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Immediate Effect of Gluteus Medius Kinesio-Taping on Plantar Pressure Distribution and Balance Among Healthy Individuals

DEEPA SHEKHAR†[1], HEMANT K. KALYAN‡[2], PREM VENKATESAN‡[1], NITHIN PRAKASH‡[1], and KARVANNAN HARIKESAVAN‡[1]

[1]Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India; [2]Department of Orthopedics and Sports Medicine, Manipal Hospitals Bangalore, Old Airport Road, Bangalore

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 16(1): 587-598, 2023. Gluteus medius eccentrically regulates hip adduction and internal rotation in unilateral postures against gravity. Any weakness to Gluteus medius can lead to poor posture, impaired balance and altered plantar pressure. There is a scarcity of literature to find the immediate effect of gluteus medius kinesio-taping on plantar pressure distribution and balance among healthy individuals. A Randomized cross-over trial was conducted in outpatient physiotherapy department of Manipal Hospitals Bangalore, on 28 healthy individuals from March 2021 to April 2022. The taping was done on the dominant leg of the subjects, with no tape, sham tape and kinesio tape with a least 30-minute time difference. Mean maximum plantar pressure, dynamic balance and squat score was analyzed under three tape conditions. The mean maximum plantar pressure was assessed using Foot Work Pro, dynamic and static balance was assessed using Biodex Balance SD and squat score using Kinovea software. Friedman's test was used to analyze the mean difference between the groups. There was a significant difference in the static overall stability index (p = 0.001), static antero-posterior stability index (p = 0.001), static mediolateral stability index (p = 0.047), overall static sway (p = 0.008) dynamic antero-posterior stability index (p < 0.001), dynamic overall stability index (p = 0.013), dynamic mediolateral stability index (p < 0.001), overall dynamic sway (p < 0.001) and deep squat score (p = 0.009). The results of the study suggest that kinesio-taping is an effective method on improving the dynamic balance and deep squat quality in normal healthy individuals.

KEY WORDS: Lower extremity, athletic tape, postural balance, foot, posture, young adult, pressure

INTRODUCTION

The hip abductor muscle group gluteus medius, gluteus minimus, and tensor fascia lata play a crucial role in stabilizing the pelvis during locomotion and single-leg stance (14). The Gluteus medius is a main hip abductor muscle that eccentrically regulates hip adduction and internal rotation while providing pelvic support in a unilateral posture against gravity (24). Being the

principal hip abductor, it stabilizes the pelvis' frontal plane during walking and performing other functional tasks (34). It also promotes hip stability by limiting internal rotation during closed kinematic chain movements like squats and lunges. A poor hip abduction occurs when the gluteus medius is dysfunctional, which results in poor posture (20, 28).

Additionally, the hip muscles regulate the femur's motion, which in turn impacts how the lower leg and foot are positioned (16). As the foot contacts the ground, this proximal to distal control relationship has an effect on the ankle complex. If the hip muscles are not under control, this could lead to inappropriate foot placement and an increased risk of ankle injury (38). There is growing evidence to support the idea that in those with chronic ankle instability, hip muscle changes might lead to kinetic chain dysfunction during functional training and dynamic balance. Therefore, it seems that reduced function and proximal mal-adaptations are related (12). Similarly, sagittal ankle kinematics and shank muscle activity during single-leg landings were reportedly affected by hip-abductor fatigue (15). This can lead to altered plantar pressures during locomotor activities and this pressure field between the foot and the support surface during routine locomotion is known as foot plantar pressure (18).

Among the various methods that facilitate muscle activation Kinesio Taping is a more clinically used practice. It is advised for enhancing force output and muscle contraction (36). Kinesio taping is a sort of tape that aids in rehabilitation and is advised for use by athletes and patients as a supporting technique (26). One strategy that is frequently used to treat specific clinical disorders, such as shoulder impingement and patellofemoral syndrome, is taping. Although there is mixed evidence regarding its efficacy, taping is nevertheless a popular therapeutic technique (37). A recent evidence states that the application of kinesio tape to the gluteus medius improve the hip abductor strength and correct extreme dynamic knee valgus (36). Low dye tape was described by Dye in 1939. It is a common tape used for the corrections in the lower extremities. Low dye tape has been used effectively in the treatment of tibialis posterior dysfunction, patellofemoral syndrome, plantar fasciitis, and excessive pronation of the foot (35, 39). Also, the assessment of plantar pressure while running and walking showed that augmented low dye taping applied to the ankle joint caused a considerable degree of lateral shifting. The study also highlighted the value of augmented low dye taping by examining the change in muscle activation patterns and plantar pressure during treadmill running (23).

