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Correlation between Postural Sway and Dynamic Balance in Patients with Diabetic Neuropathy

Dhanashree Vilas Mode[1], Snehal Joshi[2]

[1]MPT (Neurosciences), MUHS/D.E.S Brijlal Jindal College of Physiotherapy, Pune- 411004, Maharashtra, India.
[2]Professor, MPh.T (Neurosciences), D.E.S Brijlal Jindal College of Physiotherapy, Pune- 411004, Maharashtra,India.

Corresponding Author: Dhanashree Vilas Mode

ABSTRACT

Aim and objectives of the study-To study and find out the correlation between postural sway and dynamic balance in diabetic neuropathy patients.
Method – Total 145 individuals were screened for MNSI and the individual who fulfilled the inclusion and exclusion criteria were included in the study according to the sample size,60 patients were selected Postural sway was assessed by Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) test of posturography by balance master and Dynamic balance was assessed by Dynamic Gait Index(DGI). Data was recorded and then analyzed with Spearman's correlation coefficient test.
Outcome measures: MNSI questionnaire, Modified Clinical Test of Sensory Interaction on Balance, Dynamic Gait Index
Results- The correlation between postural sway in 4 different situations (eyes open and eyes closed on firm surface and foam surface) and dynamic balance was correlated. The correlation of postural sway (eyes open firm surface) and the total score of DGI showed statistically significant negative correlation. But the correlation coefficient indicated low negative correlation with r value of -0.312.The correlation of postural sway (firm surface eyes closed) and the total score of DGI showed statistically significant negative correlation. But the correlation coefficient indicated low negative correlation with r value of -0.44. The correlation of postural sway (eyes open foam surface) and the total score of DGI showed statistically significant negative correlation. But the correlation coefficient indicated low negative correlation with r value of -0.317.The correlation of postural sway (foam surface eyes closed) and total score of DGI Statistically showed no significance.
Conclusion- There is no correlation between postural sway and dynamic balance in diabetic neuropathy patients.
Discussion-In the present study, which was done to correlate postural sway and dynamic balance in diabetic neuropathy patients. A weak negative correlation was found between postural sway on firm surface (EO), (EC), foam surface (EO) and dynamic balance in diabetic neuropathy patients and no correlation was found between postural sway on foam surface(EC)and dynamic balance in diabetic neuropathy patients.

Keywords- Postural sway, Dynamic balance, Diabetic neuropathy.

INTRODUCTION

Diabetes mellitus is fast gaining and one of the most common metabolic and chronic disorders across the world. Globally there were 366 million people affected with diabetes in 2011 and it is expected that it will rise to 552 million by 2030[1]. Diabetic neuropathy (DN) is the common and most frequent complication of diabetes mellitus and the incidence increasing with the duration of diabetes[2].

Balance is the maintenance or restoration of a person's centre of mass within their limits of stability[3]. The balance depends on motor factors (ROM and muscle strength) and sensory factors (vestibular, visual, and proprioceptive).Lack of accurate proprioceptive feedback and loss or reduction of peripheral sensory information from the feet leads to an inability of central nervous system to appropriately integrate with available postural control information about balance [4-8]. These factors might result in impaired balance in diabetic neuropathy patients. Postural sway is the movement of the COM in a standing position [9]. Postural sway is often quantified by measuring the motion of centre of pressure (COP). COP shift profiles are closely related to sway of centre of mass [10]. DN patients have been reported to have large changes in postural sway compared with normal individuals [11]. A computerized dynamic posturography system is an assessment technique which can measure postural control by measuring postural sway.[12]

Dynamic balance is ability to perform a task while maintaining stable position[13]. Dynamic gait index is a clinical tool developed to asses dynamic balance and risk of fall. It evaluates both steady state walking and walking during more challenging tasks [14-24]. Previous studies reported that postural sway increases with ageing [25]. There are studies which concluded that increase in postural sway causes reduction in dynamic balance [26] and in contrast to these, there are also studies done which stated that reduction in postural sway does not necessarily improves dynamic balance[25,27,28]. There is dearth of literature regarding balance problem in diabetic neuropathy patients. So there was a need to find out correlation between postural sway and dynamic balance in diabetic neuropathy patients.

MATERIALS AND METHOD

Type of study: Cross sectional (observational) study.

Study Population: Individuals with diabetic neuropathy.

