medicine. All recordings were made between 10:00 a.m. and 12:00 p.m. in the supine position at room temperature. Result: Basal Galvanic skin resistance was higher in the diabetic patients. There was significant decrease in GSR with posture change. GSR higher in those patients those have longer duration of diabetes .there was no significant difference in GSR in male and female Conclusion: Hyperhidrosis and anhidrosis are caused by high blood sugar levels. Diabetes-related anhidrosis, decreased cutaneous blood flow, and

impaired sweating all contribute to greater galvanic skin resistance in type 2 diabetic mellitus.

Keywords---galvanic skin resistance, type-2 diabetic mellitus, autonomic nervous system, metabolic syndrome.

Introduction

Diabetes mellitus is a chronic metabolic disease caused by hyperglycemia .it attributed to defective insulin secretion, insulin resistance, the release of excess free fatty acids, and advanced glycated end products. Prolong duration and uncontrolled T2DM lead to many microvascular complications like neuropathy, retinopathy, and nephropathy. Neuropathy is the most frequent complication in diabetes, caused by an abnormality of the autonomic nervous system which is associated with peripheral neuropathy mostly seen in diabetes mellitus. In Peripheral neuropathy, small and long nerve fibers are damaged. Small fiber neuropathy occurs due to hyperglycemia, vascular endothelial dysfunctions, platelet hyperreactivity, oxidative stress, and low-grade inflammation.¹

In small fibers neuropathy damages nerve fibers which invert the sweat gland. Result in impaired sweat secretion from palm, hand, and feet. Sudomotor functions refer sweat gland activity it is under the control of the autonomic nervous system. Sudomotor dysfunction is the most common and earliest neurophysiological sign of small fiber neuropathies. It is a valuable diagnostic tool for the early detection of small fiber neuropathies.² There are various methods for the detection of small fiber neuropathies; the Intraepidermal Nerve Fiber Density (IENFD) is measured from punch skin biopsies. it is the gold standard but an invasive procedure and inappropriate long-term follow-up. Sweat gland activity is also recorded from a digital polygraph by galvanic skin resistance. ³ Galvanic skin resistance (GSR) refers to the resistance of the skin from a minute galvanic current (5 μ A) and it caused by the activity of the sweat gland.

Aim and objectives

- To record Galvanic skin response in type 2 diabetes mellitus patients and compare with age and sex-matched healthy controls
- Compare Galvanic skin response with the duration of type 2 diabetes mellitus

Material And Methods

The study was conducted in the research lab department of Physiology and patients were taken from medicine OPD of NIMS hospital and research center. Ethical clearances were obtained from the institutional research committee. Written consent was taken from all the participants after explaining about study and procedure of the examination.

Inclusion criteria

- Know type 2 diabetes mellitus patients age group 25-60 both male and female with and without the feature of peripheral neuropathy.
- Willing participate and give written consent
- Controls are healthy individuals free from any disease and illness

Exclusion criteria

- Know type 2 diabetes mellitus patients with any severe complications exclude from the study like
- Smokers, alcoholics, and patients on drugs with affecting the autonomic nervous system.
- Patients have any dermatological disease

Material And Methods

Sixty known type 2 diabetes mellitus patients according to American Diabetes Association (ADA) HbA1c > 6.5, were screened for the study. Both gender male and female, age groups range from 25 to 60 years were included in study as cases and 60 healthy individuals without any dermatological and neurological signs and symptoms were included as control group. The subjects were taken from medicine OPD from 9 am to 12 pm. Subjects have breakfast. After that producer of examination explains to subject in the native language that they easily understand and a written informed consent taken from all the subjects.

General Physical Examination and vitals were measured (age, height, weight, BMI, Plus, Blood Pressure). A detailed clinical history of the subject was taken, past history family history personal history such as alcohol, smoking, tobacco, duration of diabetes, sign and symptoms of neuropathy like tingling, numbness, and abnormal sensation of hot and cold. GSR was recorded using Physio-Pac 4 channel digital polygraph. Before the recording of GSR, the DC amplifier was calibrated. For GSR recording high-frequency filter setting of 15 Hz, low-frequency DC, sensitivity 10 K, and sweep speed 1mm/sec. For the recording of Galvanic skin response 15 min rests in the supine position given to the subject in noise free room. Then the two electrodes are fixed on the index and middle finger of the hand and record GSR in supine and GSR in standing position.

Statistical Analysis

Statistical analysis was performed using SPSS software. Continuous variables were expressed as mean \pm Standard deviation (SD) or range, and qualitative data were expressed in percentages. A Paired t-test was used for the comparison of means between the two groups. All tests were two-tailed, confidence intervals were calculated at a 95% level and a p-value of < 0.05 was considered significant.

Result

For interpretation of the result, data was analyzed statically . The student's unpaired t-test was used to compare GSR between cases and the control group.

$P < 0.05$ was taken as significant. The student's unpaired t-test was applied to find the difference between increased GSR with increased duration of disease.