Gluteus medius is prone to weakening and inhibition, which has been linked to a number of injuries, including chronic pain, and severely impacts sports performance (7). Dysfunction to gluteus medius can occur due to postural habits like, single leg standing and lying with the top leg flexed and adducted over the bottom leg (34). This can lead to weakness or dysfunction and resulting in balance issues (7). The reason for this weakness can be attributed to the adaptive lengthening of the Gluteus medius muscle (34). Gluteus medius being a strong predictor in the kinematics of the lower limb, any dysfunction can lead to altered walking and postural impairments. This reduced function due to proximal malfunctions can lead to the altered plantar pressure also.

Though studies have been done on investigating the effectiveness of kinesiotaping in correcting knee valgus (36), improving knee function and reducing pain in patellofemoral pain syndrome (1), and improving muscle fatigue and dynamic balance in elders (2, 33, 43) , there is a scarcity of literature to find the immediate effect of gluteus medius kinesio-taping on plantar pressure distribution and balance among healthy individuals. Also, there has been studies that proved the efficacy of exercise in the activation of gluteus muscle strengthening, but the effect of taping has not been studied yet. If taping found to be effective in muscle facilitation, it can be used as an adjunct in sports and geriatric population. Hence this study aims at finding the immediate effect of gluteus medius kinesio-taping on plantar pressure distribution and balance among healthy individuals.

METHODS

Participants

This study was conducted in the outpatient physiotherapy department Manipal Hospitals Bangalore. 28 healthy individuals of age 18 to 40 years who are free from pain, disease, or deformity of the spine and lower extremities were included in the study. Subjects with a history of injuries related to hip, knee, and foot, surgeries of the spine, pelvis, or extremities, Type 2 diabetes or neuropathy, vestibular, neurological, optical, and/or auditory impairments, and adhesive allergies were excluded. The subjects were unfamiliar with the effects of Kinesio taping.

The study was a randomized cross-over trial conducted confirming to the CONSORT guidelines conducted from March 2021 to April 2022. Ethical approval was obtained from the Ethical Committee, Manipal Hospitals, Bangalore and the study protocol was registered with CTRI India with Registration Number. CTRI/2021/03/032432**.** Informed consent from the subjects was obtained before participation. The sample size was estimated using the formula $N = 2(Z1\text{-}\alpha/2 + Z1\text{-}\beta)^2 / \Phi d^2$ with a Φd^2 value of 0.75 (20) and $Z1\text{-}\alpha/2 = 1.96$ at 5% (level of significance) and $Z1\text{-}\beta/2 = 0.84$ at 80% (power), which gave a sample size of 28. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (30).

Protocol

The subjects were randomly allocated into no tape, low dye taping and kinesiotaping using simple random sampling technique. The statistician generated random number using computer generated random number sequence generator and was concealed using sealed opaque envelopes. To avoid the accumulation in the perception of the effect of tape, the individuals were administered with all 3 cassettes with a least 30-minute time difference. The taping was done on the dominant leg of the subjects. In kinesiotaping, the leg was placed in hip flexion, adduction, and internal rotation, but this wasn't done in sham taping (Figure 1, 2). The Kinesio Y strip was applied to the patient with zero tension on the lateral surface of the greater trochanter. The end section (lag end with around 1 2 inches) was inserted without any tension still applying light or paper off the tension that was applied with about 15 - 25% of the available

tension stretch in length. The examiner applied the tape to the PIIS with the same 15 to 25 percent tension and the end portion untightened (22).

Figure 1. Application of the right gluteus medius muscle experimental KT from insertion to origin with hip flexion and adduction.

Figure 2. Application of sham taping from insertion to origin with no hip movements.

Following enrolment, an experienced physiotherapist assessed the baseline values for the outcome measures, such as the Biodex balancing system score, deep squat test score, and plantar pressure measurements, were obtained.

