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### RESEARCH ARTICLE

#### EFFECT OF KINESIO TAPE ON ANKLE JOINT POSITION SENSE AND EVERTORS PEAK TORQUE IN FOOTBALL PLAYERS FOLLOWING EXERCISE INDUCED FATIGUE.

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#### Abstract

**Aim:** This study aimed to assess whether the application of Kinesio taping (KT) of peroneus longus muscle would maintain ankle joint position sense (JPS), and evertors peak torque (EPT) in football players following exercise-induced fatigue. **Methods:** Forty football players from 1<sup>st</sup> and 2<sup>nd</sup> divisions of professional Saudi football leagues volunteered in this study. Volunteers were randomly assigned to Kinesio tape group (KTG) or control group (CG). Volunteers' ankle JPS, at 10<sup>0</sup> inversion and full range of motion of inversion -5<sup>0</sup> (FROM - 5<sup>0</sup>), and EPT were evaluated at baseline and following fatigue protocol. Volunteers in KTG were taped after baseline evaluation. **Results:** this study showed that volunteers in KTG recorded a non-significant difference of absolute angular error (AAE) post fatigue compared to baseline for both target angles. While volunteers in CG showed significantly higher AAE post-fatigue compared to baseline for both target angles. Further, KTG showed a significantly lower AAE post fatigue at target angle 10<sup>0</sup> inversion compared to CG. EPT was significantly lower post fatigue compared to baseline in KTG and CG. Further, post fatigue EPT was non-significantly different between KTG and CG. **Conclusion:** KT application might help in maintaining JPS, but not EPT following exercise-induced fatigue in football players.

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#### Introduction:-

The ankle joint is one of the most commonly injured parts of the body for individuals who participate in competitive activities, accounting for approximately 30% of all sports related injuries (Hootman et al., 2007; Martin et al., 2013; Waterman et al., 2010). Ankle injury information pointed out that ankle sprains were the most common ankle injury in 33 different sports (Fong et al., 2007). Further, lateral collateral ankle sprains were reported in 77 % of ankle ligaments injuries (Fong et al., 2009). The high incidence of ankle sprains in sports called for prophylactic measures where several interventions had been recommended (Porter and Rushton, 2015).

Kinesio tape (KT) is an adhesive tape frequently used in sports to serve different purposes including pain reduction and restoring range of motion (ROM) (Gonzalez-Iglesias et al., 2009), muscle facilitation and inhibition (Fayson et

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al., 2015; Subasi et al., 2016), and improving of joint function, and stability (Chang et al., 2010; Hsu et al., 2009). Further, proprioception is suggested to be enhanced due to stimulation of cutaneous mechanoreceptors during the KT application to the skin (Chang et al., 2010). Fatigue of supporting muscles is one of the reported factors that increases the risk of inversion ankle sprains (Gabbett, 2000). Some level of fatigue will be expected and achieved during athletic practice or competition (Ament and Verkerke, 2009). It is reported that neuromuscular control of the ankle is affected during fatigue period influencing ankle dynamic stability (Woods et al., 2003). Likely, the contribution of fatigue in risk of inversion ankle sprains result from altering ankle joint position sense (JPS) (Mohammadi and Roozdar, 2010). Evertor muscles are of interest since ankle evertors help in preventing inversion injuries which is the most common mechanism of lateral ankle ligaments injuries (Willems et al., 2002; Wilson and Madigan, 2007)

Whether the suggested effects of KT on proprioception and muscle activity could counteract the effect of fatigue of ankle evertors is not clearly investigated. Accordingly, this study aimed to check the effect of application of KT to peroneus longus muscle on ankle JPS and EPT following exercise-induced evertor muscles fatigue.

