EFFECT OF DIFFERENT MATERIALS ON FOAM PADS USED IN MODIFIED CLINICAL TEST OF SENSORY INTERACTION ON BALANCE (MCTSIB) FOR BALANCE IN INDIVIDUALS WITH VESTIBULAR DYSFUNCTION.

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ABSTRACT

Introduction Vestibular dysfunction affects a significant number of individuals, leading to dizziness and balance impairment. Population studies indicate that approximately 1.6% of individuals experience peripheral vestibular disorders. The Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) is widely used to assess a patient's dependence on sensory inputs for balance and to customize rehabilitation strategies accordingly.

Methodology A total of 66 participants were recruited and divided into two groups of 33 each: Group A (foam mat) and Group B (foam mat with an additional sensory mat). Each participant was required to stand on the respective surfaces for 30 seconds across three trials, and an average of these trials was recorded as the final pre- and post-data.

Results The study compared balance performance between Group A and Group B under different conditions. While both groups exhibited similar performance with eyes open on foam, Group B showed significantly improved balance with eyes closed, benefiting from the additional sensory input. **Conclusion** Findings suggest that adding sensory cues such as an artificial grass mat in Group B helped mitigate the lack of visual information, thereby enhancing balance control. **Keywords**: mCTSIB, foam mat, artificial grass mat, vestibular dysfunction, balance.

INTRODUCTION

Vestibular dysfunction, affecting 30–60-year-olds, leads to dizziness and instability. Up to 25% of adults experience dizziness, increasing with age.[1] Poor balance due to vestibular dysfunction affects 35% of adults, rising to 50% in those over 60.[2] The vestibular system integrates sensory input for postural control and spatial orientation.[3]

The semicircular canals detect angular motion, providing neural input to the CNS for balance and mobility. Disorders affecting these canals, such as BPPV, Meniere's disease, and vestibular neuritis, disrupt balance.[3][4] Recent studies reveal a broader vestibular network influencing neurocognitive functions.[5][6]

Vestibular dysfunction impairs daily activities and mental well-being, causing dizziness, vertigo, and anxiety.[6][2][7] Treatment includes vestibular rehabilitation, medication, and lifestyle modifications.[8]

Common vestibular disorders include BPPV (displaced calcium crystals),[9] Meniere's disease (vertigo, tinnitus, hearing loss),[10] vestibular neuritis (nerve inflammation),[11] and labyrinthitis (inner ear inflammation).[12] Diagnosis relies on clinical history, balance assessments, and tests like CTSIB and Dix-Hallpike maneuver.[14][15]

Aging-related vestibular dysfunction includes hair cell degeneration, reduced blood flow, and vestibular nerve fiber loss, affecting balance.[13] Middle-aged individuals are also at risk due to trauma and environmental factors.[17][18]

Clinical Test of Sensory Interaction and Balance (CTSIB) CTSIB assesses sensory integration in balance by testing firm and foam surfaces under different visual conditions.[15] Difficulty balancing with eyes closed suggests vestibular reliance. CTSIB informs rehabilitation strategies like vestibular therapy to enhance postural control.[16]

Modified Clinical Test for Sensory Interaction and Balance (mCTSIB) in the Indian Population Balance control relies on sensory integration.[19]mCTSIB, a modified CTSIB, assesses sensory reliance through postural sway measurements.[20][25] Limited research exists on mCTSIB in Indian populations,[20][26] necessitating normative data collection.[19] Cultural and environmental factors may influence balance assessments.[27]

This study investigates mCTSIB performance in Indian adults, exploring sensory integration strategies. Tailoring assessments to specific demographics enhances accuracy and rehabilitation effectiveness.[28][27]

Methods Study Design: Randomized Clinical Trial Participants: 66 individuals (33 per group) aged 30–60 with vestibular dysfunction

METHODOLOGY

This study received ethical clearance, and informed consent was obtained from participants. A total of 66 participants were randomly assigned to two groups:

