VER
Vascular & Endovascular Review

Correlation Between Texture Discrimination Ability In Sole Of Foot & Dynamic Balance In Patients With Stroke: A Cross-Sectional Study

Thrishala Noronha[1], Ajay Kumar[2*], Vijaya Kumar K[3], AP Vishal Deviprasad[4], M. Premkumar[5]

[1]Dean cum Associate Professor, PhD Scholar, Institute of Physiotherapy, Srinivas University, Srinivas University, City Campus, Pandeshwar, Mangalore, Karnataka, Pincode-575001, ORCID ID: 0000-0002-6999-6198.
Email ID : thrish22.cp@srinivasuniversity.edu.in
[2]*Professor, Institute of Physiotherapy, Srinivas University, Mangalore, India. ORCID ID: 0000-0002-0633-1471;
Email ID : drajay@srinivasuniversity.edu.in.
[3]Additional Professor, Department of Physiotherapy, Kasturba Medical college, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India. ORCID ID: 0000-0003-4937-7442,
Email ID: vijay.kk@manipal.edu.
[4]Consultant Physiotherapist, Sai Physiotherapy Rehabilitation Centre, Baripada, Odisha, India- 757001.
Email ID: dev.vishalprasad22@gmail.com.
[5]M. Premkumar, MPT (Cardiopulmonary), PhD, Institute of Physiotherapy, Srinivas University, Associate professor, Srinivas University, City Campus, Pandeshwar, Mangalore, Karnataka, Pin code- 575001, India, 9442508754, ORCID ID: 0000-0001-6182-2014.
Email ID : 80pk2009@gmail.com, premkumar.ipt@srinivasuniversity.edu.in

Corresponding Author:
Ajay Kumar,
Professor, Institute of Physiotherapy, Srinivas University, Mangalore, India.
Email ID: drajay@srinivasuniversity.edu.in , ORCID ID: 0000-0002-0633-1471;

ABSTRACT

Background: The prevalence of somatosensory issues are 65% among stroke patients. In conservative sensory examination, texture discrimination is mostly missed. Some studies have also revealed that despite having intact sensory system there are some patients who still have balance issues. Aim of this study: To find the correlation between Texture Discrimination ability and Dynamic balance in stroke patients. Methodology: 52 patients were assessed for texture discrimination ability (TDA) was using a texture discrimination ability kit and dynamic balance using the Dynamic Gait Index (DGI). Results: There was a strong significant positive correlation suggesting that, more the texture discrimination ability in the sole of the foot, better the dynamic balance in the stroke patients (r=0.756, p=0.000). Conclusion: Foot TDA showed a correlation with dynamic balance in stroke, which indicated that sensory perception originating from cutaneous receptors of the sole of the foot plays an important role in regulating balance

Keywords - Texture discrimination ability, dynamic balance, stroke, correlation, foot sensation..

How to Cite: Thrishala Noronha, Ajay Kumar, Vijaya Kumar K, AP Vishal Deviprasad, M. Premkumar, (20yy) Correlation Between Texture Discrimination Ability In Sole Of Foot & Dynamic Balance In Patients With Stroke: A Cross-Sectional Study, Vascular and Endovascular Review, Vol.8, No.13s, 162-166.

INTRODUCTION

A stroke is a clinical condition characterized by the swift development of observable signs indicating focal (or global) disruptions in cerebral function, enduring for over 24 hours or resulting in death, and without any evident cause except of vascular origin, as defined by the World Health Organization (WHO).[1] This condition may manifest with the abrupt appearance of various neurological symptoms such as limb weakness or numbness, speech issues, visual impairment, balance disturbance, and sensory deficits.[2]

Following a stroke, somatosensory loss is frequently observed and has been documented in as many as 65% of stroke patients.[3] The compromised sensation in the body represents a substantial impairment, impacting the exploration of one's surroundings, safety, and the process of motor recovery.The somatosensory loss following a stroke may range from loss of basic tactile sensations like light touch, pressure, and localization to more discriminatory senses such as temperature discrimination, proprioception, and texture discrimination among which notably, around 50% of patients experience a loss in texture discrimination.[4,5] It's worth noting that the potential oversight of discriminative sensory loss in conventional sensory testing was underscored in a study conducted by Kim and Choi-Kwon, focusing on patients in the acute phase of a stroke.[6]

..

