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JOINT MOBILITY AND ELECTRICAL MUSCLE ACTIVITY DURING MVIC AT ANKLE IN PATIENTS WITH LONG TERM TYPE II DIABETES

Namitha Smith*	BPTh, Dr. Vithalrao Vikhe Patil Foundation's College Of Physiotherapy, Maharashtra, India. *Corresponding Author
Surendra Wani	PhD., Asso. Professor, Dr.Vithalrao Vikhe Patil Foundation's College Of Physiotherapy Maharashtra, India.

ABSTRACT This study aimed at comparing ankle joint mobility and electrical activity of ankle muscles during MVIC in patients with long term type 2 diabetes and healthy controls. 15 healthy and 15 patients with long term type 2 diabetes (minimum duration – 10years) within the age group of 45-70 year were allocated in Group 1 and Group 2 respectively. Ankle range of motion of dorsiflexion and plantarflexion was measured by universal goniometer whereas electrical muscle activity of ankle muscles (tibialis anterior, gastrocnemius medial and lateral head) during MVIC was recorded using surface EMG. Results revealed a remarkable reduction in dorsiflexion range of motion and reduction in electrical activity of plantar flexors during MVIC bilaterally in Group 2 compared to Group 1 ($p < 0.05$). In conclusion, patients with long-term type 2 diabetes have limited dorsiflexion range of motion and reduced EMG electrical activity of plantar flexors.

KEYWORDS : Ankle Joint Mobility, Electrical Muscle Activity, Long-term Type 2 Diabetes.

INTRODUCTION

Diabetes mellitus (DM) is a multisystemic, metabolic disorder characterized by persistent increase in blood glucose levels caused due to reduced insulin production or associated with insulin resistance or both(1). Diabetes causes substantial morbidity and mortality in elderly population. India is considered as "Diabetes Capital" of the world as around 49% of the world diabetes burden was reported in India with more than 60 million cases(2).

Diabetes affects multiple systems clinically along the course of disease due to increased uncontrolled hyperglycemia affecting quality of life of the individuals surviving with it.(3,4) Musculoskeletal complications are frequently reported as the long term effect of diabetes mellitus.(1) A vast literature is available to confirm the relationship of diabetes and musculoskeletal disorders. Hyperglycemia in diabetes causes collagen abnormalities which ultimately leads to altered mobility functions. Hyperglycemia promotes non-enzymatic glycosylation of collagen which forms cross linkages in a great number in the extra-cellular matrix of the joint capsule, cartilages, ligament, tendons and muscles. As the cross linkages increases, , the mechanical properties of tissues changes. It ultimately reduces the elasticity and increases the stiffness of the muscles.(5,6,7). Andersen (2004) stated a significant muscle strength reduction with and without neuropathy in long-term diabetic patients. In diabetes, muscle growth and development is significantly impaired due to decline in skeletal muscle capillarization and angiogenesis, resulting in reduced muscle mass and myofibril size as a result of poor metabolic control (1).

Diabetes often involves small joints of hand, shoulder, ankle, feet and rarely spine regions(1). Morphological changes in feet are found to be developed due to repetitive mechanical stress imposed on sensory deprived area. Also motor deficits e.g. limited joint mobility at ankle is impotent to provide a shock-absorbing mechanism during gait and thus it loses its ability to maintain normal plantar pressures.(6,8). Repetitive and abnormally high loading on forefoot may disturb the ability of the soft tissue to respond and may culminate in ulceration. Hence, due to the inability to effectively treat these foot ulcers, the rate of amputation has been increased in the population. This tremendously affects one's quality of life, hampers functional independence and influences participation of an individual in activities of daily living(6,8).

Considering that Diabetes Mellitus has a high prevalence worldwide and it is a complex disease involving loss of muscle strength of the lower extremities and functional mobility, furthermore inactivity will lead to further loss of muscle mass, resulting in decreased muscle strength that will ultimately cause an increased effort to be physical active. Therefore in this review, we aim to document the findings of studies, representing changes in mobility by measuring dorsiflexion and plantarflexion range of motion of the ankle joint using goniometer and strength by recording electrical activity using surface EMG. So that more appropriate clinical decisions regarding physiotherapy focusing on improving or maintaining the strength and mobility can be selected in order to prevent the complication related to it. The main goal of physiotherapy will be to limit the physical disability, maintain the current performance level and prevent further deterioration of the same and improve the quality of life of the patient.

