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Effect of Rigid Tapping on Chronic Functional Ankle Instability in Basketball Players

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Abstract:

Purpose: The purpose of this study was to examine the implications of rigid tapping on the functional performance of professional basketball players who have chronic ankle instability.

Methods: Twenty-eight male professional players participated in this current study, ranging in age from eighteen to forty. The individuals exhibited ankle instability that is at least moderate grade, defined as having a Cumberland Ankle Instability Tool result of less than twenty- five. A pre-post study design was used. Two testing sessions were conducted with ankle tapping during one session and no tapping during the other. Three functional tests were administered to participants during each test session: the figure-8 hopping test, the single-leg stance test, and the Y-balance test. Tapping procedures were the same for all participants.

Results: In each test, there was a statistically significant difference between the two evaluation circumstances. Comparing the pre-taping condition to the post-taping condition revealed that the rigid taping significantly decreased the time of the figure-8 hopping test ($p<0.001$) and also improved the results of the Y-balance test in all directions and in the overall total composite score ($p<0.001$). Moreover, rigid tapping improved balance as measured by the single-leg stance test, as reflected by decreasing the number of foot errors in 30 seconds ($p<0.001$).

Conclusion: It can be concluded that rigid tapping has a significant effect on improving the functional performance of basketball players with chronic ankle instability.

Key words: ankle sprain, rigid tape, chronic ankle instability, functional instability, athletic performance, basketball.

1. Introduction:

Lateral ankle sprain (LAS) is among the most common injuries in sports, and around forty percent of people who suffer a LAS for the first time are susceptible to chronic ankle instability (CAI) (1).

While lateral ankle sprains are generally believed to affect both men and women at similar rates, according to a specific study, compared to their male counterparts, female interscholastic and collegiate basketball players may be twenty-five percent more likely to suffer from grade I ankle sprains (2). Acute ankle sprains involve lesions or disruptions of ankle ligaments, with sprains of the lateral ankle ligament complex being the most commonly occurring type among them (3).

More than 75% of acute ankle sprains are identified as lateral ankle sprains, with about seventy-three percent of these impacting the anterior talofibular ligament (4, 5). According to estimates, Fifty-five percent of people who have ankle sprains do not go to a doctor for treatment (6). Consequently, players may not fully recognize the severity of ankle sprains, and existing rehabilitation protocols for lateral ankle sprains might not effectively prevent repeated injuries or ongoing symptoms (7).

Lateral ankle instability refers to an unstable ankle caused by damage to the lateral ligaments due to excessive supination or inversion of the rearfoot. Whether the instability is new or long-standing is not made clear by this expression (7). Persistent symptoms such as pain, weakness, or limited ankle range of motion (ROM), decreased self-reported function, and recurrent ankle sprains that continue for more than a year after the initial injury are characteristics of chronic ankle instability (1**).** Chronic ankle instability has been associated with two potential origins: mechanical instability and functional instability (7). Functional instability was initially described by Freeman in 1965, where it was associated with proprioceptive deficits following ligament injury (8, 9). Functional instability is defined as the presence of recurring ankle instability and a sense of joint imbalance arising from proprioceptive and neuromuscular deficits, this type of instability may result from specific deficiencies in proprioception, neuromuscular control, postural control, or strength (10). Mechanical instability can be attributed to causes that affect the mechanics of one or more joints of the ankle joint complex. Possible mechanical deficiencies encompass abnormal laxity of ligament, impaired joint play, synovitis, and impingement, as well as destructive changes in the joint (7).

The high prevalence of lateral ankle sprains (LASs) and their frequent occurrence of prolonged symptoms, diminished self-reported ankle function, and further injury raises the significant public health concerns regarding LASs and their long-term effects (11). Basketball players often experience recurrent ankle sprains, leading to an increasing trend of using the rigid taping during games by the players to enhance joint stiffness, with intention of improving equilibrium and ability to carry out the athletic movements efficiently and effectively (12). A range of athletic tapes have been utilized in sports injury prevention, offering safeguarding and support for joints or muscles during physical activity (13). Among these methods, rigid taping stands out as the most prevalent, which aids in enhancing stability by limiting and controlling joint movements. Additionally, it stimulates afferent impulses to the central nervous system, resulting in improved joint positioning sensation and direction of movement (14, 15). Tapes are extensively utilized in multidirectional sports to minimize the occurrence of injuries. They serve as external support, providing stability by limiting movement and enhancing kinesthesis through increased proprioceptive stimuli on the skin (12).

