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Original Research Article

Impact of Insole in Improvement of Balance in Elderly Person with Diabetic Peripheral Neuropathy

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ABSTRACT

Diabetic peripheral neuropathy (DPN) associated with nerve disorder, deteriorate balance in elderly person followed by increase cases of fall. Deterioration of balance caused by impaired somatosensory information from foot to central nervous system. Involvements of tactile and proprioceptive stimuli were also causes deterioration of dynamic balance in elderly persons. Various types of insoles were used for improving nerve stimuli from foot to CNS. Present study was focused on immediate effect of silicone insole in improving balance which was not been done before. A total 30 elderly persons were participated in the study. Out of the 30 elderly persons, 19 persons were male and 11 persons were female. Tinetti balance scale and TUGT scale were performed and pre test and post test data were obtained. A paired t-test conducted for the comparative study of the results of tinetti balance test score pre test data and post test data shows significant difference (t-value= -4.571, p=0.000), time up and go test score pre test data and post test data shows significant difference (t-value=7.722, p=0.000) which shows improvement in dynamic balance in post test condition. These results signify insoles as prescription for elderly person who have diabetic peripheral neuropathy to improve impaired balance.

Keywords: Diabetic peripheral neuropathy (DPN), Dynamic balance, immediate effect, Insole

INTRODUCTION

Diabetic mellitus had been marked as one of the most common and rapidly increasing health problems worldwide with significant increase in developing countries by more than 2.5 fold, from 84 million in 1995 to 228 million in 2025. [1] Among all types of diabetes, about one third of the diabetic population suffers from neuropathy. Accelerating factors for rapid increase in number were reported as growing age and disease duration. [2] Patient with a diabetic neuropathy suffered with impaired somatosensory input from their feet which resulted in postural stability impairment compared to diabetic patient without neuropathy. [3-5] Peripheral neuropathy is also a common complaint of diabetes. Peripheral nerve damage will cause balance impairment in diabetic patient. In person with neuropathy due to diabetes mellitus, both tactile and proprioceptive information is not conducted to the central nervous system as in healthy people. [6] Diabetic patient with peripheral neuropathy (DPN) have lower gait velocity, decreased cadence, shorter stride length, increased stance time and higher step to step variability compared with healthy controls. [7] Both tactile and proprioceptive mechanism can be influenced by therapeutic shoe or shoe modification, which may result in improvement of balance and reduced risk of falling. [8] People with diabetic neuropathy have balance disorders even with open eyes, making them vulnerable to falls. [9-10]

Various research articles marked different types of insoles devices to enhanced somatosensory information and improve postural stability. Different kinds of material used as polyurethane, ethylene vinyl acetate (EVA), microcellular rubber (MCR), cork and silicone. [11] Short term mechanical feedback stimulation to the feet, the vibration and tactile perception in diabetic patients with moderate to severe neuropathy improved significantly during quiet standing. [12] An improvement in ML sway in older people was also reported using textured insoles that were contoured to the feet. [13]

Various research studies shows conflict in between results. Aly et al., [14] documented that patient with DPN had weaker stability measures in all balance indices compared with nondisabled subjects. Emam et al., revealed that diabetic patient with neuropathy had significant lower balance capability compared with diabetic patient without neuropathy. [9] Anna L Hatton et al., stated that it is possible that incorporating a textured insole into footwear may have brought about a dampening effect of the sensory stimulus, contributing to a non –significant findings. [15] A study conducted by Anna Lucy Hatton and et al., stated that textured surface can improve medial lateral balance performance in healthy older people, and this depends on the type of textured. [13] Watanabe and Okubo, [16] found that postural sway was significantly reduced when standing on a textured surface in comparison to a smooth surface.

Previous studies have evaluated the beneficial and non-significant effect of insole in balance in diabetic peripheral neuropathy. Clinicians were frequently prescribed the silicone insole for person with diabetic peripheral neuropathy but the effect of silicon insole on dynamic balance was still a matter of controversy due to little evidence. Thus, the purpose of this study was to evaluate the immediate effect of silicone insole on dynamic balance in persons with diabetic peripheral neuropathy.

MATERIALS AND METHODS

This study was conducted in Department of Prosthetics & Orthotics (P&O), Indian Spinal Injuries Center- IRS, New Delhi, India.

Sample size: A sample of 37 elderly persons who had diabetic peripheral neuropathy took participated in this study. 7 persons were excluded as per the inclusion criteria and 30 persons participated in the study as they were fulfilled inclusion criteria.

Inclusion Criteria: Confirmed diagnosis of Diabetic mellitus on basis of doctor's prescription, diabetic peripheral neuropathy (vibration fork test 128 hz), [26-27] age between 60– 70 years, body mass index between 25.00 - 29.99 (pre obese), [17] no previous history of ulceration, tinetti tool score [18-25] in between 19-23 (moderate risk of fall), able to maintain a upright posture without any assistive device.

