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Effects of kinesio taping on functional performance test with chronic ankle instability in collegiate basketball player.

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Abstract . Background: Chronic ankle *Instability is characterized by recurrent giving way and often develops after repeated lateral ankle sprains.Kinesiotape is more elastic than traditional athletic tape and is becoming increasingly popular. It is reported to decrease pain, improve muscle function, circulation and proprioception, however, research examining the effects of Kinesiotape in chronic ankle instability is limited.* ***Purpose****: The purpose of this study was to determine if applying Kinesiotape to chronic unstable ankle may improve performance in the five functional tests -figure-of-8 hop test, side-hop test, square hop test ,single hop test, and 6 meter cross over test, which has been shown to be a sensitive and reliable measure for* measuring functional performance, neuromuscular coordination, and joint stability. **Method***: Twenty five college level basketball players with chronic ankle instability were participated in this study. Functional performance tests are used to test the subject s joint stability under four conditions; without taping, with placebo taping, with athletic tape and with kinesio tape. Players were excluded if they had any fracture or dislocation to lower extremity.* **Result**: *Pair wise comparison of the outcome measures in the four occasions (without taping, with placebo taping, with athletic taping, and with kinesio taping) revealed statistically significant differences in all functional performance test (p=0.001). Moreover, pair wise comparison of the chronic ankle stability outcomes using athletic taping versus kinesio taping indicated a statistically significant difference ($p < 0.05$) in favor of kinesio taping measures.* **Conclusion***: kinesiotape has superior effect than athletic tape in patients with chronic ankle instability and can be used safely for improving ankle joint stability and functional performance. .* (Mehul Padasala, Jaymin H Bhatt , Rosario D'Onofrio - Effects of kinesio taping on functional performance test with chronic ankle instability in collegiate basketball player ; Ita. J. Sports Reh. Po.; 2019 ; 6 ; 1 ; 1112 -1150; ISSN 2385-1988 [online] IBSN 007-111-19 - 55 ; CGI J OAJI :0,101).

Key words: *kinesiotape, chronic ankle instability, functional performance test*.

Introduction

Ankle sprains are the most frequent injuries sustained by athletes.[1,6] Literature reveals that ankle sprains may account for approximately 20% to 40% of all athletic injuries.[7-9] Eighty-five percent of ankle sprains are caused by excessive inversion.[10,11] When the ankle rolls inward at a high velocity, it may lead to stretching or tearing of the lateral ligament complex.[5,11,13] Ankle sprains are common among athletes who participate in sports that involve running on changing terrains, repetitive jumping, or frequent changes in direction, such as basketball, volleyball, soccer, football, and cross-country.[14,16] In basketball, the ankle may roll inward when a player awkwardly lands on an opponent's foot. [83] The injured basketball player may have heard a popping noise. Symptoms may include pain, swelling, and joint stiffness. Depending on the severity of the injury, the athlete may be able to ambulate cautiously with little or no pain, or may be unable or only partially able to bear weight on the injured ankle. [2, 17,19]

Basketball is one of the most popular sports in the world with over 450 million documented participants playing organized basketball in 213 countries.[20] It is gaining global popularity and has replaced soccer as the most popular sport in Asia and Australia.[20] As the number of basketball players has increased so has the burden of injury, particularly amongst young men and women. From 2000 to 2001, basketball was the most frequent cause of sports-related emergency department visits for youth and adolescents in the United States with 3,95,251 reported cases.[21].

Studies have identified ankle injuries as the most prevalent basketball-related injury [22,23,24,] due to swift changes in direction while running, the frequent jumping and landing while shooting and rebounding, and the contact with other players.[25,26] Recovery from ankle injuries may result in missed time and residual symptoms, such as pain, instability, and weakness.[27] Other effects include medical expenses, decreased strength, delays in muscle reaction time, disability, and impaired athletic performance.[22, 27, 28]

Injuries to the lateral ligaments of the ankle complex are among the most common injuries incurred by athletes.[29] Lateral ankle sprains are thought to be suffered by men and women at approximately the same rates; however, one recent report[30] suggests that female interscholastic and intercollegiate basketball players have a 25% greater risk of incurring grade I ankle sprains than their male counterparts. More than 23 000 ankle sprains have been estimated to occur per day in the United States, which equates to one sprain per 10 000 people daily.[31] The most common predisposition to suffering a lateral ankle sprain is the history of at least one previous ankle sprain.[32-36] In sports such as basketball, recurrence rates have been reported to exceed 70%.[32, 37] Repetitive sprains have also been linked to increased risk of osteoarthritis and articular degeneration at the ankle.[38, 39]

Residual symptoms after lateral ankle sprain affect 55% to 72% of patients at 6 weeks to 18 months.[40,41] The frequency of complications and breadth of longstanding symptoms after ankle sprain has led to the suggestion of a diagnosis of the ''sprained ankle syndrome''[42] and to the conclusion ''that there is no such thing as a simple ankle sprain.''[43] It has also been estimated that 55% of individuals suffering ankle sprains do not seek injury treatment from a health care professional.[32, 36] Thus; the severity of ankle sprains may often be underestimated by athletes, and current treatment strategies for lateral ankle sprains may not be effective in preventing recurrent injuries or residual symptoms.

Lateral ankle sprains are also referred to as inversion ankle sprains or occasionally as supination ankle sprains. Individuals who suffer numerous repetitive ankle sprains have been reported as having functional instability, [44, 45, 46] chronic instability, [47] and residual instability.[48] The multitude of terms used to describe the phenomenon of repetitive ankle sprains has led to confusion in terminology. For the purposes of this article, the following definitions will apply: *lateral ankle instability* refers to the existence of an unstable ankle due to lateral ligamentous damage caused by excessive supination or inversion of the rearfoot. This term does not differentiate whether the instability is acute or chronic. "*Chronic ankle instability"* (CAI) denotes the occurrence of repetitive bouts of lateral ankle instability, resulting in numerous ankle sprains.

Traditionally, CAI has been attributed to 2 potential causes: mechanical instability and functional instability. Tropp et al[49] discussed the notion of mechanical instability as a cause of CAI due to pathologic laxity after ankle-ligament injury. Freeman et al [44,45] first described functional instability in 1965 when they attributed CAI to proprioceptive deficits after ligament injury. A more recent definition of functional instability is the occurrence of recurrent ankle instability and the sensation of joint instability due to the contributions of proprioceptive and neuromuscular deficits.[28] while the dichotomy of functional and mechanical instability helps explain 2 common potential causes of CAI, it does not adequately reflect the complete spectrum of pathologic conditions leading to CAI. Specific insufficiencies interact to create either mechanical instability or functional instability. Functional instability may be caused by specific insufficiencies in proprioception, neuromuscular control, postural control, or strength. Mechanical instability may be caused by factors that alter the mechanics of one or more joints within the ankle complex. Potential mechanical insufficiencies include pathologic laxity, impaired arthrokinematics, synovial inflammation and impingement, and degenerative changes.