Athletic tapes are primarily employed by players who have experienced ankle sprains, as this injury is the most frequently recurring among sports-related injuries, particularly in activities that involve physical interaction and frequent jumping, such as volleyball or basketball. Utilizing such tapes is intended to restrict ankle movement and improve joint stability while avoiding any adverse effects on functional performance (15, 16).

2. Subjects and Methods:

2.1. Study design:

A design employing pre- and post-assessments was utilized, and the study was conducted at Telecom Egypt Sport Club between October 2022 and August 2023. Ethical approval was available under the institutional ethical committee of faculty of physical therapy, Cairo University, Egypt number P.T.REC/012/003958 and ClinicalTrials.gov ID: NCT06024070.

2.2. Participants

Sample size determination was calculated using (G Power 3.1.9.7) software on the figure-8 hopping test (using two-tailed α: .05, β: .20 (power: 80%) was conducted based on a report by a previous publication (17). Twenty-five participants were required for this study. Twenty-eight subjects were recruited for this study from basketball sports clubs to overcome the effect of drop out. All participants were diagnosed with chronic ankle instability and referred to by an orthopedic surgeon. All participants were informed about the process that would be conducted during this research and signed in informed consent following standards of the institutional ethical committee for research involving human subjects. Participants meeting the following criteria were eligible for inclusion in this study: a) Basketball athletes aged between 18 and 40 years old. b) Body mass index (BMI) in the 18–25 kg/m^2 range. c) Individuals who experienced subjective instability sensations in the preceding six months, and exhibited ankle instability that is at least moderate grade, defined as having a Cumberland Ankle Instability Tool result of less than twenty- five. (12,18). Participants were ineligible for inclusion in the study due to any of the subsequent reasons: a) Individuals with a history of ankle joint surgery or fractures, or those with neurological or vestibular disorders. b) Participants who couldn't comprehend the protocol or test instructions' nature. c) In case of bilateral CAI, the most unstable ankle was selected for testing.

2.3. Assessment procedure:

Participants underwent testing across two times of assessment: one time involved testing the ankle with tape, while the other testing time involved testing without tape. These assessment times were conducted randomly, with a 3-day interval between them. Within each session, participants completed the following three functional tests in a randomized sequence: figure-8 hopping test, single leg stance, and Y-balance test. All subjects were barefooted during the performance of the three tests. The Cumberland Ankle Instability Tool comprises nine questions with multiple-choice responses aimed at defining the extent of functional ankle instability. Scores on this questionnaire range from 0 to 30, with items focusing on the difficulty experienced in various physical activities per ankle. It is capable of distinguishing between stable and unstable ankle joints and quantifying the grade of functional instability encountered (18). Out of the nine items, eight inquire about individuals' experiences of ankle instability or "rolling over" during sports and daily tasks, while the remaining item addresses the presence of pain. Scores vary from 0 (indicating the poorest condition) to 30 (reflecting the best condition) (18). This study utilized the Arabic version of the Cumberland Ankle Instability Tool.

2.4. Outcome measures:

Three functional tests were used in this study to assess balance and functional performance.

1. Figure-8 hopping test: it is a valid and reliable test (19). It was made using three plastic sports cones as a test marker. The first was the starting cone; after 2.5 meters (m), there was the second one; and just after another 2.5 meters, we put the final cone (17). The participant was instructed to perform a figure-8 hopping test task on the tested foot, completing two rounds around a 5-meter course as rapidly as they could. The duration taken by the participant to complete two figure-8 circuits was timed using a stopwatch. From the three attempts made, the average of the two most favorable times was noted. (17).