A physical therapist assisted in the measurement of plantar pressure on the Am footwork pro platform (amcube, Gargas, France) (4). Plantar foot pressure systems have shown excellent intrasession and intersession reliability(0.63 - 0.966) for static and dynamic conditions (3). The procedure's specifics and testing were taught to the subjects to familiarise them with it. The standing and walking exercises for the scanner were briefly demonstrated by the therapist. Individual calibration using body weight was done for each individual and the postural mode was used to eliminate the postural sway. The patients were given specific instructions about standing on the platform, including the head and foot posture. Following the standard standing measurement, the therapist asked the client to make sure that the foot strike on the platform should occur while performing the normal gait pattern of the subject. It was also advised to the subject that the walking should be accomplished without being conscious of the testing.

Figure 3. Plantar pressure measurements in walking (dynamic analysis)

Figure 4. Sagittal view of deep squat performance.

The deep squat is considered one of the 7 functional movement screening (FMS) tests by Cook with a reliability coefficient (ICC = 0.98) (10). Subjects were asked to stand upright with their legs apart and their feet aligned with their shoulders in the sagittal plane. Following this, the participants were instructed to grasp the dowel parallel to the ground. Participants were then instructed to press the dowel over their heads with their shoulders flexed, elbows extended, and abducted in the next stage of the movement.

The participants were then instructed to descend to the ground and assume a squatting stance while maintaining an upright or erect torso, as well as maintaining their heels and dowel in place. They were now instructed to remain in this crouching stance for approximately one count before slowly rising to their feet. The subjects should complete three repetitions. Criteria include asking the athlete to perform a deep squat with a 2 x 6 block placed under their heel if they did not meet the "3" requirement. With the aid of scoring and 2-d video analysis, the deep squat score was examined and graded using Kinovea software (25).

The static and dynamic stability indices MLSI, OSI, and APSI were recorded to evaluate balance utilizing Biodex Balance System™ (Shirley, New York, USA) (40, 6). Biodex balance system has shown a strong reliability(ICC = 0.75) in stability testing situations (11). This system consists of a circular deck with a diameter of 55 cm that is inside its body and 20 cm from the ground. It also can tilt from a horizontal position by around 20 degrees on all sides. In a pretesting session led by the examiners, the subjects were requested to become comfortable with the testing procedures before beginning the examinations. During the actual test, the participant was made to stand on the Biodex system deck in bare feet with the toes turned outward by 15 degrees and their hands crossed over their chests or by the side. Subjects were requested to adopt a bilateral free stance position. The trails each lasted for 20 seconds, with an interval of 10 seconds. Three tests were conducted with 5-minute rest intervals and the mean was obtained.

Figure 5. Static and dynamic balance assessment using Biodex Balance SD

The outcome measures were assessed post the application of each taping. The outcomes were assessed by a therapist who was blinded to the type of tape applied. There was a complete compliance and there was no drop outs as the measurements were taken in a single bout.

Statistical Analysis

Data analysis was done using the jamovi project (2022). *jamovi*. (Version 2.3) [Computer Software]. Mean median and mode were used for the descriptive statistics. The normality of the data was analysed using the Kolmogorov Smirnov test. Since the data were not normally distributed, Freidman's Test was done to find the mean difference between the no tape, kinesio tape and sham tape treatment. Statistical significance was accepted at $p < 0.05$. Effect size was calculated using Kendall's W test. A value < 0.3 was considered as small or trivial effect, 0.3 to 0.53 was considered as moderate effect and > = 0.53 was considered a large effect (9).

RESULTS

Twenty-eight subjects participated in the study with a mean age of 25.3 ± 3.20. Among them 20 were females and 8 were males.

The median and interquartile range for the plantar static and dynamic maximum mean pressure for the experimental tape, sham tape and no tape are given in Table 1.

The median and interquartile range of the balance parameters for experimental tape, sham tape and no tape are given in Table 2. The median and interquartile range for squat scores is represented in Table 3.

Static overall stability index, static antero-posterior stability index, dynamic overall stability index, dynamic antero-posterior stability index, dynamic medio-lateral stability index and overall dynamic stability index had significant difference between the groups. Considering the effect size, only dynamic overall stability index and overall dynamic sway had a moderate effect.