Chronic ankle instability may be caused by mechanical instability, functional instability, or a combination of this entities.[49, 28, 50]

Anatomy and biomechanics of the foot and ankle

Anatomy

The ankle complex comprises 3 articulations: the talocrural joint, the subtalar joint, and the distal tibiofibular syndesmosis. These 3 joints work in concert to allow coordinated movement of the rearfoot. Rearfoot motion is often defined as occurring in the cardinal planes as follows: sagittal-plane motion (plantar flexion-dorsiflexion), frontal-plane motion (inversion-eversion), and transverse-plane motion (internal rotation-external rotation).[51] Rearfoot motion, however, does not occur in isolation in the individual planes; rather, coordinated movement of the 3 joints allows the rearfoot to move as a unit about an axis of rotation oblique to the long axis of the lower leg. Rearfoot motion does not occur strictly in the cardinal planes because the talocrural and subtalar joints each have oblique axes of rotation. Coupled rearfoot motion is best described as pronation and supination. In the open kinetic chain, pronation consists of dorsiflexion, eversion, and external rotation, while supination consists of plantar flexion, inversion, and internal rotation.[52] In the closed kinetic chain, pronation consists of plantar flexion, eversion, and external rotation, while supination consists of dorsiflexion, inversion, and internal rotation.[52] The 3 major contributors to stability of the ankle joints are: (1) the congruity of the articular surfaces when the joints are loaded, (2) the static ligamentous restraints, and (3) the musculotendinous units, which allow for dynamic stabilization of the joints.

The ankle joint connects the lower leg to the foot and consists of 2 separate joints: the talocrural joint (TCJ) (ankle mortise) and the subtalar joint (STJ). The TCJ consists of the articulation of the distal aspect of the tibia and fibula with the talus.[53]

The distal aspect of the fibula is contained within a vertically oriented groove, the fibula notch, located on the lateral aspect of the tibia and situated between the anterior and posterior tibia tubercles.[54] The distal aspect of the tibia and fibula forms a protective housing that surrounds and articulates with the superior aspect of the body of the talus, the trochlea. The medial border of the housing consists of the medial malleolus, the distal portion of the tibia; the superior border consists of the pilon, a horizontal expansion of the tibia; and the lateral border consists of the lateral malleolus, the distal portion of the fibula.[19] During gait, range of motion of the TCJ consists of ground reactive dorsiflexion when the tibia moves forward over the foot; and plantar flexion, when the heel lifts off of the ground as the foot prepares for toe-off.[83] Although variability exists, normal range of motion of the TCJ is 50° of plantar flexion and 20° of dorsiflexion.[2, 55, 56]

The STJ consists of the articulation between the undersurface of the talus and the calcaneus (heel bone).[83] Motion of the STJ consists of eversion (the heel pivots outward) and abduction (the foot turns away from the midline), or inversion (the heel pivots inward) and adduction (the foot turns toward the midline)[83]

Although variation exists, average range of motion of the STJ is 25° to 30° of inversion and 5° to 10° of eversion. These ranges of motion are rarely exceeded during a normal walking or running gait.[56,57]

Normally, "during the stance phase of gait on even ground the heel strikes with minimal inversion at the STJ followed by eversion ranging from 5-10° at 10% of the walking cycle. From there, inversion occurs at the STJ reaching a maximum of 5° at 62% of the walking cycle. [57]"

The talus is the centerpiece of the lower extremity that connects the lower leg to the foot through its articulations with the TCJ and STJ. Shortly after the foot strikes the ground, the foot and ankle go through a series of motions that have been termed pronation. [58, 59] Pronation of the foot and ankle consists of the following movement patterns: dorsiflexion of the TCJ, positioning the wider anterior aspect of the trochlea within the ankle mortise; eversion of the calcaneus at the STJ; and the distal aspect of the talus, the talar head, dropping downward and inward. These adaptations maximize the surface contact area of the talus within the ankle mortise and the underlying calcaneus, temporarily transforming the ankle joint into a solid mass that connects the foot to the leg. Other motions occur during pronation that allow for increased mobility at the knee and midfoot articulations. The tibia rotates internally, allowing the knee joint to flex; and the navicular bone, a tarsal bone anterior to the talus, advances forward, thereby unlocking the midfoot articulations.[56,59]

Under normal circumstances, pronation of the foot and ankle permits the lower extremity to effectively absorb vertical and rotational forces associated with running, cutting, or landing from a jump without incurring injury.

Ligaments are soft tissue structures that connect one bone to another bone. The ligaments surrounding the ankle joint aid in providing passive support to the STJ and/or TCJ as these joints approach or exceed the end ranges of motion.[2] Ligaments are mainly constituted of dense parallel bundles of collagen fibers that are arranged in an undulating pattern (crimp). The crimp of the ligament has been equated to the action of a spring. When the ligament is placed under tension, the crimp of the ligament straightens; and collagen fibers are recruited to dissipate internal forces and resist excessive motion. If these forces do not exceed the mechanical strength of the ligament, pathological motion of the ankle is prevented; and the crimp of the ligament recoils. However, if the load surpasses the mechanical strength of the ligament and is applied at a fast velocity that exceeds the speed of a corrective muscle reflex, it may lead to microscopic failure of the collagen fibers or a complete rupture of the ligament.[19,60]

The ligaments that surround the ankle joint consist of the lateral collateral ligaments, syndesmotic ligaments, and the medial collateral ligaments (MCLs). The lateral collateral ligaments consist of the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and the posterior talofibular ligament.[1,53,28,61,83] The ATFL and CFL originate from the lateral malleolus; the former inserts onto the neck of the talus and the latter onto the calcaneus. The ATFL resists pathological inversion and plantar flexion of the ankle joint. The CFL resists excessive inversion of the ankle joint and is further stressed at the end ranges of dorsiflexion.[62]

The syndesmotic ligaments consist of the anterior inferior tibiofibular ligament (AITFL), interosseous ligament, posterior inferior tibiofibular ligament(PITFL), and the transverse ligament. The AITFL originates from the lateral malleolus of the fibula; travels medially, obliquely, and proximally; and inserts onto the anterior lateral tibia tubercle.[83] The interosseous ligament lies underneath the AITFL, originates from the anterior inferior aspect of the lateral malleolus, and inserts onto the anterior inferior aspect of the tibia. The PITFL originates on the lateral malleolus and inserts onto the posterior lateral tibia process , and the transverse ligament lies deep to the PITFL.[2,19,53,54,63] The function of the syndesmotic ligaments is to hold the fibula tight to the tibia, thereby preventing abnormal widening of the ankle mortise. During ground reactive dorsiflexion, the posterior aspect of the talus rotates 5° externally within the ankle mortise, the fibula rotates 3° to 5° externally, and the ankle mortise widens 1 to 2 mm.[64] Ogilvie-Harris et al conducted a study on cadaveric ankle models to evaluate the contribution of each syndesmotic ligament in maintaining an intact ankle mortise. The results indicated the following: AITFL, 35%; PITFL, 33%; interosseous ligament, 22%, and the transverse ligament, 9%.[65]

The MCLs consist of 3 superficial ligaments—the tibionavicular, tibiocalcaneal, and tibiotalar ligaments —and 2 deep ligaments—the anterior and posterior tibiotalar ligaments. These ligaments resist excessive eversion and external rotation of the ankle joint.[19, 53, 62]

Ligament factors

The ligament system plays a fundamental role in the ankle's stability and includes a talocrural complex and a subtalar complex that are functionally related. For the talocrural joint, three lateral collateral ligaments are present and one medial collateral ligament.