The foot serves as the sole connection between the individual and the ground while standing. This specialized and dynamic unit plays a crucial role in detecting and adapting to the relative motion between the ground and the body, as well as changes in the properties of the support surface. The plantar aspect of the foot is proposed to function as a sensory "dynamometric map" for human balance control. Altered tactile sensory inputs to the sole of the foot, whether enhanced or reduced, have a direct impact on both standing postural control and the kinematics of walking.[7,8] Furthermore, studies have demonstrated that augmenting somatosensory input through the use of textured insoles or engaging in barefoot walking among older adults can lead to improved postural stability. Additionally, these interventions were found to reduce prefrontal activity during gait, indicating a diminished requirement for controlled processing while walking.[9]

Studies have investigated foot sensation and its relationship with standing balance which indicated that sensory feedback originating from cutaneous receptors of the foot sole plays important role in regulating balance.[10] However, studies have also shown loss of balance despite of intact sensory detection and vestibular system, suggesting discriminative sensory loss[6] and no studies could be retrieved correlating the two. Hence the aim of this study was to find the relation between texture discrimination in the sole of foot and dynamic balance in patients with stroke.

METHODOLOGY:

This cross-sectional study was conducted on stroke patients who were attending physiotherapy sessions at neuro rehabilitation outpatient department (OPD) between October 2022 and September 2023. Sample size was calculated by G-power 3.1 version test and it was 52. A total of 52 patients (10 females, 42 males) who fulfilled the selection criteria out of 78 patients were included. The inclusion criteria was as follows: first ever stroke, age between 40-65 years, intact sensations in the sole of the feet, ambulating with or without assistance for at least 10 meters, MMSE scale >24. Exclusion criteria included any orthopaedic or neurological disease that may affect walking, history of psychiatric disorders, patients with visual or vestibular defects, unilateral neglect, aphasias and apraxia.

After ethical approval was taken from the Institutional Review Board of Srinivas University (Reg.No: 07/PGPT/EC/2022), stroke patients coming to the OPD were screened according to the selection criteria. Subjects who were included were explainedabout the purpose and the procedures of the study and written informed consent wereobtained from all participants. Following this, they were evaluated for texture discrimination ability using the TDA kit on the sole of the foot of the affected side limb and dynamic balance using the Dynamic Gait Index (DGI).

PROCEDURE:

1. Texture Discrimination Ability[7]:

The TDA test kit included four texture groups, all relevant to walking and foot sensation and function: 1. artificial turf; 2. gravel/sand; 3. mat; and 4. floor paper. Each texture group included3 materials (a total of 12 materials). The materials of the artificial turf, mat and floor paper texture groups was glued to 15×33cm wooden pallets. The gravel/sand materials were contained in a double layer of 40 denier stocking material. Thus, a test kit included 12 different materials and 16 items, as one material from each texture group is used twice.

The discrimination test involved 12 sub tests, which was presented in a randomized order. The patient was requested to identify the different materials in each subtest. Sets differed in their level of difficulty. Six of the sets included materials from the same texture group (within group) (e.g., straw mat and fine anti slip mat with the latter appearing twice), while six subsets includedmaterials from two different texture groups (between group) (e.g., sand and square striped paper, with the latter appearing twice).

Figure 1: Administration of TDA kit

The lower extremity texture discrimination test was conducted while the patient seated blindfolded and barefooted. Both a verbal explanation and a visual demonstration to the upper extremity were provided to ensure that the instructions were understood. Three material items (in a random order) were placed in front of the patient's feet. The examiner led the foot to the material and rubbed the plantar aspect of the forefoot on the material being tested. The patients were asked to discriminate one outstanding texture among three textures in each set. The stimulus was administrated passively in order to allow testing in patients with paresis/plegia (see Figure 1). A second rubbing was given when needed, to minimize failure due to attention dysfunction. Correct identification of outstanding texture in each test was given a score of one, for a maximum of 12 points.

