EFFECT OF USING ATHLETIC RIGID TAPE FOR FOOT REALIGNMENT ON BALANCE IN SELECTED SPORT'S ACTIVITIES

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Abstract

Background: In the world of sports, balance is essential in enhancing performance and reducing the risk of injuries. Basketball, being a dynamic as well as physically demanding sport, demands athletes to exhibit exceptional balance and stability. Various techniques and interventions have been explored to optimize balance and prevent injuries among basketball players. One such intervention is the use of anti-pronation taping, which aims to realign the foot and ankle

Purpose: The objective of this study was to examine the impact of using athletic rigid tape for foot realignment on balance in selected sport's activities in pronated feet.

Materials and Methods: Forty-Two female basketball players aged from fifteen to thirty years were included in this study. The participants were allocated into two groups using a random assignment method; Rigid athletic tape was applied to one group and no taping was applied to the other group. Dynamic Postural Balance was assessed using Biodex Balance System before and after 2 weeks from participation for the two groups. Results: There was improvement in both groups (Study and control groups) with significant improvement in study group (at P value < 0.05).

Conclusion: Using athletic rigid taping for realignment can improve balance in pronated foot in basketball players. This may redirect the attention of sport's rehabilitation specialists to include rigid taping to improve the performance of in sports including jumping as well as for prevention of injury.

Keywords: Athletic Tape. Rigid Tape; Realignment; Foot Posture; Balance

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Introduction

A crucial part of the foot's stability and function as a "central core" is played by the complicated muscles and arch architecture (McKeon et al., 2015).

The foot is a complex anatomical structure composed of multiple bones, joints, ligaments, muscles, as well as tendons that oversee our ability to stand up erect and to have coordinated gait motion. Due to its passive elastic as well as active components, the human foot functions as a hard lever to generate energy throughout propulsion and also as a flexible structure to absorb energy (Bruening et al., 2018; Holowka & Lieberman, 2018; Kelly et al., 2018).

There is significant variation in foot position across people, with most research studies primarily examining the medial longitudinal arch (Razeghi & Batt, 2002). Different foot positions affect the structure of the foot in different ways, which can also cause different patterns of plantar stress (Chuckpaiwong et al., 2008).

People whose foot positions are too pronated are at increased risk of injury due to the additional strain in the surrounding muscles and the high torsional force applied to the tibia. The increased strain on the lower limb is a result of the greater number of eccentric contractions needed to manage excessive movement. On the other hand, individuals with supinated foot postures are more prone to injury because they have a reduced ability to absorb and dampen ground response forces, which leads to excessive stress on their bones (Greenberg et al., 2015; Stewart, S. L. 2019).

Prior studies have determined that the consistent application of augmented low dye tape may lead to an elevation in arch height, but does not alter the recruitment of muscles in the lower limb. The tape's long-term application can lead to modifications in soft tissues due to the physical support it provides (Franettovich et al., 2010).

White non-elastic adhesive tape material is predominantly utilized for those with pes planus among a range of taping approaches. The primary taping techniques comprise low-Dye, augmented low-Dye, Modified Low-Dye, Fan-arch support, Double X, as well as Navicular sling (Larson et al., 2019; Newell et al., 2015; Holmes et al., 2002; Del Rossi et al., 2004).

Foot type has an impact on both the static and dynamic circumstances of postural stability. Hence, the assessment of balance measurements during clinical evaluation should take into account the individual's foot type (Cote et al., 2005).

The effectiveness of training on postural stability in athletes may be influenced by the specific foot type of the individual, regardless of the potential advantages of such training. Prior studies have emphasized the potential of foot type, particularly flat feet, to have a substantial influence on the regulation of ankle as well as foot movement in athletes, resulting in diminished postural balance (Moreno-Barriga et al., 2023). Furthermore, around 40% of all ankle injuries caused by trauma and roughly 50% of all ankle sprains happen when engaging in sports or exercises (Waterman et al., 2010; Doherty et al., 2014; Vuurberg et al., 2018), basketball, American football, as well as soccer have the highest occurrence rates, with percentages of 41.1%, 9.3%, and 7.9% respectively (McKay et al.,2001; Doherty et al.,2017). Ankle sprain exhibits a higher incidence among females, children, as well as athletes engaged in indoor and court sports (Doherty et al., 2014).

Materials and Methods

Participants

This study was a randomized controlled trial examining the effect of using athletic rigid tape for realignment on balance in selected sport's activities.

