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KinesioTape® Influence on Female Functional Ankle Instability: Preliminary Findings

Ana Duarte[1] and Tiago Atalaia[1*]

[1]Physiotherapy Department, Portuguese Red Cross Health School, Avenida de Ceuta, Edifício Urbiceuta, Piso 6, 1300-125 Lisbon, Portugal.

Authors' contributions

This work was carried out in collaboration between both authors. Author AD managed the literature searches, wrote the protocol, managed the experimental process, managed the statistical analysis and wrote the first draft of the manuscript. Author TA designed the study and managed the analysis of the study. Both authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

Aims: The purpose of this study was to verify the influence of Kinesiotape® (KT) and exercise on functional ankle instability score measure by the Y-test in female soccer athletes.
Study Design: Interrupted time series with treatment removal.
Place and Duration of Study: Futebol Clube Benfica. Between January 2014 and March 2014.
Methodology: Six female athletes with a mean age 22.5 (+/- 3.02) years old, mean weight 59.9 (+/- 9.9) kg, height 163.3 (+/- 6.5) cm and with functional ankle instability participated. Ankle instability was measured by the Y-Test at four different times: initial measure, after two weeks without any treatment, three weeks after KT application period and three weeks after the specific exercise plan application.
Results: The sample was reduced to five participants (7 feet) with functional ankle instability. After analysis, 57.1% of the sample benefited from the use of KT in at least two of the three directions measured. On the other hand, 42.9% showed positive changes for the anterior reach direction apparently because of the specific exercise programme for ankle instability. The Wilcoxon test

**Corresponding author: Email: tatalaia@esscvp.eu;*

results revealed statistically significant differences in the composite reach distance associated with the use of KT (P = 0.01). Significant differences were reported (P< 0.05) in the anterior reach direction related to the implementation of the exercise plan.
Conclusion: A tendency for a functional improvement of the ankle instability in the study population was observed by the use of KT. Differences between the use of KT and the exercise plan were unclear.

Keywords: Ankle instability; physical therapy; kinesiotape®; rehabilitation.

1. INTRODUCTION

Ankle sprain is one of the most common injuries of the musculoskeletal system, accounting for nearly 80% of total injuries in sports like soccer [1,2,3]. Sometimes, the optimal recovery period is not observed, leading to an increased probability of reinjures as consequence of remaining deficits [1,4,5]. These deficits normally include joint instability, as mechanoreceptors present in joint capsules; ligaments and tendons/muscles [6] are damaged by the excessive joint motion that leads to the ankle sprain. This damage diminishes the joint stability by means of its passive and active component [7]. This change in joint stability control can then allow movements to become easily excessive, as a joint fails to control its movement efficiently. These neural deficits are demonstrated in the changes in proprioception and muscle contraction time and synchronisation. Functional difficulties are then experience in daily life tasks, especially in situations that need weight bearing on the unstable ankle joint, sometimes with presence of pain, discomfort or sudden episodes of giving away [1,4,8,9]. Other studies indicate that during ankle inversion mechanism, the first control of the movement is done by the deceleration caused by the contraction of the fibular muscles, as a normal protective response. As a consequence of injury, the activation time of the fibular muscles is increased, leading to deficits in the reflex arc. Thus, the active joint protective mechanisms are delayed with an associated increment of injury recurrence [6,10,11].

One of the KinesioTape® (KT) theoretical benefits relies on the normalisation of muscle activity made by the tape stimulation at the skin and related muscles, which can contribute to a better joint alignment [12,13]. This benefit has been demonstrated in several studies which addressed ankle instability, in comparison with healthy subjects [14,15,16,17]. The expectation is that the tape will decrease the activation time of the fibular muscles, contributing to better ankle stability levels.

A further intervention typically associated with ankle instability consists of carrying out rehabilitation programmes which focus on progressive functional training, including stretching, muscle strengthening, balance training and motor coordination. This kind of intervention has demonstrated positive results in lowering the risk of injury recurrence by approximately 60% [9,18,19], with improvements in dynamic postural control and decreased sensation of instability in day-to-day activities and sports [3].

The purpose of this study is to verify whether changes in the ankle instability occur by the application of KT at the fibular muscles, and whether this approach leads to better results than those obtained by a specific exercise programme for ankle instability, in a sample of female soccer athletes with functional ankle instability.