2. Single-leg Stance: Assessing balance through the single-leg stance test is considered reliable (20). The therapist gave instructions to the patients to stand on the tested leg for thirty seconds while closing their eyes, putting arms down by their sides, and the non-testing foot positioned against the inner side of the supporting calf. If balance was disrupted, patients were advised to maintain closed eyes while trying to regain their state of equilibrium. The times of foot movements performed by the supporting foot within the thirty second period was documented. Foot movements were registered if any part of the foot lost contact with the ground, there was a change in foot direction, or if the contralateral foot made contact with the ground. The lowest total number of foot movements from three attempts was recorded as the result (21). The test was conducted in two separate sessions: one with ankle tapping and the other without tapping. The order of these sessions was randomly determined.

3. Y-Balance test: The Y-Balance Test (YBT) serves as a prevalent dynamic balance evaluation tool which is used in sports medicine and physical therapy. The Y-balance test is recognized as a reliable and valid method for evaluating dynamic balance. (22). Individuals were asked to follow a protocol that aimed to reach the anterior (ANT), posterior-lateral (PL), and posterior-medial (PM) sides of a single leg (23–25). The PL and PM sides were positioned at an angle of 135 degrees from the ANT side. (25). The player positioned themselves on the tested leg at the center of the testing grid, positioning the farthest point of their big toe in line with the starting mark, which was situated at the intersection of the three limbs, forming a Y-shape on the grid (with the non-tested foot beside the tested one). While maintaining balance on one leg, regarding the stance foot, the athlete was told to reach in three different directions: anterior, posterolateral, and posteromedial. By measuring the distance between the intersection point and the spot where the farthest part of the foot reached (marked with erasable ink), the maximum reach distance was determined. The trial was canceled and restarted if any of the following circumstances occurred: a) failure to sustain unilateral stance; b) lifting or moving the standing foot from the test grid; c) touching down with the reaching foot; d) inability to return the reaching foot to the initial point; or e) use of hands to maintain balance. (23, 26). To account for differences in leg length, normalized composite scores (CSs) were utilized. To determine the percentages for these scores, the reach distances in each direction were added up, divided by three times the leg length, and then multiplied by 100 (26). A lower limp length was measured while lying supine on an examination table. They lifted their hips from the table and then lowered them back to the initial position. The subject's limb was measured in centimeters using a cloth tape measure, starting from the anterior superior iliac spine and ending at the most distal part of medial malleolus, after the examiner gently straightened the subject's legs to align the pelvis (26).

2.5. Intervention:

The tapping procedure was standardized for all participants and administered by the same qualified physical therapist based on studies conducted by Bicici et al. and Gehrke et al. (12, 27). The patient was positioned either supine or in a long sitting posture on an examination table or a plinth, and the ankle joint was maintained in a neutral position during the taping procedures. Firstly, pre-wrap was utilized to cover the entire area prior to tapping from around the middle region of the metatarsals of the foot to above the medial and lateral malleolus at the level of the middle Achilles tendon. Using a white 1.5-inch rigid adhesive tape (premium rigid zinc oxide Mueller Euro Tape), two strips were individually affixed as anchors at each end of the pre-wrap. Subsequently, two longitudinal strips of tape were applied from the medial side of the superior anchor to the lateral side of the same anchor. Additionally, two horizontal strips of tape were utilized from the medial side of the distal anchor to the lateral side of the same anchor to provide support to the medial aspect of the foot. Figure-of-eight straps were incorporated into the taping process, following a specific application pattern.

The taping process began at the center of the upper surface of the foot and extended towards the medial side of the foot. From there, the tape passed under the foot to the lateral side before returning to the initial point on the dorsum. Finally, the tape was wrapped around the lower part of the tibia, reaching the same point on the dorsum where it started. Lateral heel lock was applied, and tape started from a point on the inner aspect of the ankle joint's center on the dorsal surface. The tape extended from the lateral aspect of the foot, encircling the heel, and circling back to the initial point by crossing over the Achilles tendon from the back. A medial heel lock was implemented, resembling the lateral heel lock but in the opposite direction. Lastly, superior and inferior anchors are made to secure all preceding strips.