#### **Methods:-**

This was a pre-post control group study. Forty uninjured football players from first and second divisions of Saudi professional football leagues volunteered to participate in the study. G\*power software was used to calculate sample size at power of 0.8. Players were excluded from the study if they previously sustained skeletal injuries or had surgeries of the ankle and foot. In addition, if they had history of first time ankle sprain within the last 3 months, or complain of chronic ankle instability. Further, if they had any open wounds of the leg, ankle and foot, skin diseases, or known hypersensitivity to tape materials. Players who volunteered and were illegible to participate were allocated randomly to one of the two equal study groups; Kinesio tape group (KTG) or control group (CG). Random number generator (<http://www.randomizer.org>) was used to generate two unsorted independent sets of numbers between 1-40 without repetition. Every enrolled player was allocated to the set in which his order of enrollment appeared. Volunteers had explanation of the aim and procedures of the study. Volunteers signed an informed consent form to confirm their participation prior to data collection. The institutional review board of Imam Abdulrahman Bin Faisal University provided ethical approval for this study.

#### **Procedures:-**

Volunteers had one visit to the laboratories of department of physical therapy, college of applied medical sciences, Imam Abdulrahman Bin Faisal University, where the study was conducted. Each volunteer was introduced to the laboratory and had a brief explanation of the isokinetic dynamometer used in the study. Then, demographic data (age, weight, and height) were recorded. Afterwards, the volunteer started warm up for 10 minutes on treadmill and 5 minutes on bicycle ergometer in preparation to evaluation and fatigue protocol. Evaluations of ankle JPS and EPT at baseline and post fatigue as well as the fatigue protocol were carried out on Biodex multi-joint system 4 (Biodex Medical Systems, Shirley, New York, USA), and were the same for volunteers in both KTG and CG. Previous literature reported non significantly different JPS comparing dominant and non-dominant legs (Lephart et al., 1998; McLoda et al., 2009). Likewise, Dabadghav (2016) demonstrated non – significantly different isokinetic inverter/evertor strength between dominant and non- dominant legs. Accordingly, the right leg was selected for test in this study for all volunteers.

#### **Evaluation:**

##### **Evaluation of ankle joint position sense (JPS)**

Ankle JPS was evaluated using Biodex multi-joint system 4. Active angle- reproduction test, which is a valid and reliable test to measure the ankle joint proprioception (Drouin et al., 2004), was used in evaluation of JPS. Volunteers were positioned based on the manufacturer's guidelines for assessing JPS for ankle joint. Volunteer under evaluation sat on Biodex chair and examiner stabilized him by chest and waist belts. The right knee was positioned and fixed with a dynamometer attachment at 45° knee flexion while his right thigh was supported and straps were used to stabilize of the leg. The tested foot was fitted with special foam shoe, placed on the footplate, and stabilized by two velcro straps that secured the foot to the ankle attachment (Fig 1).

First, the examiner explained test procedures to the volunteer. Two target positions were tested, 1) Active inversion to 10°, 2) active inversion full range of motion minus 5° (FROM -5 °), starting from neutral ankle position. A blind draw was used to randomize the order of testing for each volunteer. During the assessment, the volunteer was blindfolded to prevent any visual information from distorting the test. The volunteer performed a familiarization trial

to adapt to the test setup before beginning the data collection. Then, measurements were conducted where the volunteer carried out a set of 3 repetitions for each target angle. Each repetition consisted of two consecutive steps; first, was a training repetition where the volunteer actively moved to the target angle where the dynamometer held the position for 10 seconds, and volunteer was asked to concentrate on this angle to reproduce it during the next step. The second step was the recording trial, where volunteer moved his foot to the position he perceived to be the target angle then he stabilized the platform. Volunteers were allowed 20 seconds rest between trials of the same target angle, and one minute rest between the two target angles. Absolute angular error (AAE) was used as outcome parameter. Average of AAE of the 3 recording trials of each target angle was used for analysis.