2. METHODOLOGY

2.1 Participants

Twenty two female athletes volunteered to participate prior to the explanation of the study objectives and procedures. All signed informed consent before being submitted to clinical assessment for ankle functional instability as defined by Konradsen and Ravn [6]. Six athletes (mean age =22.5 ± 3.02 years old; mean weight=59.9 ± 9.9 kg; mean height=163.3 ± 6.5 cm) presented ankle instability. Three of them had unilateral instability and the other three had bilateral instability. Inclusion criteria were medical history of ankle sprains caused by inversion mechanism (at least one case) leading to functional impairment for 24 hours or more; pain sensation or discomfort in the affected foot in daily life activities; sense of instability during daily activities; and instability when performing soccer

related moves. The exclusion criteria were presence of leg/foot surgery in the last six months; presence of vestibular system problems; and presence of traumatic brain injury in the last three months.

2.2 Instruments

2.2.1 Y-test procedures

The Y-test is a simplified form of Star Excursion Balance Test (SEBT) and it execussion can be observed in Fig. 1. Due to its multifactorial approach (challenges postural control, strength, range of motion and proprioception of the hip, knee and foot), it is considered a good injury risk forecaster for lower limb injuries. In this test, female athletes with a composite reach distance less than 94% of their limb length were 6.5 times more likely to have a lower extremity injury. On the other hand, athletes with a right/left anterior reach distance difference greater than 4 cm have 2.5 times more chance to get injured [20].

The Y-test presents intra-rater reliability values that vary from 0.85 to 0.91 and inter-rater reliability values that vary between 0.99 and 1.0, due to its simplicity. Having only three directions (anterior, posteromedial and posterolateral), it avoids muscle fatigue during performance [20,21]. The posteromedial direction is apparently the most representative measurement of the subject's performance. In association with the anterior reach, it has enough sensitivity to detect individuals with ankle instability [21,22].

The score of the Y-Test can be simple or composite, both of which express the reach distance as a percentage of the limb length (LL). The simple score is calculated by dividing the mean of distance reach, in any of the three directions, for the limb length and then multiplying by 100 (e.g.:[direction reach/ LL]*100). The composite score is obtained, dividing the sum of the mean reaches in the three directions with the limb length and then multiplying by 100 [21,23]. This normalisation procedure is needed in order to compare results between the athletes in the study and then compare with other studies that use the same measurement system.

To perform the Y-test, athletes were instructed both verbally and by test demonstrations carried out by the examiner. The examiner indicated the order of the test (clockwise or counter-clockwise). The test was classified as null and repeated if the athlete: a) was not capable of maintaining one-foot balance with minimal oscillation; b) lifted or moved the stance foot from the grid; c) touched down with the reach foot; d) failed to return the reach foot to the starting position before the examiner gave the command to proceed with the test, thus moving in a different direction. The process is repeated while standing on the other leg, alternating between both lower limbs to avoid fatigue [21,23].

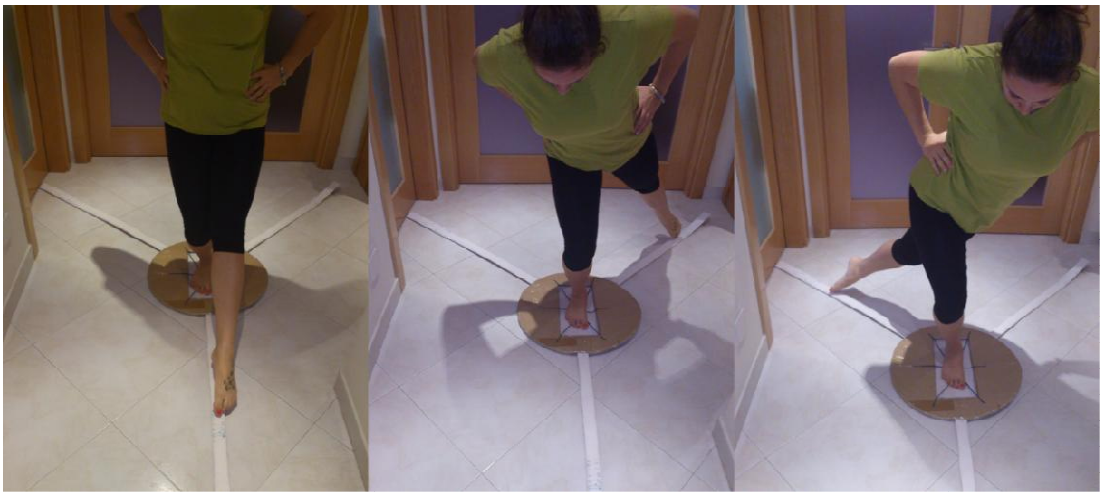

Fig. 1. Y-test execution with the three directions: anterior, postero-lateral and postero-medial (with permission)