A sample of forty-two females aged from 15 to 30 years. They were recruited from Egyptian Shooting Sports Club. The participants were allocated into two groups using a random number selection method, even numbers were the study group (Group A) and odd numbers were control group (Group B). Each group consists of 21 female basketball players with pronated feet.

All participants met the inclusion criteria:

1. Age from 15-30 years to include Under-16 Team, Under-18 Team, and First-Team.
2. The individual has engaged in basketball training for a minimum duration of one year, with a frequency of at least one session per week (Gehrke et al., 2018).
3. BMI range from 20kg/m2 - 25 kg/m2 (Butterworth et., 2015) (Raj et al., 2021).
4. Flexible pronated foot (+6 to +12) (Hogan et al., 2016).

Exclusion criteria

We did not include those who exhibited one or more of the following:

- Ankle sprain or fracture within the past six weeks.
- History of grade 3 ankle sprain.
- Surgery on a lower limb occurred during the last three months.

- Any structural abnormalities in lower limbs including leg length discrepancy, pes planus or pes cavus.
- Persisting hip or lumbar spine pain (local or referred) affecting lower extremity.
- Vestibular problems, visual problems, sensory impairment affecting balance (Halabchi et al., 2020).

Ethical Approval

Each participant was briefed about the study's objectives, methods, and risks and benefits. All individuals who took part in the study provided written consent. Approval number: P.T.REC/012/004987 indicates that the study was approved by the ethical committee at Cairo University's faculty of physical therapy.

Demographic Data Collection

Demographic data, such as age, weight, and height, was obtained. Subsequently, the body mass index (BMI) was computed by dividing the weight (in kilograms) by the square of the height (in meters).

Initial Evaluation

To exclude fixed pes planus and whether the flatfoot is reducible, Hubscher maneuver (Jack test) was used (Lee et al., 2005). The participant's leg length was measured in a supine position, on both the right and left sides. The measurement was taken from the anterior superior iliac spine to the inferior border of the same side's medial malleoli, using a standard measuring tape (Neelly et al., 2013).

1. **Foot Posture Evaluation**

The Foot Posture Index was used in this study to assess the foot posture for inclusion of subjects. It is a simple objective scale used to foot posture and identifying any potential biomechanical issues through quantification of the degree to which the foot is pronated, neutral or supinated. It is a valid and reliable scale has excellent intra-rater reliability (Remond et al., 2005). The Foot Posture Index categorizes foot posture based on six criteria (Redmond, 2005):

(1) Examination by palpation of the talar head, (2) Below and above the lateral malleolus curvatures, (3) The calcaneus' location in the frontal plane, (4) Talonavicular joint prominence, (5) The congruence of the medial longitudinal arch, (6) Forefoot abduction/adduction on the rear foot.

Each item is scored from 2 to 2, with 0 representing neutral foot posture. The scores from each component are then added up to determine the overall foot posture index. A score below zero suggests a pronated foot posture, whereas a score over zero shows a supinated foot posture (Keenan et al., 2006; Cornwall et al., 2008; Redmond, 2005; Kirmizi et al., 2020).

2. **Balance Evaluation using Biodex Balance System (BBS)**

The BBS was utilized to measure dynamic postural control in basketball players (BBS; Biodex Inc., Shirle NY, Version 3.08). The BBS utilizes a circular platform that may freely move in both the anterior–posterior as well as medial-lateral axes simultaneously, with adjustable levels of instability. The BBS permits a maximum foot platform tilt of 20° and computes three distinct measurements. The system offers a range of stability levels, ranging from the highest level of stability (level 8) to a surface that is severely unstable (level 1). (Ghait et al., 2019). This system is connected to computer software and monitored via the control panel screen. These indices are measures of standard deviations that evaluate variations around a baseline (horizontal) established before testing, while the platform is in a steady condition. The Anterior-Posterior Stability Index (PSI) as well as Medial-Lateral Stability Index (MLSI) measures the deviations from the horizontal plane along the AP as well as ML axes of the BBS. By combining the APSI and the MLSI, we get the OSI, or Overall Stability Index. Averaging the results from all three tests, the stability index is based on the angle of tilt relative to the horizontal. The OSI score is considered to be the most accurate measure of the participant's overall stability on the platform; a high score suggests significant deviation from the participant's center of gravity (Karimi et al 2008).

The assessment started with the balance platform in static position. To make sure the patient was comfortable and safe, the screen was placed so it was level with their eyes. Every single one of the participants had their own personalized support rail as well as biofeedback screen. The participant was instructed to position themselves at the precise midpoint of the platform while securely holding onto the handle provided for support. Next, advance to the stage of standing upright without relying on the support handle. Those who were just starting out or were taking their first trial were well-prepared for the balance system and protected from any unanticipated platform movements.