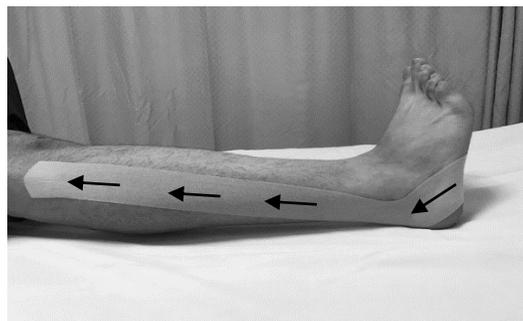
**Fig 1: Testing ankle JPS**

#### **Evertors peak torque (EPT)**

Biodex multi-joint system 4 was utilized to record peak torque of concentric ankle eversion for volunteers in both groups, before and after the fatigue protocol. The Biodex multi-joint system 4 is valid and reliable to measure the EPT (Tankevicius et al., 2013). The volunteer maintained the same position used for evaluation JPS on the Biodex multi-joint system 4. For familiarization with the isokinetic measure, each volunteer performed 3 consecutive submaximal inversion/eversion contractions with an angular velocity of  $120^\circ/\text{sec}$ . Afterwards, during the isokinetic testing, volunteer's EPT was recorded from 3 consecutive maximal force at  $60^\circ/\text{sec}$ . Examiner asked the volunteer to use safety button that allowed him to terminate the test at any time if he felt that it was too hard (Fu et al., 2008).

#### **Kinesio taping (KT) application**

The KT (Kinesio® Tex Gold™ FP) was used in this study. The KT was applied by the same therapist who well trained in applying KT. Tape was applied from insertion to origin, which was used to inhibit the muscles activity (Kase et al., 2010). During application, the volunteer rested in supine lying, and the length of the I-strip (2-inch in width) used in taping was taken as  $2/3$  of the volunteer's leg length. The anchor of the tape started without tension from the lateral side of the base of 1<sup>st</sup> metatarsal bone and lateral side of cuneiform bone, then over lateral border of the foot crossing the lateral side of cuboid (Gray, 2000). Then the ankle was plantar flexed and inverted to increase tissue tension on the lateral aspect of the ankle. The tape was stretched about 25% of its original length as it passed behind the lateral malleolus, all through the path of peroneus longus up to the head of fibula. (Kase, 2005) (Fig.2).



**Fig 2: KT application Fatigue inducing exercises protocol.**

Volunteer performed the exercise protocol that aimed to induce fatigue on Biodex multi- joint system 4 using isokinetic mode. Preset angular velocity in direction of eversion was set to 60°/s, while in inversion it was set to 400°/s. This very high preset angular velocity in inversion direction was intended to provide very light resistance to invertor muscles. Thus, protocol targeted mainly evertor muscles fatigue. The repetitions of fatigue protocol were 50 cycles of eversion/inversion. Repetitions were set according to a previous study of ankle plantar flexion fatigue protocol (Larsson et al., 2006). Thus, it was considered that 50 repetitions were sufficient for the less bulky evertors. Volunteer's position was similar to that used in evaluation of isokinetic muscle strength. During the fatigue protocol examiner provided verbal encouragement to the players were encouraged to exert as hard pushing as possible and to reach the full range of motion during each repetition (McNair et al., 1996).

### Statistical Analysis

Statistical package for the social sciences (SPSS) for windows 17.0 was used to do all the statistical analysis. Mean and standard deviations was given as descriptive statistics. For each dependent variable a mixed model ANOVA used for each dependent variable. The between factor variable was groups (KTG, CG). Within subjects factor was evaluation times (Baseline, post fatigue). P value was < 0.05.

### Results:-

Table (1) shows demographic characteristics for volunteers in the KTG and CG. The results show no statistical differences between volunteers in both groups concerning all recorded data at (P<0.05).