2.6. Statistical analysis.

Data were collected and analyzed statistically utilizing SPSS for Windows, version 25, developed by SPSS, Inc., based in Chicago, IL. The Shapiro-Wilk test was employed to assess the distribution of the data. Normally distributed continuous variables were presented as mean ± standard deviation (SD), whereas non-normally distributed continuous variables were represented by median (interquartile range). For normally distributed continuous variables, a paired-sample t-test was utilized to compare the no-tape and tape conditions. The Wilcoxon signed-ranks test was employed for non-normally distributed continuous variables. The alpha level was set at 0.05. A P-value of 0.05 or lower was considered significant.

3. Results:

Twenty-eight male players suffering from CAI had a mean ± SD of 21.29±2.29 and a mean ± SD of 22.77±2.38 kg/m2., 1.99±0.09 m, and 90.39±9.49 kg for body mass index, height, and weight, respectively (**Table 1**).

A Wilcoxon signed rank test revealed that Figure-8 Hopping Test scores were significantly lower in tape condition compared to no tape condition, z = -3.98, p = <0.001 (**Table 2**). A paired-sample t-test revealed that there were statistically significant improvements in Single Leg Stance -0.96 foot movements (95% CI -1.68, -0.25; P<0.001), Y-Balance test, anterior 5.46 cm (95% CI 3.82, 7.1; P<0.001), Y-Balance test, posterior-lateral 6.04 cm (95% CI 4.68, 7.39; P<0.001), Y-Balance test, posterior-medial 3.86 cm (95% CI 1.11, 6.61; P=0.008), and Y-Balance test, composite scores 5.01 % (95% CI 3.99, 6.03; P=0.008) (**Table 2**).

Table 1. Demographic characteristics of participants

Variable	Mean ± SD
Height, m	1.99±0.09
Weight, kg	90.39±9.49
BMI, kg/m^2	22.77±2.38
CAIT score	21.29±2.29

BMI= body mass index.
CAIT=Cumberland Ankle Instability Tool.

4. Discussion:

This study tried to determine how rigid tape affected basketball players with CAI's functional instability. Twenty-eight male subjects were included in this study, ranging in age from 18 to 40 years old. This study showed that rigid tapping can significantly improve functional instability and performance in patients with CAI. Comparing the no-tape condition to the tape condition revealed that the rigid taping improved functional performance in the figure-8 hopping test, single leg stance test, and Y-balance test (p<0.001). Ankle taping is recommended preventatively, particularly for athletes engaging in activities involving jumping, lateral movements, and running (12).

Taping is prevalent in basketball because of the sensory and mechanical advantages it provides, along with its role in enhancing joint stability. However, because using external support reduces the incidence and severity of ankle sprains through increased joint stabilization, there is debate regarding this implementation's effect on how well it works during activities. (12). Bicici et al. assessed the functional performance of fifteen male basketball players experiencing chronic ankle instability in 4 scenarios (no tapping condition, placebo, using kinesiology tape, and with rigid tape), employing various evaluation tests (hopping test, single limb test, standing heel rise test, vertical jump test, the star excursion balance test [SEBT], and the kinesthetic ability trainer [KAT] Test) (27). The researchers found no notable variation in the direction of the Star Excursion Balance Test (SEBT) across the tested scenarios. However, both rigid and elastic tape greatly enhanced the test results in the single-limb hurdle test, which involves lateral and medial hops over barriers, with no difference in results between the two types (27).

Table 2. Results of functional tests for the no tape and tape conditions					
	No tape	**Tape**	**t-value**	**p-value**	**Mean Difference (95% CI)**
Figure-8 Hopping Test¶ (s), (Median (IQR))	11.58 (11.16–13.39)	11.25 (10.8–12.28)	z=-3.98	<0.001*¶	
Single Leg Stance (foot movements)	8.89±3.75	7.93±3.15	-2.77	<0.001*	-0.96 (-1.68, -0.25)
Y-Balance test, anterior (cm)	73.43±6.14	78.89±6.95	6.83	<0.001*	5.46 (3.82, 7.1)
Y-Balance test, posterior–lateral (cm)	109.29±9.98	115.32±9.82	9.12	<0.001*	6.04 (4.68, 7.39)
Y-Balance test, posterior–medial (cm)	90.57±13.41	94.43±14.87	2.87	0.008	3.86 (1.11, 6.61)
Y-Balance test, Composite scores (%)	86.72±6.62	91.73±6.84	10.1	<0.001*	5.01 (3.99, 6.03)

¶ Value is a Wilcoxon signed rank test; * Statistically significant.