Lateral collateral ligament (LCL)

This ligament classically comprises three ligaments that insert on the fibula and terminate either on the talus or the calcaneus. The anterior talofibular ligament arises from the anterior edge of the lateral malleolus of the fibula, runs horizontally forward and downward and attaches to the neck of the talus, in front of the lateral malleolar facet. This very short ligament widens slightly from top to bottom. The calcaneofibular ligament, covered by the sheath of fibularis tendons, arises from the summit of the lateral malleolus and attaches below and behind on the lateral side of the calcaneus. Its main characteristic is related to its posterior orientation, along a 45◦ angle in relation to the lateral malleolus axis. [61,66,67,84]

The posterior talofibular ligament, located very deeply and very strong, extends horizontally from the excavation presented at the back by the lateral malleolus to the posterior side of the talus, immediately below the pulley of the talus. Possible morphological variations exist in this ligament arrangement [68] the anterior ligament can be doubled or there can be an accessory ligament between the anterior and middle ligament.[84]

Ankle biomechanics

The passive stability of the ankle is the responsibility of the ligaments and the bony constraints of the ankle joint, while the active stability depends on muscular support. The talus has no muscular insertion. Active motion depends on the long foot muscles inserting into other tarsal or metatarsal bones. Dorsiflexion and inversion are effected by the extensor hallucis longus and the anterior tibial muscles. Dorsiflexion and eversion are guided by the peroneus tertius muscles and extensor digitorum longus and brevis muscles. Plantar flexion and eversion are effected by the peroneus longus and brevis muscles. Plantar flexion and inversion are regulated by the flexor hallucis longus, the flexor digitorum, and the posterior tibial muscles.**[69]** The ligaments of the ankle can be divided into the lateral group, the medial group, and the ligaments of the syndesmosis.

The lateral ankle ligament complex is traditionally considered to consist of the anterior talofibular (ATFL), the calcaneofibular (CFL), and the posterior talofibular (PTFL) ligaments. However, in inversion the subtalar ligaments, especially the cervical ligament, the interosseous ligament, and the ligaments spanning the calcaneocuboid and the talonavicular joints, also have to be considered. Many studies have been done on talotibial ligaments to gain insight into how they function together to stabilize the joint. Of the talotibial ligaments, the ATFL is a thin 6-10 mm wide, 20 mm long, and 2 mm thick[70] weak ligament, being essentially a thickening of the anterior ankle joint capsule. It passes from the distal anterior origin of the lateral malleolus to the talus in front of the proximal part of the lateral articular surface. In neutral position its direction is parallel to a long axis of the foot and in full plantar flexion it is more parallel with the tibia.[85] The CFL is a 20-25 mm long rounded ligament with a diameter of 6-8 mm.[70] It is an extra-articular ligament closely associated with the peroneal tendon sheath. It runs obliquely downwards and backwards to be attached to the lateral surface of the calcaneus. There is a great variety in its direction and in its attachment sites.[69] A rupture to this ligament will also cause a rupture of the tendon sheath, and occasionally also damage the peroneal tendons.

The ATFL acts as a primary restraint against plantar flexion, as well as internal rotation of the foot.[71] In strain studies Renstrom et al[72] found that the strain of the ATFL significantly increases with increasing plantar flexion. In the neutral position the ligament is relaxed.[73]

The CFL does not have an independent role in talotibial joint stability, but acts instead as a guide for the axis of subtalar motion.[71] In dorsiflexion the ligament has increased strain.[72] In a Normal standing position the ligaments remain relaxed.

The lateral talocalcaneal (LTCL) extends from the talus to the calcaneus and blends its fibres with CFL and ATFL fibres. The exact incidence of injury to this ligament is not known. Transecting the subtalar ligaments results in very limited increase in motion when

Measured in degrees, but as they have very limited motion in the first place the increase after rupture is about 40%.[74] the incidence of rupture here is also unknown.

The PTFL connects the posterolateral tubercle of the talus to the medial aspect of the lateral malleolus. The PTFL has an average diameter of 6 mm. In plantar flexion and in the neutral position the ligament is relaxed, whereas in dorsiflexion the ligament is tensed.[69]The clinical significance of PTFL injuries is somewhat unclear, but it is not commonly damaged. The ATFL, CFL, and PTFL ligaments function as a unit for the talotibial complex, though one may resist a specific motion depending upon foot position.[75]

Through the full range of motion the ATFL and CFL act in synergy.[76-79] As the foot plantar flexes, the strain in the ATFL increases while the strain in the CFL decreases**.[72]**

Shybut et al[79] measured ankle ligament loads directly by using implanted buckle transducers. The results indicated that ligament loads remain low within the functional range of motion (10 degrees

of dorsiflexion to 20 degrees of plantar flexion). This supports the concept that ankle ligaments act as kinematic guides rather than primary restraints during normal activity.
Stormont et al [80] studied the stabilizing capacity of the ligaments and articular surface in the ankle with and without physiological loading. With loading, the results indicated that the articular surface becomes an important stabilizer, accounting for 30% of stability in rotation and 100% of stability in inversion. Without loading, the results indicated that the primary and secondary ligamentous constraints vary with testing modes and ankle position.

Mechanism of injury

The extent of tissue damage that will occur with the trauma depends not only on the mechanism and magnitude of the forces that act on the ankle but also on the position of the foot and ankle during the trauma.[69]
The most common mechanism causing lateral ligament injuries is a situation where the ankle goes into a combination of plantar flexion and inversion. The ATFL tears first followed by rupture of the anterolateral capsule. With further inversion, the CFL will be ruptured followed by variable injury to the PTFL and the anterior part of the deltoid ligaments.**[81]** With weight bearing, the articular surface can provide 30% of stability in rotation, and100% stability in inversion**.**[80] This ability is a function not only of the axial load but also of the close packed position.[82] Ankle destabilization thus occurs during loading and unloading, but the joint is stable once it is fully loaded.

Concepts of Chronic Ankle Instability

Chronic Ankle Instability (CAI) is defined as the perception by the patient of an abnormal ankle with a plethora of symptoms including recurrent sprains, pain, swelling and avoidance of activities.[88] It is generally classified into two components; mechanical instability and functional instability. Mechanical instability is the actual anatomical instability. It occurs when motion exceeds the physiological limit of the joint and with the presence of incompetent stabilizing structures. Laxity of the ankle joint can be demonstrated clinically or radiologically in mechanical instability.
Functional instability is defined by Freeman in 1965 as the subjective feeling of giving way which may occur despite the absence of deviation beyond the physiological range of motion of the talus.[45]
Patients may present with vague symptoms such as the sensation of the ankle or foot giving way easily. They may not have demonstrable clinical or radiological signs of laxity. It is thought to be attributed to proprioceptive and neuromuscular deficits. Hence, it is harder to define.
It has been reported in multiple studies that impaired proprioception such as abnormal peroneal muscle spindle activity and altered articular mechanoreceptor activity leads to functional instability of the ankle .[28,86,87,45,90,94.] In addition, altered neuromuscular control such as impaired neuromuscular recruitment patterns, abnormal reflex response to inversion or supination and increased peroneal response time also contributes to functional instability [28,86,87,45,90,94.] Interactions between mechanical and functional instability give rise to repetitive injuries and the chronicity of the ankle instability. Patients at risks for CAI tend to be predisposed structurally and functionally.
Examples of structural predisposition are tibia vara, varus, hind foot alignment and incompetent stabilizing structures like ligaments.[86, 87]
Anatomical deviations of the tibiotalar joint such as talar dome rotation, axis of rotation and position of the lateral malleolus can also contribute to ankle instability.[1, 7, 8] On the other hand, functional predispositions are poor postural control, impaired proprioception, strength deficits and poor neuromuscular control.[86, 87, 45,90]