Group A: Foam mat

Group B: Foam mat with an additional sensory mat

Inclusion Criteria: Participants aged 30-60 years of both genders, diagnosed with vestibular dysfunction, able to walk independently**, exclusion Criteria**, lower limb fractures or surgerie, use of walking aids or foot orthoses, severe balance impairment (unable to stand for 2-3 minutes)

PROCEDURE:

Participants were randomly assigned to Group A (foam mat) or Group B (foam mat + artificial grass mat). Each participant completed four balance conditions of the mCTSIB:

Eyes open on a firm surface

Eyes closed on a firm surface

Eyes open on foam

Eyes closed on foam

Each condition was held for 30 seconds, with postural sway recorded using a force platform. Group B performed the test with an artificial grass overlay on the foam mat to assess the impact of additional sensory feedback. Data were analyzed using statistical methods to determine significant differences between groups.

RESULT:-

Age Distribution

Table 1: Age Distribution of group A

Group A (mCTSIB)		
Age Group	No. of Patients	Percentage

31 - 40	4	12.12%
41 - 50	10	30.30%
51 - 60	19	57.58%
Total	33	100.00%

In Table.1, In Group A, using the modified Clinical Test of Sensory Interaction on Balance (mCTSIB), 12.12% of patients were aged 31-40 (4 patients), 30.30% were aged 41-50 (10 patients), and 57.58% were aged 51-60 (19 patients) out of a total of 33 patients.

Table 2: Age Distribution of group B

Group B (mCTSIB + s)		
Age Group	No of Patients	Percentage
31 - 40	6	18.18%
41 - 50	12	36.36%
51 - 60	15	45.45%
Total	33	100.00%

In table 2, Group B, which utilized both mCTSIB and an additional sensory component (mCTSIB + s), had 18.18% aged 31-40 (6 patients), 36.36% aged 41-50 (12 patients), and 45.45% aged 51-60 (15 patients), also totalling 33 patients. These distributions provide similar demographic profiles between the groups, facilitating comparative analyses in future research or clinical studies. The statistical analysis of Group A using the modified Clinical Test of Sensory Interaction and Balance (mCTSIB) reveals valuable insights into balance performance under various sensory conditions.

Table 3: Statistical Analysis of Group A.

Group A (mCTSIB)				
	EO FS	EO FoS	EC FS	EC FoS
Mean	24.42	24.00	14.91	15.82

S.D.	4.37	4.80	4.88	4.95
P-value	0.283		0.093	

In Table. 3, Group A (mCTSIB) indicate balance performance across different sensory conditions. Participants were assessed under four conditions: EO FS with an average score of 24.42 (SD = 4.37), EO FoS with an average score of 24.00 (SD = 4.80), EC FS with an average score of 14.91 (SD = 4.88), and EC FoS with an average score of 15.82 (SD = 4.95). The p-value of 0.283 for EO FS vs. EO FoS indicates no statistically significant difference in performance between standing on firm versus foam surfaces with eyes open. Similarly, the p-value of 0.093 for EC FS vs. EC FoS suggests that the difference in performance between standing on firm versus foam surfaces with eyes closed approaches no statistical significance. These findings provide insights into how sensory conditions affect balance control in individuals assessed for mild cognitive impairment and vestibular dysfunction using the mCTSIB protocol

Table 4: Statistical Analysis of Group B.

Group B (mCTSIB + S)				
	EO FS	EO F + S	EC FS	EC F + S
Mean	22.24	25.27	14.03	19.85
S.D.	4.50	4.71	5.54	4.71
P-value	0.00014		1.18E-09	

In the above Table no.4, Group B demonstrated significantly better balance control compared to Group A in all tested conditions. On a firm surface with eyes open, Group B achieved a mean stability score of 25.27 ± 4.71, outperforming Group A's 22.24 ± 4.50 (p = 0.00014). Even in challenging conditions such as eyes closed on firm surface, Group B maintained superior balance with a mean score of 19.85 ± 4.71, whereas Group A scored 14.03 ± 5.54 (p = 1.18E-09). These results indicate that the addition of sensory inputs (S) significantly enhances balance performance across different sensory conditions, highlighting the efficacy of the intervention in improving balance control in Group B.