The inferential analysis for the between group comparison and the corresponding effect size are shown in Table 4.

Table 1. Showing the plantar pressure values with each type of tape.

Type of Tape	Max Mean Plantar Pressure (Kpa)	Median	Interquartile range	95% Confidence Interval
Experimental Tape/ Kinesio Tape	Left plantar static	249	204, 285	232, 266
	Right plantar static	207	181, 241	198, 229
	Left plantar dynamic	221	194, 245	211, 236
	Right plantar dynamic	213	195, 237	204, 228
No Tape	Left plantar static	253	205, 285	228, 266
	Right plantar static	210	192, 224	197, 227
	Left plantar dynamic	222	198, 235	209, 237
	Right plantar dynamic	224	206, 237	213, 233
Sham Tape	Left plantar static	250	222, 300	238, 277
	Right plantar static	207	194, 233	199, 228
	Left plantar dynamic	225	202, 239	212, 234
	Right plantar dynamic	208	192, 238	204, 225

Table 2. Showing the plantar balance values with each type of tape.

Type of Tape	Balance Values	Median	Inter-Quartile Range	95% Confidence Interval
No Tape	Static OSI	1.19	0.97, 1.93	1.21, 1.74
	Static APSI	0.90	0.682, 1.32	0.85, 1.17
	Static MLSI	0.67	0.45, 1.44	0.701, 1.15
	Static sway Overall	1.31	1.12, 2.24	1.35, 2.12
	Dynamic OSI	1.82	1.23, 2.64	1.66, 2.47
	Dynamic APSI	1.20	0.72, 1.97	1.08,1.66
	Dynamic MLSI	1.00	0.726, 1.50	0.95, 1.49
	Dynamic sway Overall	2.36	1.66, 3.61	2.22, 3.33
Experimental Tape/KinesioTape	Static OSI	1.26	0.90, 1.46	1.05, 1.38
	Static APSI	0.82	0.59, 0.98	0.703, 0.96
	Static MLSI	0.61	0.44, 0.83	0.56, 0.78
	Static sway Overall	1.38	1.07, 1.68	1.21, 1.80
	Dynamic OSI	1.21	1.03, 1.45	1.11, 1.68
	Dynamic APSI	0.84	0.58, 1.02	0.74, 1.27
	Dynamic MLSI	0.77	0.59, 0.82	0.64, 0.90
	Dynamic sway Overall	1.38	0.90, 2.10	1.24, 2.10
Sham Tape	Static OSI	0.927	0.81, 1.20	0.89, 1.22
	Static APSI	0.65	0.56, 0.84	0.61, 0.78
	Static MLSI	0.53	0.43, 0.72	0.49, 0.76
	Static sway Overall	1.06	0.80, 1.41	0.99, 1.40

Dynamic OSI	1.04	0.89, 1.39	1.03, 1.47
Dynamic APSI	0.73	0.59, 0.99	0.68, 0.99
Dynamic MLSI	0.66	0.49, 0.84	0.59, 0.87
Dynamic sway Overall	1.19	0.71, 2.07	1.14, 1.80

Table 3. Showing the squat score values with each type of tape.

Type of Tape	Median	Inter-quartile Range	95% Confidence Interval
No Tape	1.00	1.00, 1.25	1.14, 1.72
Experimental Tape/ Kinesio tape	1.00	1.00, 3.00	1.47, 2.17
Sham Tape	1.00	1.00, 3.00	1.41, 2.09

Table 4. Showing the *p* values for Freidman's Test.

S. No	Outcome	*p* value	Effect size
1.	Plantar static maximum mean pressure left	0.784	0.009
2.	Plantar static maximum mean pressure right	0.828	0.007
3.	Plantar dynamic maximum mean pressure of left	0.598	0.018
4.	Plantar static maximum mean pressure of right	0.207	0.056
5.	Static overall stability index	0.001	0.274
6.	Static antero-posterior stability index	0.001	0.255
7.	Static mediolateral stability index	0.047	0.109
8.	Overall static sway	0.008	0.173
9.	Dynamic overall stability index	< 0.001	0.378
10.	Dynamic antero-posterior stability index	< 0.001	0.245
11.	Dynamic mediolateral stability index	< 0.001	0.260
12.	Overall dynamic sway	< 0.001	0.317
13.	Deep squat score	0.009	0.174

DISCUSSION

The study was aimed at finding the immediate effect of gluteus medius kinesio-taping on plantar pressure distribution and balance among healthy individuals. However, to the best of our knowledge, this study is the first to analyse the effect of gluteus medius taping on plantar pressure and balance. There was no significant effect on plantar pressure, but a significant effect was observed in balance and deep squat scores.