One training session was performed prior to testing to eliminate learning effect and for familiarization with the procedures (Ghait et al., 2019). The test was done in unilateral stance, 3 trials 20 sec/trial with 10 sec rest in between each trial and the rest is the average between the 3 trials. If any mistake or foul was presented during the test or the participant held on the rails or stood on bilateral stance, a reattempt had taken place. Participants were instructed to put their arms beside their body.

Dynamic Postural Control testing

- Anterior posterior (AP) stability index (SI): indicate the participant's capacity to regulate their balance in the front to back directions.
- Mediolateral (ML) stability index: indicate the subject's capacity to regulate their balance from side to side.
- Overall (OA) stability index: indicate the subject's capacity to maintain balance in various directions.
- Low stability was indicated by high values across all system indices (Ghait et al., 2019). (Figure 1).

Figure 1. Participant during Dynamic Postural Testing.

Intervention procedure

Study Group: Taping was applied to the intervention group using athletic rigid tape. To avoid losing the tightness of the tape after activities, tape was replaced each 48 hours for 2 weeks (Alawna et al., 2020; Madruga-Armada et al, 2021).

Taping procedure

Zinc oxide tape was used because it is non-elastic, rigid, with excellent adhesion and tensile strength properties. (Classic 38mm) (Mueller Euro-Tape© (Mueller Sports Medicine, Prairie du Sac, WI, USA). The application of athletic tape occurred when the athlete was in a supine or long sitting position, with the foot positioned in a neutral stance. In order to maintain uniformity, a single therapist administered all taping procedures in the study, adhering to the standardized taping methodology (Madruga-Armada et al, 2021; Nolan & Kennedy 2009). Care was taken when tape was used to prevent the risk of impeding blood flow which could lead to tissue damage and even tissue necrosis. The Low-Dye taping technique was implemented according to the instructions provided in the literature (Vicenzino et al, 1997; Holmes et al., 2002; Nolan & Kennedy 2009) In studies that utilize low-dye taping, it is considered the gold standard approach.

The initial step involved positioning longitudinal arch support strips in a side-to-medial orientation, beginning at the head of the 5th metatarsal bone and terminating at the head of the first metatarsal bone (Vicenzino et al, 1997).

The strips for the transverse arch were subsequently positioned in a side -to-medial orientation beneath the plantar region of the foot, beginning at the anterior side of the calcaneus bone and terminating at the metatarsal heads. The Low-Dye taping was performed, using an extra strip to reinforce the longitudinal arch and enhance the stability of the transverse arch support strips (Madruga-Armada et al, 2021). Ultimately, in order to secure the Low-Dye tape and prevent it from becoming displaced within a period of 48 hours, two strips of bandage were affixed to the back of the foot, effectively completing the taping process (Homles et al, 2002; Vicenzino et al, 1997).

Results

No statistically significant differences were found among the two groups in terms of age, weight, height, as well as BMI [P >0.05]. These results were illustrated in (Table 1).

Regarding overall stability index, there was a substantial reduction in both groups before as well as after treatment, with the study group showing more improvement compared to the control group. These results were illustrated in (Table 2 and fig. c)

Regarding Mediolateral stability index, there was significant decreased before as well as after treatment in both groups with study group improvement more than control group. These results were illustrated in (Table 3 and fig. b).

Regarding anteroposterior stability index, there was significant decreased before as well as after treatment in both groups with study group improvement more than control group. These results were illustrated in (Table 4 and fig. c)

Table 1. Comparison of mean age, height, weight as well as BMI among group A and group B.

	Group A	Group B	MD	t- value	p-value	Sig
	$\bar{x}$ ± SD	$\bar{x}$ ± SD				
Age (years)	16.47 ± 2.15	17.23 ± 3.09	-0.76	-0.92	0.36	**NS**
Height (cm)	169.76 ±7.17	172.71 ±9.63	-2.95	-1.12	0.26	**NS**
Weight (kg)	63.47 ±8.42	68.47 ±10.13	-5	-1.73	0.09	**NS**
BMI (kg/m²)	22.00 ± 2.47	22.89 ± 2.23	-0.88	-1.21	0.23	**NS**

$\bar{x}$: Mean	SD: Standard deviation	MD: Mean difference
t value: Unpaired t value	p value: Probability value	NS: Non-significant

Table 2. Mean OASI before as well as after treatment of group A and B.