Exclusion criteria: Ulceration on planter surface of foot, any ankle foot deformity, other disease affecting balance i.e. nervous system impairment orthopedic disorders in lower limb (amputation or fracture), non diabetic neuropathy (due to Charcot-Marie-Tooth disease or alcohol).

Sampling technique was Non- Probability Convenient sampling. Research design was Pre Test- Post test Design.

Study Procedure: A total 37 elderly person with diabetic peripheral neuropathy took part in this study. They were screened according inclusion and exclusion criteria. A sample of 30 elderly persons with diabetic peripheral neuropath were selected as per inclusion and exclusion criteria and participated in this study. A detailed explanation of the procedure was explained to the persons. Persons consenting to participate in the study and signed the consent form. Demographic data of the persons was collected in the demographic data form. Persons were assessed for pre-test data without orthotic intervention balance (without silicone insole). Pre test data was collected by using one balance scale; the Time Up & Go Test (TUGT). [23-

[25] Pre test data for Tinetti balance assessment tool test was already taken during including persons. Post test data with orthotic intervention (with silicone insole) were collected after 5 minutes of adaptation period by using two balance scale; Tinetti balance assessment tool and the Time Up& Go Test (TUGT).

Statistical Analysis

The Data were analyzed using the SPSS software (version 20). Descriptive Statistics (Mean and Standard Deviation) were computed for variable. The outcome variables used for analysis of dynamic balance. A paired t-test was used to analyze the difference between pre test data and post test data of Tinetti Balance scale and TUGT score to identify changes in balance with and without use of silicone insole. A significance level of $P \leq 0.05$ was fixed.

RESULT

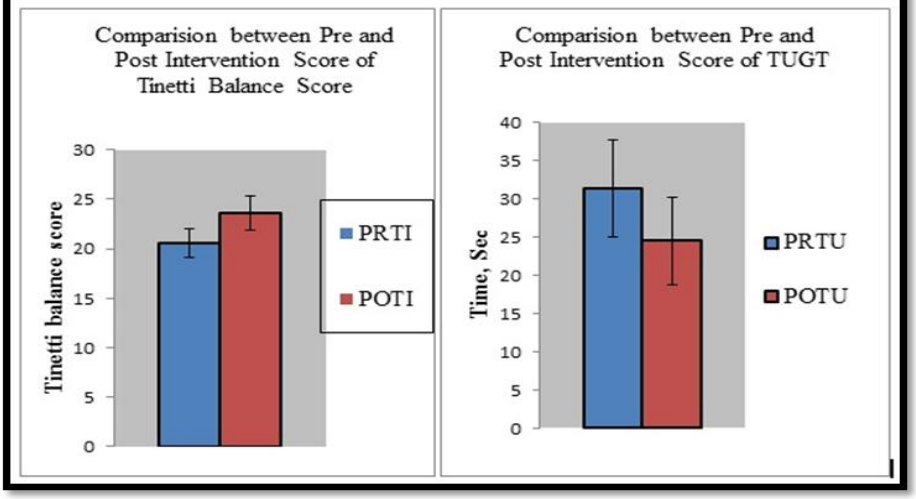
Table 1: Quantitative data of Tinetti balance score and Time Up& Go Test were obtained by comparison of dynamic balance in between pretest data and post test data.

Table 1: Quantitative data of Tinetti Balance score and Time UP & GO Test score

Comparison of Dynamic Balance between Pre & Post intervention score of ***Tinetti Balance score***				Comparison of Dynamic Balance between Pre & Post intervention score of ***Time Up & Go Test score***			
Tinetti balance score	Mean ± SD	t-value	p-value	Time Up & Go Test score	Mean ± SD	t-value	p-value
PRTI	20.567±1.4782	-9.433**	0.000	PRTU	31.333±6.3481	7. 628**	0.000
POTI	23.567±1.7157			POTU	24.5±5.734		

**- Significant at 0.05 level. Paired t – test, N=30. PRTI- Pretest Tinetti score, POTI- Post test Tinetti score, PRTU- Pretest Time Up & Go Test score, POTU- Post test Time Up & Go Test score, SD- Standard Deviation.

Graph 1: Application of Tinetti Balance Score and Time Up & Go Test (TUGT)



Graph 1:Graphical representation of experiment results of Tinetti balance score and Time Up& Go Test Score.

A total 30 elderly persons with diabetic peripheral neuropathy were participated in the study. Out of the 30 elderly persons who participated in the study, 19 persons were males with mean age (years) of 65.737 ± 2.4459 while 11 females with 65.273 ± 3.2277. The mean height (cm) of male person was 163.158 ± 7.0100

and of female was 158.636 ± 7.6062. The mean weight (kg) of male person was 73.895 ± 4.6654 and of female was 71.273 ± 7.7471. The mean BMI of male persons was 27.3626 ± 1.25672 and of female was 27.6582 ± 1.50576. A paired t-test was used to compare the difference in balance by examine pre intervention and post intervention on tinetti balance score and time up and go test score (TUGT). There are significant difference in pre intervention & post intervention of Tinetti balance score (t-value= -9.433, p=0.000). TUGT score pre intervention & post intervention also shows significant difference (t-value=7.628, p=0.000) (Table 1 & Graph 1). Thus, it indicates that the person showed improved balance scores with the given orthotic intervention.