There was significant difference in the static and dynamic stability indexes except static sway index. The findings of this study was in agreement with the findings of Zulfikri et al. (2017) (43). However, the results were not in accordance to the finding of Fayson et al. (2015) where there was an inhibitory effect of Kinesio tape (13). The discrepancy in the results of the study could be due to the difference in the taping techniques used. The dynamic balance can be hampered

by the altered kinematic movement pattern caused by the vast muscle groups controlling the hip and knee joints being fatigued (17). This reduced neuromuscular responses can lead to impaired performance and thereby affecting the dynamic balance (19). A recent study has found that the significance of the hip abductor muscle in dynamic postural control is attested to by a decline in SEBT performance and changes in EMG patterns with proximal exhaustion (2). Kinesio tape reduces the muscle fatigue in individuals and thereby improves the muscle performance (43). The facilitation effect of kinesio tape is thought to occur as a result of enhanced cutaneous mechanoreceptor stimulation. This stimulation augments the fusimotor activity and contribute to a stronger and quicker muscle contraction (21). Muscle strength also plays a major role in the dynamic balance by the neuromuscular activities. It has been hypothesised that the enhanced strength is caused by the skin stimulation produced by the tapes perhaps involving slowly adapting type 2 mechanoreceptors situated in deeper layers of the dermis, which can promote a larger recruitment of motor units (8, 27). The mechanoceptors activated during the voluntary and involuntary movements transmits the impulses to the central nervous system which initiates the anticipatory postural adjustments and thereby improving the balance (29). These all factors could have attributed to the facilitatory effect of Kinesiotape on balance in the current study.

There was significant effect of kinesio taping on deep squat score. There are no FMS interactions according to a research by An et al. (5). However, there is a considerable amount of interaction between the two groups in the FMS Hurdle Step test when compared to the line lunge and deep squat tests in both the taping and balance exercise groups. This study claimed that the application of kinesiotape to the rectus femoris, hamstrings, tibialis anterior, sartorius, fibularis brevis, and patella but not the gluteus medius affected motion in the non-weight bearing component during single repetition. On the other hand, while our investigation was limited to the gluteus medius, which likewise significantly influenced the deep squat score, kinesiotaping had no effect. The kinesiotape is hypothesized to work by exerting a concentric draw on the fascia, which may promote minor, rapid gains in muscle strength by stimulating enhanced muscle contraction. The enhanced muscle alignment and facilitated muscular activity may also be responsible for small increases in muscle strength. These factors would have attributed to the improved squat score with the kinesiotape (42).

There was no significant effect of kinesio tape on the maximum mean plantar pressure. The findings of this study agreed with the findings of Kelly et al. (2010) (23). But the findings were also in disagreement with the findings of Nolan and Kennedy (2009) (31), Ozturk et al. (2019) (32) and Sullivan et al. (2008) (41). But the results of these studies cannot be compared with the findings of the current study as the taping was done to ankle joint and the current study was evaluating the effect of kinesiotaping on Gluteus medius muscle. Hence these results have to be cross examined with a higher number of samples.

The limitations of the study include that this study has only investigated the immediate effect of kinesiotaping. The outcome assessments were repeated for more accurate results. This would also have made the subjects accustomed to the testing and the performance would have varied

with the repeated measurements. Balance assessments was performed with the visual feedback from the monitor. This would have also assisted the subject in maintaining the balance and hence a better result. The sample size was relatively small. Only healthy participants were recruited and the taping technique did not involve blinding the subjects. Thus, future studies should be directed towards a larger sample size. Study would be conducted on specific lower extremity condition with these outcomes. Future studies should address various populations including high performance category and geriatric population.

The results of the study suggest that kinesio-taping is an effective method on improving the dynamic balance and deep squat quality in normal healthy individuals. Hence taping can be considered as a useful adjunct to various strategies used in improving balance and deep squat.

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