RESEARCH DESIGN AND METHOD

College level ethical committee approval was obtained before the commencement of the study. Patients attending and admitted in Vikhe Patil Memorial Hospital, Ahmednagar, Maharashtra,India. were invited to take part in the study and when they agreed to participate, the eligibility criteria was checked. Participants of both genders between the age group of 45 – 70 years; medically diagnosed with type 2 diabetes confirmed by reviewing lab reports with duration of diabetes of minimum 10 years or more and healthy individuals without known diabetes and with no functional impairments related to bilateral ankle joints were included in this study by purposive sampling. Patients with previous history of trauma or surgery to ankle joint, ankle joint arthritis, myotomal weakness secondary to lumbar disc prolapse common peroneal nerve injury, previous history of peripheral vascular disease, Charcot neuroarthropathy, arthrodesis and intermittent claudication were excluded from the study. Verbal and written informed consent were duly signed by all the participants. A total of 30 participants were recruited out of which 15 Participants for control group (Group 1) were recruited from the healthy hospital staff members and people accompanying patients to the hospital. 15 Participants with type 2 diabetes with normal ankle function formed Group 2. Demographic information of participants including name, age, gender, occupation, duration of diabetes, etc. was documented. Confirmation of the diagnosis of type 2 diabetes was based on medical records and previous lab report which confirmed the onset of diabetes after 25 years of age. Duration of diabetes was considered from the reported age at the time of diagnosis of diabetes; e.g. for participants with newly diagnosed diabetes, the duration of diabetes was considered as 0 and it was documented on recall basis from the participants. They were recruited consecutively and as per the availability of the EMG machine. All ankle ROM and EMG recordings were taken on bilateral ankle joints of each participant.

DETERMINATION OF JOINT MOBILITY AND ELECTRICAL MUSCLE ACTIVITY

1. Range of motion measurement of Dorsiflexion and Planta rflexion using Universal goniometer:

Ankle joint mobility was assessed by measuring range of motion of ankle dorsiflexion and plantarflexion using universal goniometer following the standard procedure as mentioned by Norkins (9).

2. Electrical muscle activity of selected ankle muscles during MVIC recording using surface EMG analysis:

Electro-physiological function in terms of muscle activity / recruitment (EMG activity in terms of RMS values) of tibialis anterior and gastrocnemius(medial and lateral head) muscles was evaluated using surface electromyography (sEMG) during MVIC by a dual-channel EMG system (RMS-EMG NCV electromyogram keypad 2 channel EMG). Maximal voluntary isometric contraction (MVIC) of all muscles on both the sides were recorded in ideal manual muscle testing position (MMT) in accordance with standard physical therapy guidelines as described by Kendall (10). Two bipolar Surface electrodes of 8 mm in diameter, with an inter-electrode distance of 1.5 cm were placed for each muscle as per the guidelines mentioned by U.K Mishra et al(11). A ground electrode was placed over lateral fibular head. Adequate exposure of the muscle being examined was done. The amount of maximum recruitment (RMS values) of each ankle muscle was recorded during MVIC and then compared among the two groups.

STATISTICALANALYSIS

Descriptive statistic with mean and standard deviation and inferential statistic using student's unpaired “t” test to compare in between two groups.

The statistical tests were performed using Statistical Package for the Social Science (SPSS v 24)

RESULTS

Out of total 30 participants, fifteen healthy individuals (M=9, F=6, Mean age=49.4years) were included in Group 1 and fifteen type 2 diabetics (M=10, F=5, Mean age=56.06 years) were included in Group 2 with mean duration of diabetes of 10.33 years.

Table.1 Average values of range of motion and electric muscle activity during MVIC among groups

ROM=range of motion; SD=standard deviation R=right; L=left; DF=dorsiflexion; PF=plantarflexion; TA=tibialis anterior; GM=gastrocnemius medial head; GL=gastrocnemius lateral head.