Inclusion Criterion:

1**.** Patients diagnosed with diabetic neuropathy; on MNSI[29]-
History - ≥ 7 and
Physical assessment- 2 to 8
2. Age more than 40 yrs[30].
3. Patients who understand English.

Exclusion Criteria:

1. Diabetic ulcer and deformities secondary to them
2. Amputation
3. Diabetic retinopathy or blindness
4. Vestibular disorder.
5. Spinal and lower limb injuries.
6. Other Neurological and musculoskeletal impairments.
7. Cognitive impairments.

Outcome measures:

1. MNSI questionnaire
2. Modified Clinical Test of Sensory Interaction on Balance
3. Dynamic gait index

Study settings: Community based

Sampling technique: Purposive sampling

Sample size: Sample size was 60 with 19.1% prevalence, 5% level of significance and 90% power of test using Daniel formula. This sample size was calculated with the help of biostatistician using formula

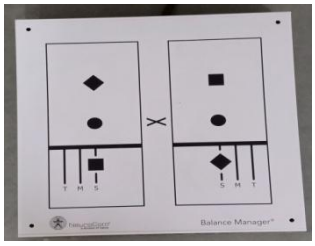
$$n = \frac{Z^2\, Px(1-P)}{d^2}$$

Where,
n = The desired sample size
z = Level of confidence according to standard normal distribution
p = Prevalence
d = Margin of error acceptable

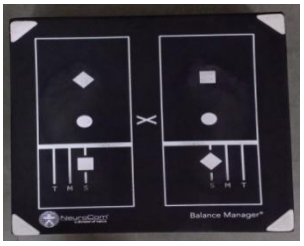
Procedure- Ethical clearance was obtained from the institutional ethics committee. Individuals from age above 40 years from community were approached for the study. Both males and females were included. Interested individuals were asked to fill the history part of the MNSI for the information about diabetic neuropathy and the other part of physical assessment was completed by

myself. Total 145 individuals were screened for MNSI and the individual who fulfilled the inclusion and exclusion criteria were included in the study. Written consent was taken from these individuals. Postural sway was assessed by using, Neuro-Com basic balance manager i.e. Basic Balance Master (Version 9.2) from Natus balance and mobility. Modified Clinical Test of Sensory Interaction on Balance of posturography was used to assess postural sway .Dynamic balance was assessed by dynamic gait index .Data was recorded and then analyzed with Spearman's correlation coefficient test.