**Table 1:-** Volunteers' demographic characteristics

Variables	Groups		Independent t-test P value
	KTG (n=20) Mean (±SD)	CG (n=20) <sup>a</sup> Mean (±SD)	
Age (years)	25.8±3.75	24.4±3.29	0.471
Weight (kg)	70.4±6.67	72.55±5.59	0.255
Height (cm)	171.95±4.06	172.6±3.69	0.510
BMI (kg/m <sup>2</sup> )	23.76±1.45	21.01±1.50	0.707

P < 0.05

### Joint Position Sense (JPS)

Evaluation of JPS of the ankle at 10° and FROM -5° inversion target positions was done using active reproduction of active ROM. The outcome measure was mean absolute angular error (AAE). Results showed significant main effect of fatigue on JPS (F (3, 36) = 6.573, P=0.001). Also, significant interaction between JPS and groups (F (3, 36) = 3.932, P=0.016). Between groups comparisons showed non-significant difference at baseline. While, post fatigue evaluation showed significantly less AAE in KTG compared to CG at 10° inversion. On the contrary, no significant difference between AAE for both groups at FROM -5°. Within groups comparisons showed significantly higher AAE post fatigue compared to baseline in the control group at 10°, and FROM -5° inversion. Meanwhile, the difference at KT group for 10° and FROM -5° inversion was not significant comparing baseline and post fatigue evaluations (table 2). The results indicated that the KT maintained the JPS at both targets after the fatigue protocol.

**Table 2:-** Comparison of mean (AAE) for volunteers in KTG and CG at pre and post fatigue evaluation at 10° and FROM -5°

Evaluations	Groups		Pairwise comparisons	
	KTG Mean (+ SD)	CG Mean (+ SD)	F- Stat.	Sig.
Baseline 10°	2.4 (+ 1.19)	2.21 (+ 1.41)	0.850	0.362
Post fatigue 10°	2.44 (+ 1.26)	3.56 (+ 1.59)	6.146	0.018*
Pairwise comparisons F-stat Paired Sig.	0.142 0.708	11.626 0.002*		
Baseline FROM -5°	1.96 (+ 1.33)	2.17 (+ 1.19)	0.399	0.602
Post fatigue FROM -5°	2.76 (+ 1.54)	3.84 (+ 3.04)	0.763	0.165
Pairwise comparisons F-stat Paired Sig.	2.300 0.138	10.089 0.003*		

\* P < 0.05

### Evertors peak torque (EPT)

The statistical results showed significant main effect of fatigue on EPT ( $F_{(1, 38)} = 23.327, P < 0.001$ ). While the interaction effect between EPT and groups was non-significant ( $F_{(1, 38)} = 0.377, P < 0.543$ ). Pairwise comparisons showed significant reduction of EPT following fatigue in both KTG and CG. On the other hand, between groups pairwise comparisons showed non-significant difference between mean EPT both at baseline and post evaluations (Table 3).

### Discussion:-

The aim of this study was to investigate the effects of KT on ankle proprioception, and isokinetic peak torque after evertor muscles fatigue. This would give a clue whether KT application to ankle evertors could help in preventing lateral ankle sprains.

**Table 3:-** Comparison of mean Eversion peak torque (EPT) for volunteers in KTG and CG at pre and post fatigue evaluation

Evaluations	Groups		Pairwise comparisons	
	KTG Mean (+ SD)	CG Mean (+ SD)	F- Stat.	Sig.
Pre fatigue EPT (Nm)	16.39 (3.73)	16.81 (4.49)	0.106	0.747
Post fatigue EPT (Nm)	13.76 (3.34)	13.42 (4.72)	0.069	0.794
Pairwise comparisons F-stat Paired Sig.	8.885 0.005*	14.819 0.000*		

\*  $P < 0.05$

### Joint position sense (JPS)

The results of the study showed that using KT maintained the ankle JPS following the fatigue protocol at  $10^\circ$  and FROM  $-5^\circ$  inversion positions in KTG. On the contrary, ankle JPS significantly decreased at both angles following fatigue in the control group. AAE compared post fatigue was significantly lower in the KTG at  $10^\circ$  inversion compared to CG. These results suggest that the application of the KT might be beneficial to maintain the ankle JPS if applied before the football match or training.

Bjorklund et al. (2001) suggested that fatigue may influence the mechanoreceptors in the muscles around the ankle joint, thus adversely affects ankle proprioception. It is suggested that KT helps skin to stretch as much as possible by creating enough space between the skin and the muscles. Such stretching enhances proprioception through increasing the stimulation of cutaneous mechanoreceptors (Chang et al., 2010; Halseth et al., 2004; Kase and Kase, 2003).