Outcome measure ROM (in degrees)	Group 1 mean +/-SD	Group 2 mean +/-SD	p value	Percentage Change(%)
DF (R)	19.46±4.31	10.73±5.49	<0.001	44.86
DF (L)	20.8±6.17	13.73±6.54	0.0066	33.99
PF (R)	37.53±9.53	34.53±5.85	0.3243	7.99
PF (L)	33±9.15	31.6±6.15	0.6386	4.24
Muscle Activity (in microvolts)				
TA (R)	114.06±34.52	102±35.87	0.3722	10.57
TA (L)	96.93±28.23	94.6±37.37	0.8535	2.40
GM (R)	96.26±50.22	67.6±38.78	0.1021	29.77
GM (L)	87.06±50.38	67.13±31.34	0.2192	22.89
GL (R)	94.2±46.62	63.6±39.74	0.0421	32.48
GL (L)	92.53±39.99	61.33±24.99	0.0196	33.71

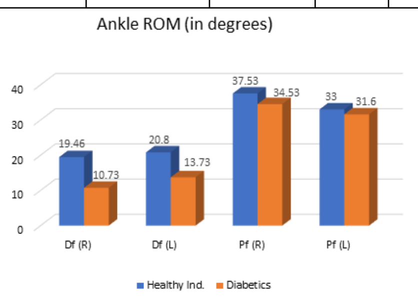

Fig.1 Comparison of ankle joint mobility in group 1 and group 2

Fig.1 shows the notable difference in DF ROM between the groups.

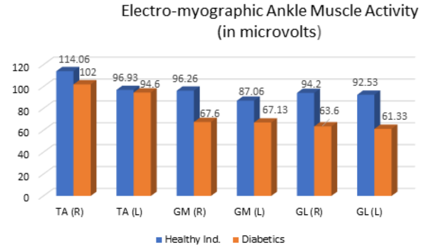

Fig.2 Comparison of electric muscle activity of ankle muscles in group 1 and group 2.

Fig 2. Shows significant changes in RMS values of plantar flexors i.e. GM and GL between the groups.

DISCUSSION

The present study evaluated ankle joint mobility-ROM of dorsiflexion and plantarflexion and electrical activity of ankle muscles- tibialis anterior, gastrocnemius medial and lateral head bilaterally during maximal voluntary isometric contraction among patients with long-term type 2 diabetes.

There was significant reduction(R=44.86% & L=33.99%) in dorsi-flexion range of motion bilaterally and reduction in EMG activity during MVIC of both heads of gastrocnemius bilaterally(R GL=32.48%, L GL=33.71% ; R GM=29.77%, L GM=22.89%) compared to healthy individuals.

The experimental data of the present study demonstrated reduced ankle joint mobility specifically, reduction in dorsiflexion range of motion in patients with type 2 diabetes. Although, the difference was statistically non-significant but minimal reduction in plantarflexion(R) by 7.99% and plantarflexion(L) by 4.24% was observed compared to healthy individuals between the groups.

Similarly the electrical activity recorded during MVIC demonstrated notable decline in plantar flexors, specifically in gastrocnemius lateral head bilaterally (R) GL=32.48%, L GL=33.71%)._Gastrocnemius medial head also showed some reduction in muscle activity during MVIC (R=29.77%, L=22.89%). The reduction in electrical activity of tibialis anterior during MVIC was observed 10.57% at right side and by 2.40% at left side.

Our findings were supported by the study conducted by Claudia et al.(5). They reported reduction in ankle joint mobility in sagittal plane as compared to controls was 11% for Diabetics, 20% for Diabetic Neuropathy, respectively whereas in our study there was approx. 44% and 10% reduction in Sagittal plane. Similarly, in a study done by Zimny et al. (6), reported a limited joint mobility, significantly dorsiflexion range in the patients with diabetic neuropathy compared with both the diabetic group and the control subjects. In an another study done by Rao et al.(8), the key findings demonstrated significant lower peak dorsiflexion range and higher passive ankle stiffness in diabetics than non-diabetics. But in contradiction, the study by Francia et al. (12) found that Ankle joint mobility of plantar flexion was reduced about 36% and dorsal flexion by about 23% in diabetic subjects compared to controls ($p < 0.001$).