Pathological Conditions

Chronic Ankle Instability

Forty to 75% of individuals with initial acute ankle sprains have a risk of recurrent sprains.previous study [44, 45] by Freeman identified chronic ankle instability (CAI) as chronic or repeated incidents of lateral ankle instability (LAI) with sprains. Proprioceptive input in the ankle joint may be decreased due to differentiation of lateral ligaments.[44] CAI results in the feeling of giving way and repetitive sprains with possible pain and swelling [28,45] CAI may be classified into MAI, FAI, or the combination of MAI and FAI.[28]

Mechanical Instability

Pathological conditions, including laxity, arthrokinematic restrictions, synovial irritation, or degenerative changes, may cause MAI in the ankle joints.[28] The pathological alterations after ankle sprain such as hyper mobility or laxity have been examined extensively at the talocrural joint .[95] The amount of damage to the lateral ligaments with the injury results in the amount of laxity in the ankle joint.[97] Laxity or hyper mobility can be found at the talocrural joint even though the ligaments are fully treated after an acute ankle sprain.[97] Increased joint laxity may cause recurrent ankle sprains in the common injury mechanism. A previous study[58] found that significantly more laxity at the talocrural joint had been measured in individuals with CAI through an anterior drawer and a talar tilt test while only 42% of CAI participants showed a positive anterior drawer test in another study.[96] Mechanical instability at the talocrural joint may be a common symptom, but it may not necessarily be presented in all individuals with CAI.[96]

Arthrokinematic change after the initial ankle sprain may also be the cause of recurrent ankle sprains in individuals with CAI.[98] Excessive anterior and inferior translation of distal fibula may occur due to less tightness of the ATFL in a resting position.[98] Pathological limited arthrokinematics may decrease the dorsiflexion range of motion (ROM) in the ankle joint**.**[28] Decreased dorsiflexion ROM may obstruct the ankle joint from reaching the closed-pack position.[28] Therefore, the athletic who suffers limited dorsiflexion may be exposed to a high risk of ankle injury mechanism due to allowing easier inversion and internal rotation. Additionally, MAI may lead to synovial inflammation and degenerative change in the ankle joint.[28]

Functional Instability

Functional ankle instability (FAI) can be described as a functional disability of the ankle.[45] Patients with FAI reported that a residual symptom of ankle sprains is the feeling of their foot giving way.[45] Twenty to 50% of individuals with initial ankle sprain reported residual symptoms.[45,99,82] On the other hand, one previous study reports that FAI may be a participative complaint of instability in the absence of mechanical disruption.**[100]** FAI may be linked to deficits in proprioception and neuromuscular control.[28] The neuromuscular system may play a role in dynamic support of the ankle[28] An individual's position sensor in the ankle joint becomes hampered when the ankle joint is injured. A disabled position sensor in the ankle joint may decrease its ability of proper stabilization which may prevent injury**.**[101] Decreasing proprioception function may decrease the ability to stabilize the joint which limits that joint's Range of Motion (ROM) excess beyond anatomical limitation. Loss in proprioception function may more likely be the cause of reoccurring ankle sprains.[45] A study conducted by Freeman et al[45] found that the damaged mechanoreceptor following ankle sprains may result in decreased proprioceptive input in the ankle joint. Additionally, Lentell et al[102] revealed that the damaged type II mechanoreceptor following ankle sprains may significantly decrease passive motion in the ankle joint.

Individuals who suffer from acute ankle sprain and CAI present impairments of postural control in the ankle joint.[28] Proper postural control in the ankle joint may be derived from an ankle strategy which maintains the center of gravity.[28] Additionally, research[103] has found that abnormal postural control ability may increase the risk of ankle sprains, and greater deficits in postural control have been found in individuals suffering from acute ankle injury than in health individuals without a history of ankle injury. Also, individuals with CAI presented a significantly lower outcome in the Star Excursion Balance Test (SEBT), one of the measuring tools for dynamic postural control, than the SEBT outcome for their uninvolved ankle.[104]

Quantifying Ankle Instability

The ankle conditions, FAI, MAI, and Copers, may be classified through the use of questionnaires. However, there is no gold standard tool which researchers and clinicians may apply to discriminate the various ankle conditions.

The Cumberland Ankle Instability Tool (CAIT) is a commonly used questionnaire.[106]The CAIT includes 9 questions to determine severity of ankle instability. A possible maximum score is 30, with a score greater than 28 indicating a highly stable ankle. A previous study[105] by Hiller et al. found that the score of 27.5 shows the maximum of Youden's index (68.1 = sensitivity (%) + specificity (%) – 100). The sensitivity of CAIT is 82.9% and specificity is 74.7% with a positive likelihood ratio of 3.27 and a negative likelihood ratio of 0.23.[105] Thus, Hiller et al.[105] suggested that clinicians and researchers may apply the score of 28 as an indicator of ankle instability. A score less than 28 but greater than or equal to 24 indicates moderately unstable ankle.[106] This measure has shown significant high test-retest reliability (0.96).[105] The CAIT has also shown significant correlation with the Lower Extremity Functional Scale and the Visual Scale**.**[105]

Kinesio tape

Kinesio Tape (KT) was developed in the 1970s by a chiropractor named Dr. Kenzo Kase.[107] KT came into the public eye after the 2008 Olympics in Beijing, China, when it was worn by many high profile athletes. KT is an elastic tape that is 100% cotton and is supposed to resemble the thickness of the epidermis, can stretch up to double of its original size causing a constant pull on the skin, can also be worn for up for 5 days, and is water resistant.[107,110] Since it is water resistant, it can be worn during aquatic sports, unlike other adhesive tapes. During manufacturing of the tape, the tape is applied to a substrate paper with a 10% stretch applied to the tape.[110] According to the manufacturers of the KT tape, the tape causes micro convolutions, or folds, in the skin which causes a lifting of the skin away from the tissue underneath.[110] This facilitates a release of pressure on tender tissues underneath and provides space for lymphatic fluid movement. KT is purported to have many physiological and biological effects on the body including: (1) it corrects muscle function by strengthening weak muscles, (2) it improves circulation of blood and lymph by lifting the skin and fascia, (3) it decreases pain through neurological suppression, (4) it repositions out of places joints by relieving irregular muscle tension and muscle imbalances which helps to return the function of fascia and muscle to normal, (5) it increases proprioception through an increase stimulation to cutaneous mechanoreceptors from the stretch of the tape on the skin.[111,112]

According to the Kinesio Taping Association International, [113] there are four different types of tape application strips available including: an I strip, a Y strip, an X cut, and a fan cut. There are also different tension guidelines that are used to have different biological effects on the body. There is the super light tension that is 0-10% which will affect the epidermis. Then there is the paper off tension at 10-15% which will affect the lymphatic system. Then there is light tension at 15-25% which is has an inhibitory effect on muscle. Then there is moderate tension at 25-35% which is used to facilitate the muscle. Next is severe tension at 50-75% which is used for mechanical and functional corrections, then the full tension is 75-100% which is used for ligament corrections.[113] There are two basic KT muscle application concepts, inhibition and facilitation. Inhibition is used for overused muscles from acute conditions or muscle spasms. Facilitation is used for weak muscles from chronic conditions or for rehabilitation. For inhibition, the tape will be applied with 15-25% tension in the direction from the insertion of the muscle to the origin of the muscle. For facilitation, the tape will be applied with a 25-35% tension in the direction from the origin of the muscle to the insertion.[113] There have been studies that have looked at KT effects on proprioception,[111,114] pain,[112,115,118] range of motion, [112,117] strength,[120-122]functional performance, [108,123] and balance, [124] but this study will only focus on function performance as very few study available previously.