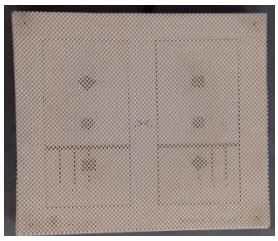
Basic Balance Master



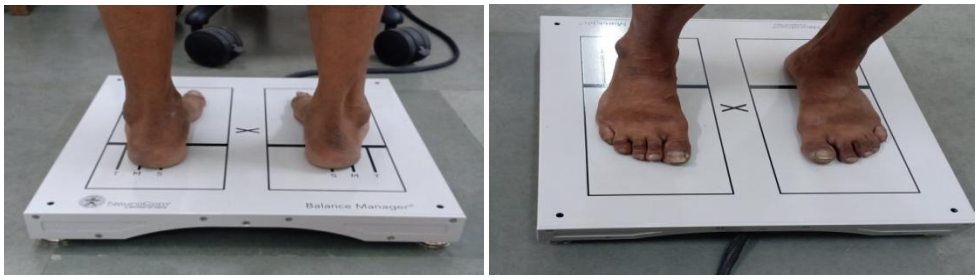
Firm surface



Foam surface



No slip mat



Foot placement on static short foot plate

Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) foam and firm surface

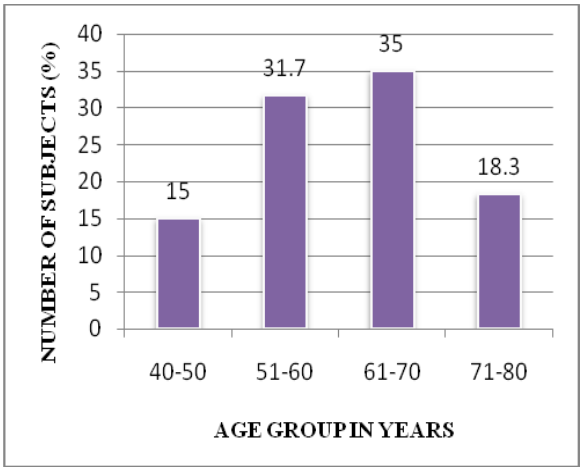
The mCTSIB provides a means to quantify postural control under various sensory conditions. It assesses patient's postural sway under a variety of conditions to infer the source of instability. Standing on firm surface, (eyes open, eyes closed) Standing on foam surface,(eyes open and eyes closed). The patient performance is timed for 10 seconds each for 3 trails. Test is terminated when a subject's arm or feet change position. Time is stopped during a trial and recorded if, Patient deviates from initial crossed arm position, Patient opens eyes during an "eyes closed" trial condition, or Patient moves feet (takes a step) or requires manual assistance to prevent loss of balance. The best performance of 3 trails was used for data analysis.

Standing on firm and foam surface with eyes open and eyes closed.

Statistical analysis- The statistical analysis was done with Spearman's correlation coefficient test. The estimated sample size for the study was 60 and the participants were selected according to inclusion and exclusion criteria. All the participants were assessed based on MCTSIB and DGI and analyzed further.

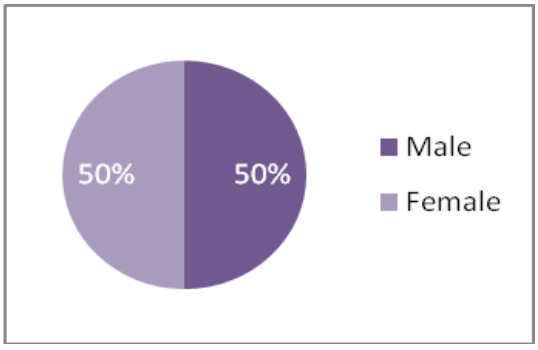
Results- The obtained results after analysis are plotted in the form of tables and graphs below.

		FREQUENCY	PERCENT
AGE GROUP	40-50	9	15.0
	51-60	19	31.7
	61-70	21	35.0
	71-80	11	18.3
	Total	60	100.0



1. Table and graph of age wise distribution of subjects

		FREQUENCY	PERCENT
SEX	MALE	30	50.0
	FEMALE	30	50.0
	TOTAL	60	100.0

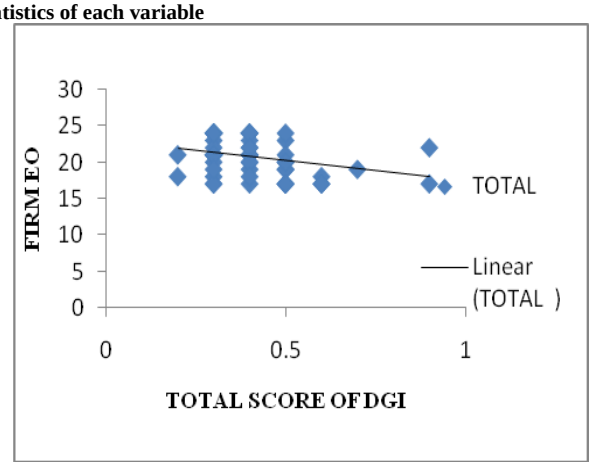


2. Table and graph of gender wise distribution

	N	Mean	Std. deviation	Std. Error	Range	Minimum	Maximum
AGE	60	61.42	9.30	1.20	34.00	44.00	78.00
FIRM EO	60	0.40	0.14	0.02	0.70	0.20	0.90
FIRM EC	60	0.54	0.22	0.03	0.90	0.30	1.20
FOAM EO	60	0.79	0.17	0.02	0.80	0.50	1.30
FOAM EC	60	1.58	0.35	0.04	1.50	0.60	2.10
TOTAL SCORE	60	20.82	2.42	0.31	7.00	17.00	24.00