OASI	before treatment	after treatment	MD	% of change	P-value	Sig
	$\bar{x}$ ±SD	$\bar{x}$ ±SD				
Group A	1.85 ± 0.44	1.30 ± 0.38	0.55	29.72	0.001	S
Group B	1.96 ± 0 .42	1.58 ± 0.30	0.38	19.38	0.001	S
MD	-0.11	-0.28				
P-value	0.42	0.012				
Sig	NS	S				

$\bar{x}$: Mean	SD: Standard deviation	MD: Mean difference
p value: Probability value	S: Significant	NS: Non-significant

Table 3. Mean MLSI before as well as after treatment of group A and B.

OASI	before treatment	after treatment	MD	% of change	P-value	Sig
	$\bar{x}$ ±SD	$\bar{x}$ ±SD				
Group A	1.85 ± 0.44	1.30 ± 0.38	0.55	29.72	0.001	S
Group B	1.96 ± 0 .42	1.58 ± 0.30	0.38	19.38	0.001	S
MD	-0.11	-0.28				
P-value	0.42	0.012				
Sig	NS	S				

$\bar{x}$: Mean	SD: Standard deviation	MD: Mean difference
p value: Probability value	S: Significant	NS: Non-significant

Table 4. Mean APSI before as well as after treatment of group A and B.

APSI	before treatment	after treatment	MD	% of change	P-value	Sig
	$\bar{x}$ ±SD	$\bar{x}$ ±SD				
Group A	1.75 ± 0.31	1.08 ± 0.25	0.67	38.28	0.001	S
Group B	1.62 ± 0.43	1.28 ± 0.20	0.34	20.98	0.001	S
MD	0.13	-0.2				
P-value	0.29	0.008				
Sig	NS	S				

$\bar{x}$: Mean	SD: Standard deviation	MD: Mean difference
p value: Probability value	S: Significant	NS: Non-significant

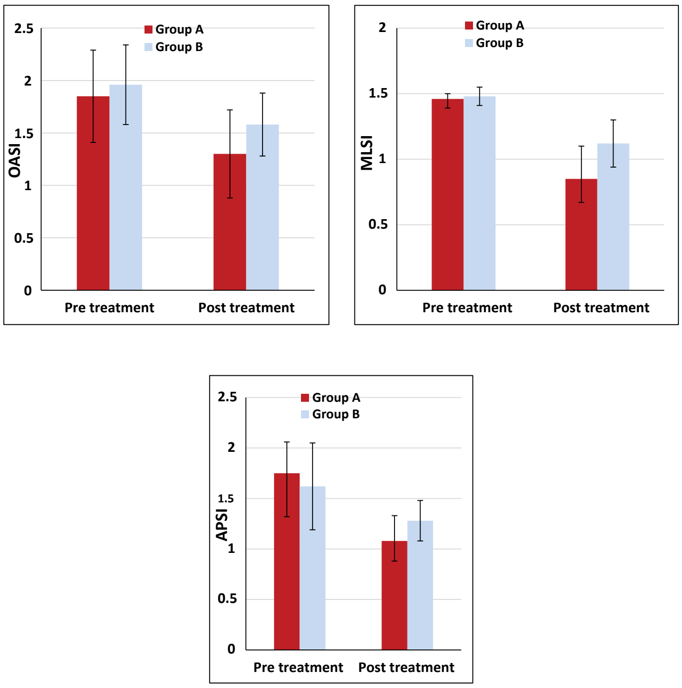

Figure 2. Comparison of balance results between before as well as after treatment

(a). Mean OASI before as well as after treatment of group A & B.

(b). Mean MLSI before as well as after treatment of group A & group B.

(c). Mean APSI before as well as after treatment of group A & B.

Discussion

The findings of the current study suggest that balance was improved after application of anti-pronation taping for realignment of foot in basketball players. Both groups experienced an improvement in balance, with the study group showing greater improvement, this may be because of conducting the study in the pre-season period, which contains emphasizing of basic physical skills training including balance.

Taping techniques are commonly employed in sports rehabilitation to prevent sports injuries by providing support to joint structures as well as muscles, as well as to accelerate the recovery process (Thelen et al, 2008). The two primary categories of effects associated with taping are neurophysiologic and biomechanical. Taping the body has simple neurophysiologic benefits, such as enhancing the body's proprioceptive function to heal from chronic injuries, preventing new ones, supporting injured muscles and joints (Lephart, 1995; Williams et al, 2012). Taping produces the subsequent biomechanical impacts: it alters movement, corrects posture, supports structural function in conjunction with weaker muscles or tendons, and slows down motion.