We observed the following result:

Variables	Case (mean \pm SD)	Control (mean \pm SD)	P-value
Age (years)	50.65 \pm 8.65	46.98 \pm 9.76	0.035
Height (feet)	5.26 \pm 0.39	5.28 \pm 0.44	0.78
Weight(kg)	64.85 \pm 13.89	58.82 \pm 8.02	0.004
BMI	25.38 \pm 6.09	23.26 \pm 4.13	0.028
HbA1c (%)	8.95 \pm 2.02	5.10 \pm 0.41	0.000

Demographic variables like age, height, weight, and BMI were analyzed by student's t-test, there was a significant difference between the age, weight, and BMI ($p > 0.05$) and no significant difference in height of control and cases. In the control group, the mean age was 46.98 years and ranged from 30 to 55 years. The height of the control group ranged from 4.4 to 6 feet and a mean of 5.28 feet. The weight of the control group was 41–74 kg with a mean of 58.82. BMI of the control group ranged from 16.4–34.8 with a mean of 23.26.

In the diabetic group, ages ranged from 27–60 with a mean of 50.56. The height of the diabetic group ranged from 4.1–5.9 feet and a mean of 5.26 feet. The weight of cases ranges from 37–110 kg with mean 64.85. BMI of the control group ranged from 13.4–38.2 with a mean of 25.38. Glycated Haemoglobin (HbA1c) in the control group, ranged between 4.4–5.8 % with a mean of 5.10. HbA1c in the diabetic group ranged between 6.5–14.4 with a mean of 8.95 ($p > 0.05$).

Group	Laying	Standing	T- value	DF	P-value
Case	1127 \pm 618	797 \pm 522	3.16	114	0.002
Control	528 \pm 195	321 \pm 140	6.71	107	0.000

GSR in the control group in supine posture ranged from 107 k Ω to 965 k Ω with a mean of 528 k Ω and in standing, posture ranged from 96 k Ω to 718.16 k Ω with a mean of 321 k Ω . The difference of GSR in posture from supine to standing was significant (p - value < 0.05) GSR in Type -2 Diabetes Mellitus in supine posture ranged from 204k Ω to 2180.56 k Ω with a mean GSR of 1127 k Ω and GSR in standing posture ranged from 100.26 k Ω to 1722.56 k Ω with a mean GSR 797 k Ω . There was a significant difference in GSR with postural change (p -value < 0.05). There was a significant difference in GSR in both groups with postural change.

Duration of T2DM < 6 year	Duration of T2DM > 6 year	P- value
902 \pm 533	1805 \pm 246	0.000

The duration of Type- 2 diabetes mellitus, mean duration was 6.68 years with ranged between 1–30 years. From the data, we observed that GSR significantly increased with the duration of the disease. We find that the mean GSR is higher

(1805 k Ω) in case those with a duration of diabetes of more than 7 years and those who have a duration < 6 years have lower (902 k Ω) GSR in comparison to those who have a longer duration of disease (p-value <0.05)

Group	Male	Female	P- value
Case	1069 \pm 616 (31)	1190 \pm 625 (29)	0.45
Control	540 \pm 190 (29)	517 \pm 202 (31)	0.64

When we compared gender in cases and control both groups, there was no significant changes recorded (p- value >0.05). GSR may be not depends on the gender.

Discussion

In type -2 diabetes mellitus, Sudomotor failure is the most potent sign, of autonomic neuropathy. Sympathetic and parasympathetic nervous systems are impaired in autonomic neuropathy. It includes denervation of nerve fibers present in the epidermis, dermis, and fibers also innervated to sweat glands.⁴ The activity of the sweat gland influences skin moisture and thermoregulation. in type 2 diabetes mellitus patients, impaired sweat gland activity causes dry skin, frequent wounds, and poor wound healing, which are risk factors for limb amputation.⁵

In diabetes, impaired vascular endothelial function decreased skin blood flow and impaired sweating contribute to higher galvanic skin resistance. the electrical resistance opposite to the flow of electric current, according to ohm (Ω) Law; conductivity was inversely proportional to resistance. Each active sweat gland contributes to conduction; increased sweat secretion increased conduction and decreased resistance on this basis it appears that GSR is a reliable index to sympathetic Sudomotor activity.⁶ GSR is noninvasive and simply technic of Sudomotor functions. As a previous study shows that Sudomotor denervation is a significant presentation of diabetic neuropathy, and the sweat gland innervation index (SGII) was associated with HbA1c. A skin biopsy offers a structural assessment of Sudomotor innervation.

Past studies also stated that Diabetes mellitus Reduced sweating with T1DM and T2DM; potential mechanisms related to autonomic neuropathy and reduced thermosensitivity, reduced maximal sweating rate, and/or lower number of active sweat glands; impaired ability to dissipate heat, especially during higher thermal loads and in individuals with lower fitness level.^{7, 8} In the present study diabetic subject showed significantly higher GSR in comparison to the control group. We find a significant change in GSR during posture change from supine to laying posture. Saravanan et al., also found that GSR is higher in type 2 diabetes mellitus and significant difference in GSR with posture change.⁹ Our finding is also similar to the study done by Sudha et al., Present study shows that GSR act as a marker for the detection of diabetic autonomic neuropathy.

Conclusion

The results show that most of type 2-Diabetic patients have anhidrosis due to impaired Sudomotor activity. Screening of Sudomotor activity GSR is non-invasive test, when increased acts as a predictor of early sign of autonomic neuropathy. Study suggested the potential utility of GSR for early assessment of neuropathy in type 2 Diabetes mellitus. American Diabetes Association recommended that tests can be done after diagnosis of diabetes.¹⁰

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