2. Dynamic Balance:

Dynamic Gait Index (DGI) was used to assess the dynamic balance in these patients. DGI is a reliable and valid tool to measure dynamic balance. It was primarily developed to assess a subject's ability to modify gait in response to changing task demands. The eight abilities assessed were: steady-state walking, walking while changing gait speed, walking while moving the head vertically and horizontally, walking while stepping over and around an obstacle, pivoting during walking, and stair climbing.

The items of the DGI were graded on a four point scale from 'normal performance' (3) to 'severely impaired' (0), yielding a maximum score of 24 points. The examiner's rating was based on the subject's ability to maintain a normal gait pattern and pace, without deviating or stumbling. It took approximately 10 minutes or less to carry out the DGI. A score lower than 19 points has been associated with impairment of gait and fall risk.

DATA ANALYSIS:

The data were collected and all the variables and its characteristics were described using tables and graphs. All data were coded and entered in to the software IBM SPSS version 16.0 in windows.

Descriptive analysis was done by finding mean and standard deviation of all the samples. The data were then subjected to test of normality. In interferential statistics to find out the correlation between TDA & Dynamic Balance Pearson correlation coefficient was used as the data were following normal distribution.

RESULTS:

The present study was conducted on 53 stroke individuals among them 43 were males & 10 were females.

Table 1: Descriptive statistics for age and gender, (N= 52)

Demographic Variables	Mean±SD
Age	51.3846+4.61521
Gender	42+10
Side of Hemiparesis	35+17
MMSE	25.5385+1.36427
DGI	14.6538+4.14863
Affected TDA	5.9615+1.98979
Non-Affected TDA	7.8462+1.67314

Table 1 presented the mean±SD of demographic variables of Age, Gender, Side of Hemiparesis, MMSE score, Dynamic Gait Index, Affected side and unaffected side Texture Discrimination Ability scores.

Table 2: Correlation between TDA & DGI.

Side	Correlation coefficient	p Value
Affected side with DGI	0.756	**0.001*** **
Non-affected side with DGI	0.526	**0.001*** **

Table 2 presented the correlation between affected and non-affected TDA with DGI values. The results showed statistically significant high positive correlation between the TDA & Dynamic balance (r=0.756,p=<0.000) when compared to non-affected side TDA with DGI with p≤0.001 and Confidence Interval (CI) of 99%..

DISCUSSION:

The current study was done to find out the correlation between the Texture Discrimination Ability (TDA) on the sole of the foot with Dynamic Balance. According to our best knowledge this is the first study done to find the correlation between Texture Discrimination Ability (TDA) and Dynamic Balance.

A total of 96 individuals were screened to find the eligibility criteria out of which 52 individuals were included according the inclusion criteria. The mean TDA & DGI score was 5.96 & 14.65 respectively. So on finding the correlation between TDA & DGI the present study showed a strong significant positive correlation.

The current study is in line with some of the previously published literatures.[11-13] A study done by F. Qui et al in the year 2011 have investigated the effects of textured insole surfaces on postural sway in 10 younger & 10 older participants performing standing balance test on a force plate under 3 different surface conditions (1) bare foot; (2) with hard; (3) soft textured insole surfaces.[15] Results showed lesser postural sway in textured insoles in older population suggesting textured insoles can reduce postural imbalance.

Perception of the stimuli on the plantar sole is influencing in maintaining posture & balance during static & dynamic balance, vital for sensing and responding to relative ground/body motion and changes in support surface properties.

Previous studies have shown that, perceptual learning exercises for hardness discrimination on the soles stroke patients led to a significant decrease in postural sway, which is in line with the findings of present study.[13-15] Foot is also suggested to be a sensory 'dynamometric map' for human balance control where enhanced or reduced tactile sensory inputs to the sole of the foot impact standing postural control & gait kinematics. Hence, TDA assessment should be included for better understanding about the dynamic balance of the people following stroke.

LIMITATIONS:

There are a few limitations of the study which needs to be addressed.

The actual sample size calculated to be studied was 70. But the number of samples collected and assessed was 52 which might have given a different result from the current one.

The texture discrimination ability tool kit which was used in this study was customized so that the subjects' foot sole to be tested could be given a lot of different textures. Although the validity of the kit had been proven but the procedure through which the subject had to go through is attention seeking & time consuming.