2.2.2 Kinesiotape® procedures

In this study, the use of KT by the athletes was intended for a correct stimulation of the fibular muscle considering that we are working on intramuscular recruitment and coordination of motor units, and so increasing and synchronising motor units which will consequently proportion a correct experience of the desired movement during daily life activities and training itself [24,25,26]. Studies conclude that the rise in strength ratio is due to the increase of speed of information conducted, which is shown by a bigger amplitude on the electromyography signal in the early stage of muscle contraction. This increase happens about 20 days after the start of a three-week muscle strengthening exercise programme [26,27]. As mentioned earlier, the fibularis muscles (brevis and longus) have a key role in the protection of the ankle joint when an excessive inversion movement occurs [6,10,11]. Therefore, KT was applied in order to stimulate these muscles, as described by the KT application instructions, from the insertion in the upper lateral shaft of the fibula, to the insertion of the first (fibularis brevis) and fifth metatarsals (fibularis longus), with 10% tension, technical paper off (5,24). KT was then applied three times by an expert Physical Therapist, in a cycle of five days of use and two days of rest, during a period of three weeks. An application example can be observed in Fig. 2. Note that the band overpasses the knee joint, without any tension applied, as it improved the tape adherence during the time of application.

2.2.3 Specific exercise plan procedures

A training programme that consists of stretching exercises, muscle strengthening around the ankle joint (with and without theraband), neuromuscular control and functional tasks for individuals with ankle instability was implemented [29]. The authors showed beneficial results regarding the deficits presented in either daily life activities or training, in a short period of time [29]. This programme will only be executed for three weeks so we can match the time the athletes were subjected to KinesioTape®. The plan will then be initiated at the start of every training session, three times a week with 30 minutes duration, supervised by a sports expert Physical Therapist. He will be allowed to correct/adjust the difficulty of exercises, when necessary.

2.2.4 Data collection procedures

As mentioned earlier, muscular strength increment happens about 20 days after the start of a three-week muscle strengthening exercise programme [26,27]. To address KT influence on ankle instability, a first period of two weeks was conducted, including two Y-test measurements, one at the beginning of the two weeks and the other at the end of that period. This allowed us to describe the behaviour of the Y-test score without any treatment being applied. After the two weeks, the second phase of the study started with the application of the KT for three weeks, at the end of which, another Y-test measure was carried out. The last phase consisted of the implementation of the exercise plan specific to the functional ankle instability for three weeks, following which the final Y-test measure was done.

2.2.5 Study design and statistical approach

This study consisted of design interrupted time series with treatment removal and statistical analysis by the application of the Wilcoxon text, which allows correlating all data obtained with the Y-test. The Wilcoxon test was used due to the fact that the sample did not present a normal distribution. Statistical data computation was performed using IBM's SPSS Statistics software (version 20.0).

3. RESULTS AND DISCUSSION

Of the six athletes initially selected only one could not complete the study due to an injury in the left knee. The sample was then reduced to five participants (7foot's) with functional ankle instability.

Table 1 presents the score variation of Y-test assessments. In the first assessment, 66.7% of participants showed a bilateral difference higher than 4cm in the anterior reach direction and 33.3% demonstrated a composed score of less than 94%. In the assessment preformed following KT application, the percentage of anterior reach differences higher then 4cm decreased to 28.57%, with no changes observed in the percentage of composed scores under 94%. In the assessment after the programme of specific exercises, an increase in the anterior reach percentage of participants with scores higher than 4cm was observed (42.86%), but the composed score showed a decreased percentage of scores under 94% (28.57%).