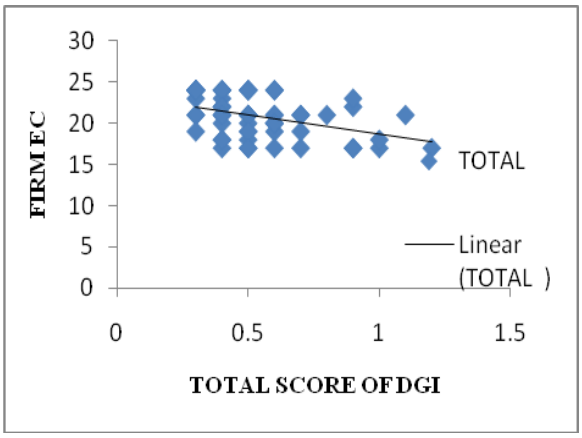
3. Table of descriptive statistics of each variable

		FIRM EO
TOTAL SCORE OF DGI	Spearman's Correlation	-0.312
	P	0.015 (p<0.05), Significant
	Inference	Negative correlation



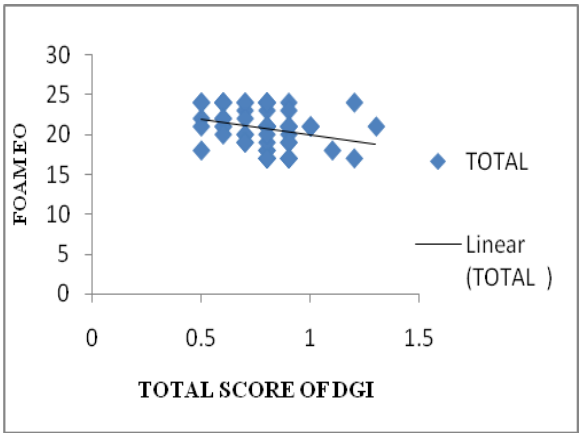
4. Correlation of total score of DGI and eyes open firm surface in mCTSIB test of posturography

		FIRM EC
TOTAL SCORE OF DGI	Spearman's Correlation	-0.44
	P	.0001 (p≤0.001), Highly Significant
	Inference	Negative correlation



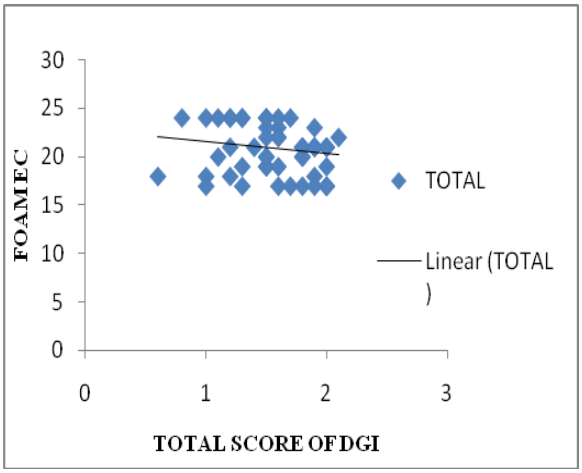
5. Table and graph of correlation of total score of DGI and eyes closed firm surface in mCTSIB test of posturography

		FOAM EO
TOTAL SCORE OF DGI	Spearman's Correlation	-0.317
	P	0.013 (p<0.05), Significant
	Inference	Negative correlation



6. Correlation of total score of DGI and eyes open foam surface in mCTSIB test of posturography

		FOAM EC
TOTAL SCORE OF DGI	Spearman's Correlation	-0.235
	P	0.07 (p>0.05), Not significant
	Inference	Negative correlation



7. Correlation of total score of DGI and eyes closed foam surface in mCTSIB test of posturography

DISCUSSION

The present study was conducted in order to investigate the correlation between postural sway and dynamic balance in dynamic neuropathy patients. All the participants were assessed for Postural sway and dynamic balance.

Table and graph no 4 describe the correlation between postural sway measured on firm surface(stable) with eyes open and the total score of DGI.

This showed a statistically significant negative correlation. But the correlation coefficient indicated a low negative correlation with r value of -0.312.

This conveyed that the postural sway velocity increases as the score of DGI decreases.

Due to the similarity between surfaces, the sensory systems which were acting during the test on balance master and on the ground while performing DGI were the same. Also in addition to this, the eyes were open during both the conditions. Due to this, the dynamic gait index score did not reduce even if the postural sway was increased.

There was a low negative correlation between postural sway and dynamic balance this may be due to the difference in the motor pattern recruitment during mCTSIB test and dynamic gait index.[32] The components of DGI were similar to those which were performed during activities of daily life. Due to repeated practice and performance of similar task one gets adapted to these activities. So because of these adaptations the deviations while performing a dynamic gait index cannot be appreciated completely by naked eyes.[33] But in balance master as the force plate is very sensitive, it detects the mild changes occurring in postural sway velocity in every direction.