The reduction in dorsiflexion range (R=44.86% & L=33.99%) and may be due to increased thickness and stiffness of Achille's Tendon and Plantar Fascia in patients with diabetes offering Giacomozzi C et al. higher resistance to dorsiflexion.(5) Also, deficit in range of ankle motion has been explained previously as a consequence of shortened plantar flexors(13). Our findings can be justified by the presence of ankle stiffness in patients with diabetes. Ankle stiffness can be influenced due to the presence of prolonged glycemia by 48% and long duration of diabetes by 24% as reported by Rao et al(8). The literature (13,14), confirms the hypothesis that the limited active range of motion is result of concurrent alterations of structure and coefficient of elasticity of cartilages and capsule due to pathophysiological process evident in diabetes i.e. non-enzymatic glycosylation of collagen which negatively impacts the joint flexibility. In addition, tissue damages along with alteration of cartilage, ligament and tendon due to hyper glycaemia explains the worsening of muscle performance ultimately leading to limited ankle active joint mobility in long-term diabetic patients.(7,15,16,17). Therefore, our findings of decreased mobility at the ankle specifically dorsiflexion in those with diabetes mellitus are consistent with the findings of other studies that have measured foot and ankle mobility in this patient population(18,19,20).

As reported in the study (13) the patients with Diabetes mellitus and peripheral neuropathy often have a decreased ability to generate muscle force approximately 36% less concentric plantar flexor peak torque compared with subjects in the comparison group. Whereas Claudia et al. found that there was major impairment associated with the action of the dorsal flexors rather than the plantarflexors of the ankle following our study findings.(5) But there is also an evidence for loss of sarcomeres is in parallel from the finding- reduction of peak torque generating capacity of the plantarflexors in individuals with diabetes mellitus`. Our findings may follows the concomitant positive association between plantar flexor strength and stiffness(22) which was beyond the scope of the study. It was also reported that individuals with diabetes mellitus often use less ankle motion during functional activities(21) suggesting that their plantarflexors may function in a smaller range compared to nondiabetic individuals and that this may lead to associated muscle accommodations such as fiber shortening. Reduction in the number of sarcomeres in parallel would tend to reduce passive stiffness but may be accompanied by a change in the ratio of connective to contractile tissue. The gastrocnemius, therefore, emerges as the predominant factor influencing the mechanical behavior of the plantarflexors(13). This explanation given in previous study is consistent with our finding in present study. The electrical activity was found less in gastrocnemius lateral head and medial head between group 1 and group 2. Comparatively the electrical activity was found insignificant in dorsiflexors.

On comparing the results of previous research articles, we assume that the values of percentage reduction in ankle joint mobility and electrical muscle activity was found to be slightly more in the present study due to the evaluation of ROM and muscle activity in less sample of diabetic population.

CLINICAL IMPLICATION

The findings in the current study warrants the clinicians to evaluate ankle range of motion and ankle muscle strength as a part of routine diabetic evaluation. Our study provided the evidence for the need of including the ankle range of motion exercises and ankle muscle strengthening exercise to improve ankle function in patients with diabetes which may prevent the further ankle and foot complications like ulcerations which may future cause for amputation if not treated effectively.

FUTURE SCOPE

Future Randomized Controlled Trial can be performed to prove the effectiveness for ankle ROM and strengthening exercise in improving ankle functioning in the patients with type 2 diabetes.

CONCLUSION

Patients with long-term type 2 diabetes have limited dorsiflexion range of motion and reduced electrical activity of plantar flexors.