KT is latex free and quick drying, and is typically applied in single strips and left on the skin for 3 to 5 days at a time. When it is used to prevent ankle sprains, it may be better tolerated and more cost effective than taping with non-elastic athletic tape. Due to its elastic properties, the ability of KT to enhance functional stability of the ankle relies on its purported effects on proprioception and muscle activation rather than mechanical support.[125]

Ankle taping is the major method in preventing ankle injuries in sports players.[126] Kinesio taping is an increasingly popular, alternative method of taping. It uses Kinesiotape - a coloured, elastic tape which can be stretched prior to application - to provide a constant shear force to the skin. Rather than being structurally supportive, as white athletic tape is, Kinesiotape claims to be therapeutic. Murray and Husk [114] propose a further mechanism, that kinesiotape causes an increase in joint position sense through stimulation of cutaneous mechanoreceptors. Through these mechanisms it is proposed that Kinesiotape will promote healing and improve functional dynamic balance, as measured by the SEBT.

Several studies have examined the effect of taping, particularly the use of white athletic tape, in CAI. Matsusaka et al.[128] demonstrated that taping has a positive effect on functional ankle instability, though Hume and Gerrard [129] reported that in rugby union players, bracing would be more effective than taping, which makes little difference. Whilst there are a number of papers investigating the effects of Kinesiotape, a great deal of these examines its effect on those with healthy ankles, not in those with CAI. However Briem et al.[130] comparing Kinesiotape, white tape and no tape conditions, found no difference in muscle activity between Kinesiotape and no tape conditions, whilst white tape led to an increase in muscle activity.

The scarcity of papers exploring the potential of Kinesiotape to not just structurally support but also promote healing of the chronically unstable ankle was therefore one of the fundamental reasons for this study. The main aim of this study being to investigate the effect of the Kinesiotaping method and tape on subjects with a chronically unstable ankle during the Star Excursion Balance Test. The hypothesis being that Kinesiotaping would lead to a statistically significant improvement in function when applied to a chronically unstable ankle, due to those methods proposed by Kase.[127]

Photo 1. Kinesio taping application in chronic ankle sprain.

Tape strips comprising Kinesio tape job. Numbers indicate order of application. (Photo 1)
The Kinesiotape was applied to the unstable ankle as for a lateral ankle sprain.[131] the subject's foot was placed in a relaxed position initially with the foot up. Firstly, a strip of tape was placed from the anterior midfoot to immediately inferior to the tibial tuberosity, over the tibialis anterior muscle, whilst being stretched at 120% of its length. The second strip was applied from the medial malleolus, round the heel, and just below the lateral malleolus. The first branch was applied anteriorly, the second posteriorly, to the lateral malleolus and from there onwards both ran to attach laterally to the end of the first tape. The third strip was stretched to 140% and was applied across the ankle, just covering the medial and lateral malleoli. Finally, the fourth strip was applied from the arch and stretched to six inches above both malleoli.[111]

Photo 2. Athletic taping application in ankle

In the athletic taping method. 1.Place one pad over the front of the ankle and the other over the back of the ankle. These pads will help prevent blisters. Then cover the foot and ankle with pre-wrap going from the arch of the foot up to the start of the calf muscle. Use the spray adhesive to help secure the pre-wrap. Apply the spray adhesive according to the manufacturer's instructions, and only apply as high as the pre-wrap will be placed. **2**. Place two anchors of athletic tape at either end of the pre-wrap as shown. **3**. Place a stirrup of athletic tape starting from the inside of the ankle, under the heel and attaching to the other side of the anchor of athletic tape. Add two more stirrups of athletic tape so you have three total. **4.** Close up all areas of pre-wrap.**5.** Create a figure 8 by starting on the inside and wrapping around the lower leg, then crossing over the top of the ankle and continuing to wrap under the arch**. 6.**Tape around the heel for a “heel lock.” You can alternate either inside or outside, but make sure to do two “heel locks” for each side**. 7**. Complete another figure of eight. **8**.Close up any open areas of tape by applying pre wrap again.[144] (Photo 2)

In the placebo taping method Athletic tape was used for the placebo taping method. 'I' shaped tapes were cut and applied with no tension.[108] (Photo 3)

Photo 3.Placebo taping method application.

Method

Subjects

There were 25 collegiate basketball players between the ages 18 to 23 years old were recruited from different colleges in Ahmedabad. All subjects had CAI which was determined by the Cumberland Ankle Instability Tool (CAIT). (Table 1)

Participants were included if they: (1) participated in an intercollegiate basketball program in varsity or junior varsity level under the supervision of a coach during the 2017 seasons, (2) multiple episodes of the ankle giving way within the past 12 months,(3) To be included in the study, participants had to have sustained at least one ankle sprain from a sudden inversion trauma, at least one month prior, which resulted in pain and swelling over the lateral ligament and limping, and(4) have at least moderate functional ankle instability, defined as a score of <25 on the Cumberland Ankle Instability Tool (CAIT) [105.]

Participants were excluded from the group (1) if they had history of lower extremity,(2) had symptoms of an acute ankle sprain (3) lower limb surgery, injury to knee or hip or low back injury.(4) had history of fractures in the previous 12 months, (4) were free of any diagnosed balance or vestibular disorders, and (5) had no history of concussion in the previous one month. (5) have used KT on the ankle.

Before participating in the study, all subjects read and signed an informed consent form.

Functional performance test

The five functional tests -figure-of-8 hop test, side-hop test , square hop test and single hop test , 6 meter cross over test were selected to provide different challenges to the ankle. The order of Functional performance tests were random and were determined by participants. On one day following a10-min warm-up (including 5-min cycling and 5-min stretching movements), subjects performed three trials of each FP test with a 30 second rest between trials and a 2-min rest between tests to minimize fatigue. After completing the warm-up period, each participant performed each test procedure three times with maximum effort, and the best of these three trials was recorded as the final score for each individual test. A 2-min rest was given in between each trial to decrease the chance of fatigue .The investigators provided standardised verbal encouragement during each trial to consistently optimise test performance. No feedback was given to participants for the duration of testing. For those tests where time was measured, a stopwatch was used and time recorded to the nearest hundredth of a second.

1**. Single limb hop test**-For the single-hop test, participants were instructed to hop forward as far as possible. The distance was recorded from the position of the toes on the starting line to the end of the jump to the nearest 0.01 m [132] If the subject fell or was unable to maintain balance during the test period, the trial was discarded and repeated. Best of 3 trial was taken for measurement. Using 3 trials, reliability for this test was excellent, with an intraclass correlation coefficient (ICC) of 0.93.