Table and graph no 5 describe the correlation between postural sway measured on firm surface eyes closed and the total score of DGI.

This showed a statistically significant negative correlation. But the correlation coefficient indicated a low negative correlation with r value of -0.44.

When we stand on the balance master force plate and when we perform on the ground surface, the supporting surface remains similar that is both are firm surface this could be the reason for the correlation between postural sway and dynamic balance in this condition.

Normally the individual uses the vestibular and somatosensory system to maintain their balance in eyes closed condition because the visual system is eliminated.[34,35] But as in diabetic peripheral neuropathy, the somatosensory system may be affected and in addition to that if the visual inputs are also blocked so, this may be the reason that the postural sway velocity was increased. This can be supported by an article, "postural sway in diabetic peripheral neuropathy among Indian elderly" stated that postural stability was affected in

participants with diabetic neuropathy and was further worsened when vision was occluded.[36] In addition to this, the motor pattern recruitment while performing DGI and performing mCTSIB test were different. So this may be the factors due to which the low negative correlation was found in postural sway and dynamic balance.

Table and graph no 6 describe the correlation of postural sway measured on foam surface eyes open and the total score of DGI.

This showed a statistically significant negative correlation. But the correlation coefficient indicated a low negative correlation with r value of -0.317.

In this condition the vestibular and visual system were contributing for maintenance of the center of mass within the base of support. While performing DGI components at least any two systems from somatosensory, visual and vestibular were contributing for maintaining center of mass within base of support. Due to these factors there was a correlation between postural sway and dynamic balance.

In diabetic peripheral neuropathy, the proprioceptive and somatosensory input could be altered.[37] The proprioceptive and somatosensory input which one gets on foam surface and ground surface were different. During mCTSIB test performed with eyes open on foam surface, proprioceptive and somatosensory input that were the movable surface and texture of the surface had already challenged in this condition so this may be the reason for postural sway to increased. Motor pattern recruitment on foam surface and ground surface, changing center of mass over the base of support while performing components of dynamic gait index was different which may cause a reduction in dynamic gait index score.

Table and graph no7 describe the correlation of postural sway measured on foam surface eyes closed and the total score of DGI.

In this condition, there was no statistical difference found between postural sway and dynamic balance. Because this situation was more complicated as compared to other conditions mentioned above (firm with eyes open and eyes closed, foam eyes open), in eyes open condition there were visual cues, vestibular inputs to maintain the postural stability but in this condition proprioception, somatosensory inputs were altered, and visual cues were blocked.[37] In contrast to this while performing components of DGI minimum two systems were intact in each component. Also, the surface was familiar while performing DGI.

In this study, the correlation of following was done:

1. Total score of DGI versus postural sway velocity on firm surface with eyes open.
2. Total score of DGI versus postural sway velocity on firm surface with eyes closed.
3. Total score of DGI versus postural sway velocity on foam surface with eyes open.
4. Total score of DGI versus postural sway velocity on foam surface with eyes closed.

In the first three conditions, there were at least two systems acting among the visual, somatosensory, and vestibular due to which the low negative correlation was observed.

As compared to the first three conditions forth condition was maximally challenging. So, this may be the reason that there was no significant correlation between the postural sway and the dynamic balance.

Many studies done before concluded that an increase in postural sway has been shown to be associated with a reduction in balance ability which leads to an increased incidence of falls.[26] In addition to this study, Niam et.al also reported a negative correlation of postural sway with dynamic balance (BBS) in stroke patients.[38]

In contrast, the finding of the present study showed low negative correlation between postural sway measured on firm surface eyes open and eyes closed and foam surface eyes open and total score of DGI for dynamic balance in diabetic peripheral

neuropathy patients. There was no significant correlation found in postural sway measured on foam surface with eyes closed and the total score of DGI for dynamic balance.

Also, there were some previous studies done to investigate the relationship between postural sway and dynamic balance which concluded that postural sway does not mean poor balance.[26,27] The increase in postural sway may be due to maintain the postural stability and thus prevent falling.[9] In diabetic peripheral neuropathy patients there may be the affection of either or both the small and large nerve fiber in limbs which may affects the proprioception and the somatosensory system.[39,40,41] To prevent falls or to maintain the postural stability and to maintain the center of mass within the base of support there are movements made by the body which is known as postural sway.