REFERENCES:

1. Somkuwar H., Wani S. (2018), "Skeletal Muscle Function in Patients with Diabetes." Gerontology & Geriatrics Studies, India. 4(3) 302-303.
2. Prevalence of diabetes in India, forumIAS, July 03, 2018
3. Rubin RR., Peyrot M. (1999), "Quality of life and diabetes." Diabetes Metab Res Rev. 15(3):205-18.
4. Prajapati V, Blake R, Acharya L, Seshadri S. (2018),"Assessment of quality of life in type II Diabetic patients using the modified diabetes quality of life (MDQoL)-17 Questionnaire." Brazilian journal of Pharmaceutical Sciences. 53(4):e17144.
5. Giacomozzi C., D'Ambrogi E., Cesinaro S., Macellari V., Uccioli L. (2008), "Muscle performance and ankle joint mobility in long-term patients with diabetes", BMC Musculoskeletal Disorders 9,99.
6. Zimny S., Schatz H, Pfohl M. (2004), "The Role of Limited Joint Mobility in Diabetic Patients With an At-Risk Foot." Diabetes Care, 27(4): 942-946.
7. Guirro E., Guirro R., Dibai-Filho A., Montezuma T., Vaz M.(2014) "Decrease in Talocrural Joint Mobility is Related to Alteration of the Arterial Blood Flow Velocity in the Lower Limb in Diabetic Women" J Phys Ther Sci. 26(4): 553–556.
8. Rao SR., Saltzman CL., Wilken J, Yak HJ. (2006),"Increased Passive Ankle Stiffness and Reduced Dorsiflexion Range of Motion in Individuals With Diabetes Mellitus." Foot & Ankle International 27(8):617-22.
9. Norkins C, White J. Measurement of Joint Function, a guide to Goniometry. (3rd edition).
10. Kendall FP, McCreary EK, Provance PG. Muscle testing and Function with Posture and Pain (5th edition)
11. Mishra UK and Kalita J Clinical neurophysiology 2nd edition.
12. Francia P, Anichini R, De Bellis A, Seghieri G, Lazzeri R, Paternostro F, Gulisano M. (2015) "Diabetic foot prevention: the role of exercise therapy in the treatment of limited joint mobility, muscle weakness and reduced gait speed." Italian Journal of anatomy and embryology. 120(1):21-35.
13. Salsich GB, Mueller MJ, Sahrmann SA. (2000), "Passive Ankle Stiffness in Subjects With Diabetes and Peripheral Neuropathy Versus an Age-Matched Comparison Group." Physical Therapy. 80(4):352-62.
14. Hajrasouliha AR, Tavakoli S, Esteki A, Nafisi S. (2005) "Abnormal viscoelastic behaviour of passive ankle joint movement in diabetic patients: an early or a late complication? Diabetologia." 48:1225–1228.
15. Giacomozzi C., D'Ambrogi E., Uccioli L., Macellari V.(2005) Does the thickening of Achilles tendon and plantar fascia contribute to the alteration of diabetic foot loading? Clin Biomech. 20:532–539.
16. Abate M, Schiavone C, Pelotti P, Salini V. (2011), "Limited joint mobility (LJM) in elderly subjects with type II diabetes mellitus." Arch Gerontol Geriatr, 53:135–140.
17. Mueller MJ, Minor SD, Sahrmann SA, Schaaf JA, Strube MJ.(1994), "Differences in the gait characteristics of patients with diabetes and peripheral neuropathy compared with age-matched controls."Phys Ther. 74:299–308.
18. Glasoe WM, Allen MK, Ludewig PM, Saltzman CL.(2004) "Dorsal mobility and first ray stiffness in patients with diabetes mellitus." Foot Ankle Int. 25:550–555.
19. Trevino SG, Buford WL, Jr, Nakamura T, John Wright A, Patterson RM.(2004), "Use of a torque-range-of-motion device for objective differentiation of diabetic from normal feet in adults." Foot Ankle Int. 25:561–567.
20. Mueller MJ, Minor SD, Sahrmann SA, Schaaf JA, Strube MJ.(1994), "Differences in the gait characteristics of patients with diabetes and peripheral neuropathy compared with age-matched controls." Phys Ther. 74:299–308.
21. Birke JA, Franks BD, Foto JG.(1995) "First ray joint limitation, pressure, and ulceration of the first metatarsal head in diabetes mellitus." Foot Ankle Int. 16:277–284.