Gehrke et al. investigated the impacts of kinesio tape and rigid taping on carrying out sports like activities in twenty-one basketball players with CAI. Functional performance was evaluated unilaterally using the Star Excursion Balance Test (SEBT) and the Figure-of-8 hop test in three conditions: no taping condition, with applying rigid taping, and with kinesio taping. The order of tests was randomly assigned.

The findings indicated no notable statistical variation in the SEBT between the various taping conditions. However, major changes in the results were detected in the figure-8 hop test between rigid taping and control in favor of rigid taping, as well as between elastic taping and control in favor of elastic taping. The elastic tape was found to be less irritating in use than the rigid tape.

Based on the findings, athletic taping is useful for enhancing equilibrium and performance in players with chronic ankle instability, particularly in exercises that cause a significant joint load, like the figure-of-eight hop test. Both elastic and rigid taping were equally effective in these situations. However, the elastic tape was preferred by players due to its higher comfort level. Overall, the study suggested that athletic taping can be beneficial for players with CAI (12). These findings come in accordance with our current study results. The impact of rigid ankle tape on performing tasks, self-efficacy, and feelings of steadiness, and self-assurance during physical activities in people with functional ankle instability was also examined by Halim et al. Twenty-five individuals experiencing functional ankle instability were included among university students and sporting clubs for participation in the study.

Five functional tests (the figure-8 hopping test, hopping obstacle course, SEBT, single-leg stance, and stair descent test) were completed by the subjects with applying tape and without ankle tape. The levels of self-confidence assessments were a secondary outcome measure. The study identified that rigid ankle tape using caused a reduction of the time taken for stair descent by 4% but did not have an impact on results in the other tests. However, self-efficacy significantly increased with ankle tape usage. Participants also reported increased perceived stability, confidence, and reassurance when the ankle was taped during the stair descent test and two-hopping tasks (28).

Also, our results are not supported by Cline et al., who did research to examine the impact of kinesiotaping (KT) on enhancing equilibrium and postural control during both static and dynamic conditions compared to non-elastic tape and a control condition. Using a crossover design, they investigated the impact of KT in relation to non-elastic tape and a control condition on postural control among patients with CAI. Twenty-four individuals with CAI participated in the study, undergoing testing across three conditions: KT taping, non-elastic taping, and a control condition. For dynamic postural control assessment, SEBT was utilized in three directions: anterior (ANT), posteriolateral (PL), and posteriomedial (PM). The application of non-elastic tape involved a pre-wrap, followed by a series of anchors, strips, heel locks, and closure strips.

The findings revealed that neither non-elastic nor KT tape produced immediate improvements in static and dynamic postural control among CAI patients. However, both types of tape did enhance perceived stability in these individuals (29). The current study showed that rigid tapping had an effect on functional performance in basketball players with CAI. Comparing the no taping condition to the taping condition revealed that the rigid taping significantly decreased the time of the figure-8 hopping test in the tapping condition ($p<0.001$) and also improved the results of the Y-Balance Test in all directions and in the overall composite score ($p<0.001$). Moreover, rigid tapping improved balance as measured by the single-leg stance test, as reflected by decreasing the number of foot errors in 30 seconds ($p<0.001$). The effect of rigid tapping on functional performance may be due to its ability to increase ankle stability and sensory inputs, which gives the athlete the confidence and stability to improve performance.

Conclusion:

Based on the outcomes of this research, it can be inferred that the application of rigid tapping has a significant effect on improving the functional ankle instability and functional performance of basketball players with CAI.

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8. Declaration of interest:

The authors declare no competing interests.

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