Table 5 : Statistical Analysis between the Group A and B.

Group A (mCTSIB) & Group B (mCTSIB + s)				
	EO FoS	EO F + S	EC FoS	EC F + S
Mean	24.00	25.27	15.82	19.85
S.D.	4.80	4.71	4.95	4.71
P-value	0.141		0.0006	

In the above Table. 5, Comparing balance performance between Group A (mCTSIB) and Group B (mCTSIB + S), both experienced more challenging foam surface conditions, which reveals a potential benefit from the additional sensory intervention provided to Group B.

While both groups showed similar performance with eyes open on foam, Group B demonstrated significantly better balance with eyes closed on foam and added sensory input (EC F + S, mean = 19.85) compared to Group A with eyes closed on foam alone (EC FoS, mean = 15.82), p = 0.0006.

DISCUSSION

Findings align with research on sensory feedback improving postural control. Artificial grass mats enhance proprioception, reducing visual dependency and improving stability. Boonsinsukh et al.[29] found that different foam pad types influence balance performance, aligning with our findings that additional sensory input improves stability. Similarly, Giray et al.[30] emphasized the role of sensory integration in vestibular rehabilitation, supporting our conclusion that sensory-enhanced environments aid postural control.

The results indicate that the additional sensory input may enhance afferent feedback, leading to better postural control and compensation strategies. These findings support the concept of sensory integration training as an essential part of vestibular rehabilitation. The significant improvement seen in Group B suggests that incorporating additional sensory stimulation, such as textured surfaces, could be an effective intervention for individuals struggling with balance deficits. Prior studies, including those by Chaikeeree et al.,[31] have indicated that multisensory training enhances neuroplasticity and facilitates better postural adaptations.

Danial G et al.[32] concluded that percentile ranking data from the BTrackSmCTSIB protocol serves as a valuable clinical tool, enabling accurate comparisons against healthy adults. This facilitates early identification of sensory-related balance deficits, allowing for targeted interventions and improved rehabilitation outcomes. By leveraging such data, clinicians can develop more personalized balance training programs, ultimately enhancing patient quality of life.

Furthermore, these results highlight the importance of personalized rehabilitation strategies. Patients with vestibular dysfunction exhibit varied responses to sensory stimuli; therefore, interventions must be tailored to their specific deficits. The study also opens avenues for further exploration into how different sensory surfaces and training protocols can be optimized for maximum benefit.

Future research should explore different materials for sensory input, investigate long-term adaptation effects, and evaluate the application of similar interventions in clinical rehabilitation programs. Expanding the sample size and including diverse populations will further validate these findings and establish standardized guidelines for sensory integration training in vestibular rehabilitation.

CONCLUSION

The study demonstrates that artificial grass mats significantly enhance balance in individuals with vestibular dysfunction when incorporated into mCTSIB. The additional sensory input improved postural stability, particularly in challenging conditions such as eyes closed on foam. This suggests that modifying sensory environments can be a practical and effective intervention for those experiencing balance deficits.

These findings contribute to the growing evidence that sensory feedback plays a crucial role in postural control. The results highlight the need for integrating innovative materials into clinical assessments and rehabilitation programs. Future studies should explore the effectiveness of different textured surfaces, long-term adaptation, and patient-specific rehabilitation approaches.

The incorporation of sensory-rich environments into rehabilitation programs can lead to better patient outcomes, reduced fall risk, and improved quality of life. By optimizing sensory integration strategies, clinicians can develop targeted interventions that cater to individual patient needs, ultimately enhancing functional independence in individuals with vestibular dysfunction.

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