The results of this study indicate that there was no significant difference in AAE between KT and control groups at FROM  $-5^\circ$  following fatigue protocol. Normally close to the end range of joint motion stretching of the skin and stimulation of cutaneous mechanoreceptors takes place (Riemann and Lephart, 2002). Thus, the postulated mechanism by which KT enhances proprioception would be available for players in both groups near the end range. Accordingly, this might have closed the gap between the reported AAE in both groups at FROM  $-5^\circ$  inversion. This finding was supported by a recent study who investigated the effect of KT on ankle proprioception in 26 individuals who had experienced ankle sprain (Seo et al., 2016). The study assessed joint position sense during dorsiflexion/plantarflexion and inversion/eversion. The study found that joint position sense after Kinesio taping was improved immediately in the dorsiflexion and inversion positions. On contradiction to the results of the present study, a previous RCT investigated the effect of KT on ankle proprioception in 68 healthy individuals immediately after KT application and 48 hours later and found that KT did not improve the ankle proprioception (Miralles et al., 2014). Differences from current study may result from different KT application, difference in time of measurements, and presence of fatigue protocol in the current study. Briem et al. (2011) analyzed the effect of KT compared to non-elastic sports tape in 51 male athletes. The author found non-elastic sports tape better in improving dynamic ankle muscles' support. Further, they suggested that efficacy of KT is unlikely to prevent ankle sprain via the same mechanism. However, this study was a repeated measure crossover study under different conditions. It was not clear in their report whether they allowed a wash out time or not. Further, effect of fatigue in the current study may be a source of difference. Furthermore, in another contradicting study, Halseth et al. (2004) concluded that KT did not change in proprioception at the ankle plantar flexion and plantar flexion with inversion in healthy subjects.

Differences in outcomes compared to current study may be related to the application of fatigue protocol and participation of athletes in the current study. Besides, the difference in ankle positions during testing in both studies.

### **Evertors Peak Torque (EPT)**

The results of this study suggested that EPT decreased significantly following fatigue in both KTG and CG, with no significant differences between mean EPT of both groups post fatigue. In the current study, it was hypothesized that applying KT with inhibition technique would minimize evertors activity during fatigue protocol. Thus, KT would likely reduce the effect of fatigue on evertors and maintain EPT. However, findings showed that KT was not able to maintain EPT following fatigue. The reason might be that the application of KT might had created a lower EPT baseline immediately following application, before fatigue protocol. Such possibility could not be verified in this study as it lacked an immediate assessment of EPT following application and before fatigue. Either way, EPT non-significant difference between KTG and CG post fatigue suggests that the application of KT would not achieve the required outcome. The current findings are supported by the result of the study by Strutzenberger et al. (2016) who investigated whether gluteal KT might enhance strength of lower limbs muscles with or without fatigue in rugby players. They demonstrated that following muscles fatigue KT was not able to influence the leg's explosive strength. Likewise, Yeung et al. (2015) conducted an investigation about the effect of KT on peak torque of the knee extensors following fatigue. They reported that the peak torque was not maintained following fatigue protocol. On the other hand, study's findings came inconsistent with the study of Ahn et al. (2015) who found that KT was effective in restoring the peak torque of quadriceps muscle after muscle fatigued induction of 45 healthy participants. Authors in Ahn's study applied KT extensively over vastus medialis, vastus lateralis, and rectus femoris. They attributed their results to facilitation of motor function due to cutaneous afferent stimulation. Therefore, extensive cutaneous stimulation might cause their effects in contrast to current study.

### **Conclusion:-**

Results of this study suggest that KT could be helpful in preventing lateral ankle sprains in football players. This likely effect could be achieved through maintaining ankle JPS in inversion, rather than maintaining EPT, following evertor muscles fatigue.

### **Conflict of Interest:-**

The authors declare that they have no conflict of interest.

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