Future implications:

Future studies are recommended to find the effectiveness of texture discrimination training in improving dynamic balance in people with stroke.

CONCLUSION:

Texture discrimination ability in the sole of foot affects the dynamic balance in patients with stroke. Present study concluded that foot TDA & its relationship with balance, which indicated that sensory perception originating from cutaneous receptors of the foot sole plays important role in regulating balance.

Ethical committee approval:

Reg.No: 07/PGPT/EC/2022.

Financial support and sponsorship:

Nil.

Conflicts of interest:

There are no conflicts of interest.

Submission statement:

We represent that this submission is original work and is not under consideration for publication with any other journal.

CRediT authorship contribution statement

Author 1: Conceptualized the study, involved in formal analysis, designed methodology, wrote the original draft, and

administered the project.

Author 2: Conceptualized the study; investigated the study; wrote the original draft; wrote, reviewed, and edited the manuscript; and supervised the project.

Author 3: Involved in formal analysis, collected data, designed methodology, and investigated the data.

Author 4: Conceptualized the study; edited the manuscript; and supervised the project.

Author 5: Involved in formal analysis, collected data, and investigated the data.

All authors read and approved the final version of the manuscript.

REFERENCES

[1] Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A et al. An Updated Definition of Stroke for the 21st Century. Am Heart J 2013, July;44(7):2064-89.

[2] National Collaborating Centre for Chronic Conditions. Stroke: national clinical guideline for diagnosis and initial management of acute stroke and transient ischemic attack (TIA). London: Royal College of Physicians, 2008.

[3] Charlotte E, Peter W, Derick T. Somatosensory recovery: A longitudinal study of the first 6 months after unilateral stroke. DisabilRehabil 2007;29(4):293-9.

[4] Carey M, Oke E, Matyas A. Impaired Touch Discrimination After Stroke: A Quantitative Test. Neurorehabil Neural Repair 1997;11(4):219-32.

[5] Carey ML. Tactile and proprioceptive discrimination loss after stroke: Training effects and quantitative measurement[PhD thesis]. Australia: La Trobe University;1993.

[6] Kim JS, Choi-Kwon S. Discriminative sensory dysfunction after unilateral stroke. Stroke 1996;27(4):677-82.

[7] Ofeka H, Alperinb M, Knollb T, Livneb D, Laufera Y. Assessment of texture discrimination ability at the sole of the foot in subjects with chronic stroke compared with young and elderly subjects with no neurological deficits: a reliability and validity study. DisabilRehabil 2017;40(16):1960-6.

[8] Gorst T, Freeman J, Yarrow K, Marsden J. Assessing plantar sensation in the foot using the Foot Roughness Discrimination Test (FoRDT™): a reliability and validity study in stroke. PM&R2019;doi:10.1002/pmrj.12085

[9] Clark DJ, Christou EA, Ring SA, Williamson JB, Doty L. Enhanced somatosensory feedback reduces prefrontal cortical activity during walking in older adults. GerontolGeriatr Med 2014;69(11):1422-8.

[10] Citaker S, Gunduz AZ, Guclu MB, Nazliel B, Irkec C, Kaya D. Relationship between foot sensation and standing balance in patients with multiple sclerosis. Gait Posture 2011;34(2):275-8.

[11] Sullivan JE, Hedman LD. Sensory Dysfunction Following Stroke: Incidence, Significance, Examination, and Intervention. Top Stroke Rehabil 2015;15(3):200-17.

[12] Connell LA, Lincoln LB, Radford KA. Somatosensory impairment after stroke: frequency of different deficits and their recovery. Clin Rehabil 2008;22(8):758-67.

[13] Jonsdottir J, Cattaneo D. Reliability and Validity of Dynamic Gait Index in persons with chronic stroke. Arch Phys Med Rehabil 2007;88(11):1410.

[14] Morioka S, Yagi F. Effects of perceptual learning exercises on standing balance using a hardness discrimination task in hemiplegic patients following stroke: a randomized controlled pilot trial. Clin Rehabil 2003;17(6):600-7.

[15] Qui F, cole MH, Davids KW, Henning EM, Silburn PA, Netscher H, Kerr Gk. Gait Posture. 2012; 35: 630-5