Generally, Simoneau et al. (1997) found that applying strips of athletic tape over the ankle joint enhances the perception of ankle joint position. These findings align with the results of the present study.

Regarding the impact of taping on realignment, Vicenzino et al.,2005 Concluded that the use of anti-pronation tape effectively manages pronation during static as well as dynamic activities. The alterations in static foot position caused by the tape were consistent with those observed while walking as well as jogging.

Moreover, Vicenzino et al., 2005 suggested that on comparing control group to study group, the use of anti-pronation taping demonstrated immediate and sustained effectiveness in preventing pronation both immediately after application and following 20 minutes of activity. The efficacy of these strategies in managing pronation during weight-bearing activity suggests their potential utility in addressing abnormal pronation as a component of clinical evaluation and treatment, aligning with the findings of this investigation.

In Addition to Ridder et al., 2015, found that taping had a substantial impact on the movement of the ankle joint and alleviated the feeling of instability in individuals having chronic ankle instability.

Moreover, Alawna & Mohamed, 2020, the findings indicated that ankle tape led to enhanced proprioception and balance in volleyball players who had chronic ankle instability, both after a period of 2 weeks and 2 months. Which corroborated the findings of this investigation?

In Addition to, Kim et al., 2020 found that both elastic as well as non-elastic ankle taping had a positive impact on balance during jump landings in people suffering from chronic ankle instability.

With most recently, Dendrinos et al., 2022 determined that exercise enhances neuromuscular control and activates the lower limb's proprioceptive systems. When compared to control groups, those whose ankles were taped showed a marked improvement in lower limb function.

The effects of tape on balance have been the subject of several research, with highly conflicting conclusions. (Hadadi & Abbasi, 2019; Alawna et al., 2020). Several studies have shown that ankle joint tape has a substantial improvement on perceived stability, static and dynamic balance control, as well as functional performance. However, it does not have a significant impact on postural control after a period of 7 days (Gehrke et al., 2018). Conversely, other research has shown that ankle joint tape does not have a significant impact on ankle functional instability, functional performance, both static and dynamic balance control, or reaching distance in subjects having chronic ankle instability (Halim- Kertanegara et al., 2017). In addition, the ankle taping studies exhibit a moderate level of methodological quality and provide limited evidence. This can be attributed to the fact that these studies have solely focused on the immediate impacts of taping on balance and function, while also including a small number of participants. Furthermore, these studies primarily utilized taping as a protective measure rather than as a tool for foot realignment.

Lange et al., 2004 demonstrated that anti-pronation significantly changed plantar pressure during ambulation with enhancing stability which agrees with the current study, However, they demonstrated only the immediate effect of anti-pronation taping. On the other hand, Park et al., 2015 concluded that anti-pronation tape can have both long-term effects and provide temporary relief from symptoms in cases of plantar fasciitis. Franettovich et al., 2006 proposed that neurophysiological alterations may play a role in the mechanism underlying anti-pronation taping, resulting in enhanced balance. Franettovich et al., 2008 also reviewed different anti-pronation techniques to assess their biomechanical effect in a systematic review. They demonstrated that the calcaneal eversion angle of the standing leg alignment was lowered by approximately 17% thanks to the biomechanical taping effect produced by anti-pronation tape (static activities). Positive effects on the navicular height (8~16% increase), arch height ratio, internal rotation of tibia, calcaneal eversion reduced by 4.6 degrees, as well as dynamic activities and their impact on plantar pressure (e.g., walking or running) were also seen immediately following tape application. These results came into agreement with this study. However, this systematic review could not consistently observe the impacts of exercise depending on its duration. Additionally, there was no discussion of the psychological impact of taping or the potential placebo effect.

On the Other hand, Sawkins et al., 2007 proposed that ankle tape exerts a placebo effect by influencing the perception of stability, confidence, as well as reassurance, which may enhance its efficacy in injury prevention.

Moreover, Meta-analysis was suggesting by Park 2019, resulted that it is not feasible to ascertain the degree to which anti-pronation taping was successful in avoiding navicular descent or influencing balance.

Conclusion

The current study suggests that using athletic rigid taping for realignment can improve balance in pronated foot in basketball players, which later need to be considered through the pre-season preventive and corrective tools for enhancing the balance of the athletes and prevention of further injury.

Limitations

It is important to take into account the fact that the present study has some limitations. The sample studied may not be representative to the entire basketball population; it was limited to athletes who play in Egyptian Shooting Sports club.

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