2. Figure-of 8 hop test- a 5-m course outlined by cones was used.[133] Each participant was instructed to hop on 1 limb, twice around the course, as fast as possible. We marked any trials in which a participant put the contra lateral foot down, fell, missed the stopwatch pad, or did not complete the course as outlined as unacceptable and asked to perform the trial again. Using 3 trials, reliability for this test was excellent, with an intraclass correlation coefficient (ICC) of 0.95.

3. Side hop test, all participants were instructed to hop on 1 limb laterally over a 30-cm Distance[133] One repetition constituted hopping laterally 30 cm and back to the starting location. Each participant completed 10 repetitions and was instructed to do so as quickly as possible. If a participant fell, put the contra lateral foot down, missed the stopwatch pad, or did not completely clear the 30-cm distance while hopping the trial, we recorded the trial as unacceptable and the participant repeated the trial again.Trial reliability was conducted for this test and determined to be good with an intraclass correlation coefficient an ICC of 0.84.

4. 6-meter crossover hop test, a line 6 m long was used. The participants were instructed to hop on 1 limb diagonally over the 15-cm-wide line, alternating sides for the entire 6 m, as fast as possible We recorded a trial as unacceptable if the participant put the contra lateral foot down, fell, missed the stopwatch pad, or did not completely clear the width of the line. The trial was repeated if not acceptable. Trial reliability for this test was excellent, with intraclass correlation coefficient an ICC of 0.96.

5. Square hop consists of a 40 x 40 cm square marked on the floor with tape (photo 12). Starting outside of the square, participants were instructed to hop in and out of the square as fast as possible

for 5 repetitions. One repetition constituted hopping in and out of the tape outline completely around the square back to the starting point. With the right limb, participants hopped in a clockwise direction and, with the left limb, they hopped in a counterclockwise direction. When a participant fell, put the contra lateral foot down, hopped in the wrong direction, missed the stopwatch pad, did not completely clear the outline of the tape on the right and left sides of the square, or did not clear the outline of the tape on the top and bottom of the square with the balls of the feet, we marked the trial as unacceptable and the participant repeated the trial. Trial reliability for this test was good, with an intraclass correlation coefficient ICC of 0.90.
For all participants, we recorded the time to complete each test and used the mean of the 3 trials for each test for statistical analysis.

Statistical Analysis

Data was presented as mean ± SD. Data was analyzed using the Statistic Package of Social Sciences (SPSS) version 16.0. The mean of the 3 readings i.e. final score of each Functional performance test was used for statistical analysis. Intra group comparison was done using the Friedman test and z test was used to examine the difference in measurement between conditions. Results were considered to be statistically significant at $P<0.05$.

Results

The purpose of this study was to determine how the use of Kinesio Tape will improve the functional performance of college level of basketball player in case of chronic ankle instability. The data that was collect on each subject was based on 5 variables; single limb hop test, figure of 8 hop test,6 meter cross over hop test, side hop test, square hop test. Each subject has four different measures -without taping, placebo taping, athletic taping and kinesio taping for 5 different functional performance test variable. The participant sample was 25 college student-athletes from different college.There was highly significant difference in performance among the five different functional performance tests. Participants performed equally well with kinesio taping and athletic taping and performed worse with placebo taping and without their ankle tape.

Characteristics	N	Minimum	Maximum	Mean	Standard deviation
Age(years)	25	18	23	20.68	1.57
Height(cm)	25	160	180	170.6	4.33
weight(kg)	25	60	75	68.92	3.94
BMI	25	19.6	27	23.74	1.80
CAIT score	25	18	25	20.84	2.11

Table 1. Descriptive statistics of collegiate basketball player**.** Mean, SD and range for age, height, weight, CAIT score for all participants. CAIT score is out of 30 with a score of ≤ 24 indicative of functional ankle instability.

Single-limb hopping test-interpretation

There was highly significant difference in performance among the four variables on the single-limb hopping test (p=0.001) and F value 50.32. Participants completed the single-limb hopping test with the kinesio tape applied in 163.92 ± 19.64 cm, with the athletic tape applied in 156 ± 20.03 cm,with placebo taping in 148.08± 17.55 and without tape in 141.6 ± 17.55 cm (Table 2).

	Variance	Minimum	Maximum	Mean	Standard Deviation	Friedmen Test Value	P Value
Single limb hop test	Without taping	107	195	141.6	17.5546	50.328	0.001**
	Placebo taping	119	205	148.08	17.5544		
	Athletic taping	120	212	156	20.0333		
	Kinesio taping	120	217	163.92	19.6488		

Table 2. Friedmen test to assess the effect of various taping on single limb hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant

Single-limb hop test –interpretation

Pair wise comparison of the single limb hopping test in the four different occasions without taping, with placebo taping, with athletic taping, and with kinesio taping with 6 different variation by the LSD test revealed a highly statistically significant difference found between without taping versus athletic taping (p=0.0343) in favor of athletic taping and highly significant differences between without taping versus kinesio tapping (p =0.00001) in favour of kinesio taping. Also, a highly statistically significant difference between placebo taping versus kinesio taping (p=0.0013) favoring kinesio taping. Moreover, pair wise comparison of the ankle stability outcomes without taping versus placebo taping, placebo taping versus athletic taping and athletic taping versus kinesio taping indicated a no statistically significant difference found. (Table 3).

Sr No.	Variance	N	Z Value	P Value
1	Without taping Vs Placebo taping	25	1.3051	0.0959 ^
2	Without taping Vs Athletic taping	25	2.7032	0.0034 **
3	Without taping Vs Kinesio taping	25	4.2356	0.00001**
4	Placebo taping Vs Athletic taping	25	1.4867	0.0685 ^
5	Placebo taping Vs Kinesio taping	25	3.006	0.0013**
6	Athletic taping Vs Kinesio taping	25	1.4113	0.0790 ^

Table 3. Z test to comparison between various taping on single limb hop test in college level basketball athlete.

Level of significance p≤0.05

** - highly significant

^ - not significant

There was highly significant difference in performance among the four variables on the Figure of 8 hop test (p=0.001) and F value 51. Participants completed the Figure of 8 hop test with the kinesio tape applied in 12.51 ± 4.70 sec, with the athletic tape applied in 19.77 ± 3.86 sec, with placebo taping in 25.86 ± 2.65sec and without tape in 29.66 ± 2.24 sec (Table 4).

	Variance	Minimum	Maximum	Mean	Standard Deviation	Friedmen Test Value	p Value
Figure of 8 hop test	Without taping	27.32	39.42	29.6628	2.2489	51	0.001**
	Placebo taping	22.52	31.13	25.8696	2.6508		
	Athletic taping	9.23	26.12	19.7796	3.8617		
	Kinesio taping	9.11	27.10	12.5152	4.7064		

Table 4. Friedmen test to assess the effect of various taping on Figure of 8 hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant

Figure of 8 hop test-interpretation

Pair wise comparison of the figure of 8 hop test in the four different occasions without taping, with placebo taping, with athletic taping, and with kinesio taping with 6 different variation by the LSD test revealed a highly statistically significant difference found between without taping versus placebo taping (p =0.00001) ,without taping versus athletic taping (p=0.00001) in favour of athletic taping and highly significant differences between without taping versus kinesio tapping (p =0.00001) in favour of kinesio taping. Also, a highly statistically significant difference between placebo taping versus athletic taping (p=0.00001) and placebo taping versus kinesio taping (p=0.00001) favoring kinesio taping. Moreover, pair wise comparison of the ankle stability outcomes athletic taping versus kinesio taping indicated a statistically significant difference (p=0.02442) found. (Table 5).