Thus the result of the present study indicated it is not necessary that, an increase in postural sway indicates poor balance. To maintain the relation of the center of mass and base of support the postural sway occurred.[9,10]

Thus it can be said that a decrease in postural sway does not necessarily reflect an improvement in dynamic balance. Thus the finding of the study may be helpful in balance rehabilitation to prevent falls with the patient having diabetic peripheral neuropathy.

CONCLUSION

There is no correlation between postural sway and dynamic balance in diabetic neuropathy patients.

Clinical implication- Decrease in postural sway does not necessarily reflect improvement in dynamic balance in diabetic neuropathy patients.

REFERENCES

1. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract 2011;94:311-21
2. International Diabetes Federation (IDF). IDF diabetes atlas, 6th ed. Brussels, Belgium: IDF; 2013.
3. M. Mancini, F.B.Horak, The relevance of clinical balance assessment tools to differentiate balance deficits, Eur. J. Phys. Rehabil. Med. 46 (2010) 239–248.
4. Boucher P, Bard C, Teasdale N, Fleury M, Courtemanche R: Postural stability in diabetic polyneuropathy. Diabetes Care 1995, 18:638–645. PMID: 8586001.
5. Horak FB, Nashner LM, Diener HC: Postural strategies associated with somato-sensory and vestibular loss. Exp Brain Res 1990, 82:167–177doi:10.1007/BF00230848. PMID: 2257901.
6. Bonnet C, Carello C, Turvey MT: Diabetes and postural stability: Review and Hypotheses. J Mot Behav 2009, 41:172–190. Doi:10.3200/JMBR.41.2.172- 192. PMID: 19201687.
7. Horak FB, Dickestein R, Peterka RJ: Diabetic neuropathy and surface sway referencing disrupt somatosensory information for postural stability instance. Somatosens Mot Res 2002, 19:316–326. Doi:10.1080/0899022021000037782. PMID: 12590833.
8. Ahmmed AU, Mackenzie IJ: Postural changes in diabetes mellitus. J Laryngol Otol 2003, 117:358-364doi:10. 1258/00221503321626393. PMID: 12803785.
9. Horak FB: Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Age Ageing, 2006, 35: ii7–ii11.
10. Morass, P.G., G. Spade, and R.Capra . 1999. Computing the com from the cop in postural sway movements .hum.mov.sci.18:759-767
11. Horak FB, Hlavacka F: Somatosensory loss increases vestibulospinal sensitivity. J Neurophysiol, 2001, 86: 575–585.
12. Mohieldin M. Ahmed, Douaa M. Mosalem, Wafaa A. Tarshouby, Aziz K. Alfeeli, Ayyoub B. Baqer, Mohamed H. Mohamed: Computerized Dynamic Posturography in Patients with Diabetic Peripheral Neuropathy and Visual Feedback-Based Balance Training Effects. Maced J Med Sci. 2014 June 15;7(2):271-276.
13. Winter DA, Patla AE, Frank JS. Assessment of balance control in humans. Med Prog Technol. 1990;16:31–51.