DISCUSSION

The present study showed the immediate effect of silicone insole in improvement of dynamic balance in elderly person with diabetic peripheral neuropathy. The results obtained from the statistical analysis revealed that elderly persons who have diabetic peripheral neuropathy might get benefited with silicone insole as shown significant improvement in post test interventions in tinetti balance test and time up and go test score.

In elderly population, ageing deteriorates balance and increase number of fall due to difficulties in postural control. Diabetes mellitus was marked as growing in prevalence and many patients with diabetes suffer from peripheral neuropathy. DPN showed a negative effect on balance in people, resulting in increased fall rates. [9] Diabetic patient with peripheral neuropathy reported with significant change in quantitative data on lower gait velocity, decreased cadence, shorter stride length, increased stance time and higher step to step variability compared with healthy controls. [13] Changes in touch sensation and proprioception at the foot were also commonly associated with poor function and risk of falling in elder persons. [8] Balance could be improved with vibration and passive tactile cues which activate the sensory afferent system [11] and textured insoles with passive intervention to enhanced somatosensory input from the planter surface of the foot in diabetic neuropathy. [8] Present study was also supported by Akbari etal., [8] which stated that static and dynamic balance can improved with use of textured floor surfaces and textured shoe insoles.

The results obtained from present study revealed that persons were benefited with silicone insole show significant improvement in post intervention balance scores on tinetti balance test (t-value= -9.433, p=0.000) and time up and go test score (t-value=7.628, p=0.000). A mean of tinetti balance score without orthotic intervention was 20.567±1.4782 showing persons were in medium risk of fall. When they were given silicone insole, their tinetti balance score improves up to 23.567±1.7157 showing that silicone insole has immediate effect in improving dynamic balance. The mean of TUGT score at pre intervention for elderly person were 31.333±6.3481 which decreases up to 24.5±5.734 with intervention of silicone insole. The result interprets that Silicone insole improves dynamic balance in elderly persons with diabetic peripheral neuropathy indicated by less time taken in TUGT scores in post intervention.

The response from silicone insole based on textured surface, relationship between textured and cutaneous mechanoreceptors and relationship between cutaneous mechanoreceptor and balance. Cutaneous mechanoreceptor in the sole of the feet detected tactile stimuli and provide information to central nervous system related with pressure distribution at the sole of the feet. Change in pressure often related to a change in upright position. [9] Previous studies showed relationship in between cutaneous mechanoreceptor and balance. Do et al., [28] and Isamu et al., [29] revealed that during walking, the cutaneous mechanoreceptors on the foot sense the state

of contact between the foot and ground and provide peripheral sensory input to the central nervous system for balance control. Various studies also showed relationship in between balance and diabetic peripheral neuropathy. DPN leads to sensory and motor deficits, which often results in mobility-related dysfunction, alteration in gait characteristics, balance impairments. [7] Improvement in balance with use of textured insole also showed in various studies. As per Lalita et al., [30] and Liu et al., [31] short term mechanical feedback stimulation to the feet, the vibration and tactile perception in diabetic patients with moderate to severe neuropathy improved significantly during quiet standing. Pallurel et al., [32] used textured insoles comprising indentation of varying density and height which meant the surface were probably in fuller contact with a greater surface of the sole of the foot because it has been suggested that total and even stimulation of the sole is important for stimulation of mechanoreceptor by textured surface. Priplata and colleague [15] also studied the use of insoles to propagates vibration to the plantar foot surface, which caused similar improvements in balance control in diabetic patient. A study conducted by Hatton and et al**.,** [7] used two different type of textured insole that textured surface can improve medial lateral balance performance in healthy older people, and this depends on the type of textured. In this present study, authors found almost similar result where silicone insole shows immediate improvement in dynamic balance in elderly person with diabetic peripheral neuropathy. An explanation for this finding could be that enhanced somatosensory feedback received from the plantar surface of the feet provide more accurate information about foot position which helps in maintaining balance in elderly parsons.

CLINICAL IMPLICATION

Quantification of data of present study emphasis that silicone insole might be effective in improving dynamic balance in elderly persons with diabetic peripheral neuropathy. This helps clinicians, academicians and research scholars to have a better explanation and rationale for silicone insole prescription for elderly person who having diabetic peripheral neuropathy to improve their balance.

FUTURE OUTCOME

This research was conducted for short period only. Future research involving a longer time of application can be possible by extending the time of follow up for several months. As mentioned earlier, this study uses only a smaller sample of elderly persons having diabetic peripheral neuropathy. The relevance of this study can be increased by taking a large sample size.

CONCLUSION

The ultimate effect of this study was improvement in dynamic balance with the aim of reducing balance problem in elderly persons suffer from DPN. This study also recommends silicone as better choice of prescription for elderly person with diabetic peripheral neuropathy, who were under risk of fall due to impaired balance.

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