Sr No.	Variance	N	Z Value	P Value
1	Without taping Vs Placebo taping	25	5.4562	0.00001**
2	Without taping Vs Athletic taping	25	11.0578	0.00001 **
3	Without taping Vs Kinesio taping	25	16.4375	0.00001**
4	Placebo taping Vs Athletic taping	25	6.5015	0.00001**
5	Placebo taping Vs Kinesio taping	25	12.3652	0.00001**
6	Athletic taping Vs Kinesio taping	25	1.9696	Significant

Table 5. Z test to comparison between various taping on figure of 8 hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant
* - Significant

There was highly significant difference in performance among the four variables on the 6 meter cross over hop test (p=0.001) and F value 27.48. Participants completed the Figure of 8 hop test with the kinesio tape applied in 8.34 ± 2.78 sec, with the athletic tape applied in 9.11 ± 3.05 sec, with placebo taping in 10.27 ± 2.19sec and without tape in 12.92± 1.16 sec (Table 6).

	Variance	Minimum	Maximum	Mean	Standard Deviation	Friedmen Test Value	p Value
6 Meter Cross hop test	**Without taping**	**11.12**	**14.9**	**12.9272**	**1.1627**	**27.48**	**0.001****
	Placebo taping	**7.18**	**14.75**	**10.2724**	**2.1974**		
	Athletic taping	**5.15**	**15.12**	**9.1152**	**3.0534**		
	Kinesio taping	**4.23**	**13.47**	**8.3468**	**2.7841**		

Table 6. Friedmen test to assess the effect of various taping on 6 Meter Cross over hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant

6 meter crossover hop test- interpretation

Pair wise comparison of the 6 meter crossover hop test in the four different occasions without taping, with placebo taping, with athletic taping, and with kinesio taping with 6 different variation by the LSD test revealed a highly statistically significant difference found between without taping versus placebo taping (p =0.00001) ,without taping versus athletic taping (p=0.00001) in favour of athletic taping and highly significant differences between without taping versus kinesio tapping (p =0.00001) in favour of kinesio taping. Also, a highly statistically significant difference found between placebo taping versus kinesio taping (p=0.00001) favouring kinesio taping.

Moreover, pair wise comparison of the ankle stability outcomes placebo taping versus athletic taping and athletic taping versus kinesio taping indicated a no statistically significant difference found (Table 7).

Sr No.	Variance	N	Z Value	P Value
1	Without taping Vs Placebo taping	25	10.7438	0.00001**
2	Without taping Vs Athletic taping	25	8.9294	0.00001**
3	Without taping Vs Kinesio taping	25	7.5922	0.00001 **
4	Placebo taping Vs Athletic taping	25	1.5382	0.062^
5	Placebo taping Vs Kinesio taping	25	6.4196	0.00001 **
6	Athletic taping Vs Kinesio taping	25	0.9257	0.1773 ^

Table 7. Z test to comparison between various taping on 6 Meter Cross over hop test in college level basketball athlete.

Level of significance p≤0.05

** - highly significant

^ - not significant

Side hop test-interpretation

There was highly significant difference in performance
Among the four variables on the side hop test (p=0.001) and F value 39.09.
Participants completed the Figure of 8 hop test with the kinesio tape applied in 8.05 ± 1.84 sec, with the athletic tape applied in 9.15 ± 2.10 sec, with placebo taping in 10.44 ± 1.60 sec and without tape in 11.19± 0.78 sec (Table 8).

	Variance	Minimum	Maximum	Mean	Standard Deviation	Friedmen Test Value	p Value
Side hop test	Without taping	9.76	13.11	11.1928	0.7819	36.096	0.001**
	Placebo taping	7.25	12.48	10.4476	1.6001		
	Athletic taping	5.65	13.10	9.1528	2.1010		
	Kinesio taping	5.10	12.5	8.0568	1.8412		

Table 8. Friedmen test to assess the effect of various taping on side hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant

Side hop test -interpretation

Pair wise comparison of the side hop test in the four different occasions without taping, with placebo taping, with athletic taping, and with kinesio taping with 6 different variation by the LSD test revealed a highly statistically significant difference found between without taping versus athletic taping (p=0.00001) in favour of athletic taping and highly significant differences between without taping versus kinesio tapping (p =0.00001) in favour of kinesio taping. Also, a highly statistically significant difference found between placebo taping versus kinesio taping (p=0.00001) favouring kinesio taping.

Moreover, pair wise comparison of the ankle stability outcomes without taping versus placebo taping (p=0.018219), placebo taping versus athletic taping (p=0.036639) and athletic taping versus kinesio taping (p=0.024881) indicated a statistically significant difference found.(Table 9).

Sr No.	Variance	N	Z Value	P Value
1	Without taping Vs Placebo taping	25	2.092	0.0182 *
2	Without taping Vs Athletic taping	25	3.2598	0.0011**
3	Without taping Vs Kinesio taping	25	8.5171	0.00001**
4	Placebo taping Vs Athletic taping	25	1.7911	0.03663 *
5	Placebo taping Vs Kinesio taping	25	4.9011	0.00001**
6	**Athletic taping Vs Kinesio taping**	**25**	**1.9620**	**0.0248***

Table 9: Z test to comparison between various taping on side hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant
* - Significant

Square hop test-interpretation

There was highly significant difference in performance among the four variables on the square hop test (p=0.001) and F value 32.90.
Participants completed the Figure of 8 hop test with the kinesio tape applied in 8.03 ± 2.54 sec, with the athletic tape applied in 8.98 ± 2.01 sec, with placebo taping in 9.74 ± 1.81 sec and without tape in 11.55± 0.82 sec (Table 10).

	Variance	Minimum	Maximum	Mean	Standard Deviation	Friedmen Test Value	p Value
Square hop test	Without taping	10.32	12.8	11.5520	0.8297	32.904	0.001**
	Placebo taping	7.32	13.34	9.7460	1.8150		
	Athletic taping	6.02	13.10	8.9824	2.0144		
	Kinesio taping	4.21	12.34	8.0368	2.54866		

Table 10. Friedmen test to assess the effect of various taping on square hop test in college level basketball athlete.
Level of significance p≤0.05
** - highly significant

Square hop test –interpretation.

Pair wise comparison of the side hop test in the four different occasions without taping, with placebo taping, with athletic taping, and with kinesio taping with 6 different variation by the LSD test revealed a highly statistically significant difference found between without taping versus placebo taping(p=0.00001), without taping versus athletic taping (p=0.00001) in favour of athletic taping and highly significant differences between without taping versus kinesio tapping (p =0.00001) in favour of kinesio taping. Also, statistically significant difference found between placebo taping versus kinesio taping (p=0.003148) favouring kinesio taping.

Moreover, pair wise comparison of the ankle stability outcomes placebo taping versus athletic taping (p=0.07952) and athletic taping versus kinesio taping (p=0.072752) indicated a no statistically significant difference found.(Table 11).

Sr No.	Variance	N	Z Value	P Value
1	**Without taping Vs Placebo taping**	**25**	**4.5263**	**0.00001 ****
2	**Without taping Vs Athletic taping**	**25**	**5.8989**	**0.00001****
3	**Without taping Vs Kinesio taping**	**25**	**6.5582**	**0.00001****
4	**Placebo taping Vs Athletic taping**	**25**	**1.4083**	**0.07952 ^**
5	**Placebo taping Vs Kinesio taping**	**25**	**2.7320**	**0.00314 ***
6	**Athletic taping Vs Kinesio taping**	**25**	**1.4556**	**0.0727 ^**

Table 11. Z test to comparison between various taping on side hop test in college level basketball athlete.