14. Herdman SJ. Vestibular Rehabilitation. 2nd ed. Philadelphia, PA: F.A.Davis Co; 2000.
15. Shumway-Cook A, Woollacott M. Motor Control Theory and Applications, Williams and Wilkins Baltimore, 1995: 323-324.
16. AV Verleih. Dynamic Gait Index.AVI. Available from: http://www.youtube.com/watch?V=jtnjfsvnpsy[last accessed 25/05/13]
17. Lin JH, Hsu MJ, Hsu HW, Wu HC, Hsieh CL. Psychometric Comparisons of 3 Functional Ambulation Measures for Patients With Stroke. Stroke. 2010 Jul 29.
18. Jonsdottir J, Cattaneo D. Reliability and validity of the dynamic gait index in persons with chronic stroke. Arch Phys Med Rehabil. 2007 Nov;88(11):1410-5.
19. Wrisley D, Walker M, Echternach J, Strasnick B. Reliability of the Dynamic Gait Index in people with vestibular disorders. Arch Phys Med Rehabil. 2003;84:1528–1533
20. Mcconvey J, Bennett S. Reliability of the Dynamic Gait Index in individuals with multiple sclerosis. Arch Phys Med Rehabil. 2005;86:130–133.
21. Herman T, Inbar-Borovsky N, Brozgol M, Giladi N, Hausdorff JM. The Dynamic Gait Index in healthy older adults: the role of stair climbing, fear of falling and gender. Gait Posture. 2009 Feb;29(2):237-41. Epub 2008 Oct 8.
22. Lin, J. H., Hsu, M. J., et al. (2010). Psychometric comparisons of 3 functional ambulation measures for patients with stroke. Stroke 41(9): 2021-2025
23. Cattaneo, D., Regola, A, et al. (2006). Validity of six balance disorders scales in persons with multiple sclerosis. Disability and Rehabilitation 28(12): 789-795
24. Marchetti GF, Whitney SL, Blatt PJ, Morris LO, Vance JM. Temporal and spatial characteristics of gait during performance of the Dynamic Gait Index in people with and people without balance or vestibular disorders. Physical Therapy, 2008 May;88(5):640-51.
25. Kim JW, Eom GM, Kim CS, et al.: Sex differences in the postural sway characteristics of young and elderly subjects during quiet natural standing. Geriatr Gerontol Int, 2010, 10: 191–198.
26. Lajoie Y, Gallagher SP: Predicting falls within the elderly community: comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch Gerontol Geriatr, 2004, 38: 11–26.
27. Cho KH, Lee KJ, Song CH: Virtual-reality balance training with a video game system improves dynamic balance in chronic stroke patients. Tohoku J Exp Med, 2012, 228: 69–74.
28. Ha H , Cho K Lee W:Reliability of the good balance system for postural sway measurement in post stroke patients .J Phys Ther Scii , 2014,26:121-124.
29. Jeba Chitra1, Suchit S. Shetty2 Screening of proprioception of ankle joint in patients with diabetic neuropathy- an observational study. International Journal of Therapies and Rehabilitation Research 2015; 4 (4): 104-107
30. Yang Z, Chen R, Zhang Y, Huang Y, Hong T, Sun F, Ji L, Zhan s .scoring system to screen for diabetic peripheral neuropathy .The Cochrane Collaboration. Published by JohnWiley & Sons, Ltd.2014
31. S Ashok,M Ramu,R Deepa,V Mohan: Prevalence of neuropathy in type 2 diabetic patients attending a diabetis center in south india. JAPI,vol.50,April 2002.
32. Xiaogang Hu et al. Assessing altered motor unit recruitment patterns in paretic muscles of stroke survivors using surface electromyography. J Neural Eng. 2015 December ; 12(6): 066001.
33. Flavio T. P. Oliveira and David Goodman. Conscious and effortful or effortless and automatic: a practice performance paradox in motor learning. Perceptual and motor Skills, 2004, 99, 315-324.
34. Black A, Wood J. Vision and falls. Clinical and Experimental Optometry. 2005 Jul 1;88(4):212-22.
35. Paulus WM, Straube A, Brandt TH. Visual stabilization of posture: physiological stimulus characteristics and clinical aspects. Brain. 1984 Dec 1;107(4):1143-63.
36. Snehil Dixit, Arun Maiya, B.A. Shasthry, Senthil Kumaran D. & Vasudeva Guddattu: Postural sway in diabetic peripheral neuropathy among Indian elderly.Indian J Med Res 142 Dec 2015.
37. Cavanagh PR, Derr JA, Ulbrecht JS, Maser RE, Orchard TJ. Problems with gait and posture in neuropathic patients with insulin-dependent diabetes mellitus. Diab Med 1992; 9: 469-74.

38. Niam S, Cheung W, Sullivan PE, et al.: Balance and physical impairments after stroke. Arch Phys Med Rehabil, 1999, 80: 1227–1233.
39. Winstein CJ, Gardner ER, McNeal DR, et al.: Standing balance training effect on balance and locomotion in hemiparetic adults. Arch Phys Med Rehabil, 1989, 70: 755–762.
40. Gasser HS. The classification of nerve fibers. Ohio J Sci 1941:41;145-59.
41. Vinik AI, Mehrabyan A. Diabetic neuropathies. Med Clin North Am 2004;88:947-99.

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