Level of significance p≤0.05

** - highly significant

* - Significant

^ - not significant

Discussion

Numerous researchers have reported the effect of kinesio tape (KT) for function, pain and ROM in the past in several studies. .However, the results are mixed and further investigation are warranted .The purpose of this study was to investigate the effect of kinesio taping on functional performance in chronic ankle sprain in college level basketball players.. The main findings of the current study showed that the four different measures (without taping, placebo taping, athletic taping, and kinesio taping) revealed a statistically significant differences ($p < 0.05$) between different occasion(a) without taping versus placebo taping, (b)without taping versus athletic taping,(c) without taping versus kinesio taping ,(d) placebo taping versus athletic taping,(e)placebo taping versus kinesio taping,(f) athletic taping versus kinesio taping in figure of 8 hop test and side hop functional performance test..

The significant effect of KT on functional performance test in patients with chronic ankle sprain found in this current study may be attributed to number of hypotheses. First, the presence of impaired proprioception following a lateral ankle sprain, it is biologically plausible that KT may increase afferent input and hence improve measures of proprioception. [134] Second, KT could increase the self-efficacy of the individual with an unstable ankle, potentially resulting in greater confidence, stability and assurance when performing the five different functional performance test. Also, this come in agreement with the study of Pijnappel,[135] who found that KT favor other types of tapes in improving postural control and attributed this to the stimulation of the cutaneous extroceptors from the foot and ankle . In our study, KT was found to improve dynamic postural stability in five different functional performance test which may be attributed to its application on patients with chronic ankle sprain. In addition, Murray and Husk, [114] showed that KT enhanced proprioception in individuals who had ankle pathology, because it allowed to have its effect on injured tissue .On the other hand, Halseth et al, [111] reported that KT appears to have no effect as their studies performed on healthy ankles.

It was theorized that KT mimics the properties of the skin's epidermis. Specifically, the tape's elasticity creates a constant pull on the skin, subsequently providing constant proprioceptive information to the area of the body it covers. Elastic therapeutic tape also, has some unique attributes: its heat activated, retains its skin-adhesion properties for up to five days, and is water resistant. According to manufacturers, elastic therapeutic tape lifts the skin away from the underlying tissue to facilitate a release of pressure on injured structures.[110]

The effect of traditional tape provides superior benefits than no tape may regard to deceleration of inversion velocity and facilitation of dynamic neuromuscular protective mechanisms. Furthermore, tape offers a means to address the complex interrelated biomechanical factors that are responsible for subtalar joint injury and rotatory instability of the talocrural joint.[136]

The results of the current study showed that kinesio taping improve the performance on functional test performed by college level basketball player with chronic ankle sprain.

This is in agreement with study done by Zajt- Kwiatkowska et al.,[137] who stated that the application of Kinesio tape increased the functional capabilities of participants with acute ankle sprain. This could partly explain the differences as the current study used participants with CAI and in an immediate sense, Kinesiotape may allow a more rapid return to painless movement, though ultimately leading to the same degree of recovery. [111] The present study was, however, consistent with Hedrick, [138] who found that it was not possible to determine whether or not Kinesiotape had any effect on the ankle. It has also been suggested that subjects with chronic ankle instability perceive greater stability, confidence and reassurance when tape is applied to that ankle even if functionally there appears to be little difference. [8,139]. Therefore any benefit which may have been discovered may not be entirely due to the tape itself, rather the individual's perception of tape having been applied.

In our study we found little improvement in functional performance with placebo taping that is supported by study conducted by Sawkins et al.,[8] participants reported improved perceptions of stability, confidence, and reassurance with the placebo tape in place while performing functional tests. The hopping tests are useful functional performance tests because they require multiple demands such as muscular strength, neuromuscular coordination, and joint stability.[140] In this study the authors found significant difference between all function performance test in athlets with kinesio taping and athletic taping.when individuals perform with athletic and kinesio taping were able to be found significant difference than the performance of athlets with placebo and without taping.

Whilst taping with white athletic tape is still very popular and may help with mechanical instability [141] in supporting the chronically unstable ankle, Kinesiotape claims to have therapeutic properties [127] due to the function of the tape. Functional performance can be affected by various components of the ankle and lower limb, many of which are theoretically enhanced by Kinesiotape. The elasticity of Kinesiotape is unique compared to standard white athletic tape and reportedly leads to the enhancement of joint function [142] as the tape aids the lymphatic and circulatory systems, releasing abnormal muscle tension, thereby restoring normal function. It does this by lifting the skin, producing a greater gap between skin and muscle, allowing more space for blood and lymphatic flow, leading to increased muscle function.[143] Increased ankle proprioception due to Kinesiotape is another matter of some dispute, with Halseth et al [111] reporting that Kinesiotape appears to have no effect, while Murray and Husk, [114] showed that Kinesiotape enhanced proprioception. As this present study did not look specifically at the increase in blood flow or any change in proprioception at the ankle due to Kinesiotape, it cannot neither be accepted nor rejected that Kinesiotape may have these effects on muscle and the ankle, though as this study demonstrated that Kinesiotape did not lead to increased reach distances and hence improved functional performance, all of the theoretical effects of Kinesiotape warrant further investigation.

Kase and Hashimoto[127] state that Kinesiotape takes effect within 10 minutes of application, however an increase in the time granted forthe Kinesiotape to produce its effect may be of benefit to any further study. Thelen et al.[119] found an early benefit (within one day) in subjects with shoulder injuries to whom Kinesiotape was applied, rather than within minutes. As Kinesiotape is in some cases regarded as primarily for rehabilitation, [138] particularly in dealing with chronic issues such as CAI, which take longer to heal than an acute ankle sprain, further time for effect could be of benefit.

Conclusion

In conclusion, based on the findings of the study, the only difference between Kinesio Tape and athletic taping will be seen in all 5 functional performance test. It is also been determined by this study that when the subject's perform functional performance test with kinesio tape were able to determine if the tape helped or hindered their progression in any way throughout the study. One of the main claims of Kinesio Tape is that the tape will increase interstitial lymphatic fluid flow and reduce edema.

In collegiate basketball player with CAI, the application of Kinesiotape to the unstable ankle produces significant immediate difference to the subject's functional performance. This illustrates that the use of Kinesiotape on a chronically unstable ankle has benifical effect on functional performance in these subjects. This suggests that it will be benefit in using Kinesiotape as used in this study in the treatment of chronic ankle instability.

To understand further the role of Kinesiotape in chronic ankle instability, and indeed if it does have any role, more research is required, both into the degree of CAI which requires treatment beyond conservative management and the effects which Kinesiotape can have on the ankle under different conditions. The potential for Kinesiotape to play a part in the rehabilitation of CAI subjects, assisting in more rapid recovery, could be very important in future for sports players, both past and present.

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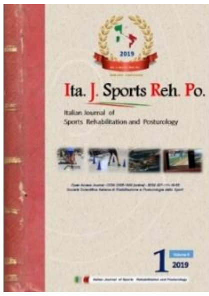

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