Fig. 2. Example of KT application (with permission)

Table 1. Differences in Y-test's measurements along the study

Reach	Anterior direction			Postero-medial direction			Postero-lateral direction			Composite score		
n=7	SN	KT	PIEx	SN	KT	PIEx	SN	KT	PIEx	SN	KT	PIEx
L1	6.56	3.71	2.34	-0.08	8.91	6.81	-4.65	10.22	4.54	0.61	7.61	4.57
L2	-3.84	10.54	0.12	-5.05	0.55	2.09	-0.79	0.36	-1.9	-3.24	3.82	-0.12
L3	0.6	0.32	2.38	8.83	1.85	-0.93	-1.35	-0.49	0.5	2.7	-0.56	0.65
L4	0.76	1.83	-0.04	-1.35	0.01	-0.11	-8.97	4.97	-1.06	-3.18	2.28	-0.42
L5	0.43	1.54	0.97	0.47	4.51	-1	4.83	0.73	-1.04	1.91	2.28	0.31
L6	-0.34	-3.84	1.63	0.11	3.13	-3.31	2.33	0.73	-1.04	0.75	0.56	-0.81
L7	-3.68	-0.37	3.36	-11.48	2.82	12.02	-12.37	0.5	6.34	-10.38	0.64	7.24

Legend:
SN- correlation between the base values measured on the 1st and the 2nd evaluation without any specific program for ankle instability.
KT - correlation between the measurement in the 2nd and 3rd assessment, before and after KinesioTape® placement.
PLEX- correlation between the measurement in the 3rd and 4th assessment, when the athletes were subject to a exercise program for ankle instability.
L1, L2, L3, L4, L5, L6 and L7- code name for seven feet with ankle instability.

In the analysis of Table 1, we can see that 57.1% of the athletes benefited from KT application in at least two directions of the Y-test, and 42.9% benefited from the use of the rehabilitation programme with specific exercises for functional ankle instability.

Data presented in Table 1 show the scores obtained by the athletes in the different phases of the study, in the directions measured by the Y-test. It is possible to see that 57.1% of the study sample benefited from the use of KT in at least two of the three directions tested. On the other hand, 42.9% had positive changes in the anterior reach direction, relative to being submitted to the specific exercise programme designed for ankle instability.

The Wilcoxon test results in Tables 2 and 3 show that significant changes ($P<0.01$) were obtained for the compose score and posterior-medial reach direction score with the use of KT. The implementation of the exercise plan resulted in significant differences ($P<0.01$) only in the anterior reach direction.

According to these results, the use of KT seems to create a positive effect that is maintained with execution of the exercise plan. Observing the differences between the scores of the non-treatment phase and the exercise phase, no conclusive result can be obtained whatever the exercise plan does has an effect on the scores of the Y-test more than the effect observed by the KT application.

Table 2. Wilcoxon test-data ranking

Reach		Anterior direction			Postero-medial direction			Postero-lateral direction			Compositescore		
Ranks		**N**	**Mean rank**	**Sum of ranks**	**N**	**Mean rank**	**Sum of ranks**	**N**	**Mean rank**	**Sum of ranks**	**N**	**Mean rank**	**Sum of ranks**
SN- Vbase	Negative Ranks	3a	3.67	11	4a	4.25	17	5a	4	20	3a	6	18
	Positive Ranks	4b	4.25	17	3b	3.67	11	2b	4	8	4b	2.5	10
	Ties	0c			0c			0c			0c		
	Total	7			7			7			7		
KT- SN	Negative Ranks	2d	5	10	0d	0	0	2d	2.5	5	0d	0	0
	Positive Ranks	5e	3.6	18	7e	4	28	5e	4.6	23	7e	4	28
	Ties	0f			0f			0f			0f		
	Total	7			7			7			7		
Plex-Kt	Negative Ranks	1g	1	1	3g	2.67	8	4g	3.5	14	3g	3	9
	Positive Ranks	6h	4.5	27	4h	5	20	3h	4.67	14	4h	4.75	19
	Ties	0i			0i			0i			0i		
	Total	7			7			7			7		
Plex-SN	Negative Ranks	2j	1.75	3.50	3j	2.67	8	4j	3.50	14	2j	3.50	7
	Positive Ranks	5k	4.90	24.50	4k	5	20	3k	4.67	14	5k	4.20	21
	Ties	0l			0l			0l			0l		
	Total	7			7			7			7		

Legend:
SN- Vbase - correlation between the base values measured on the 1st and the 2nd evaluation without any specific program for ankle instability.
a. SN < Vbase;
b. SN > Vbase;
c. SN = Vbase ;
KT-SN - correlation between the measurement in 3rd , after KinesioTape ®, and the 2nd assessment, without any specific program for ankle instability.
d. KT < SN;
e. KT > SN;
f. KT = SN;
PLEX-KT - correlation between the measurement in the 4th assessment, when the athletes were subject to an exercise program for ankle instability, and 3rd after using KinesioTape ®.
g. Plex < KT;
h. Plex > KT;
i. Plex = KT;
Plex-SN - correlation between the base values measured on the 1st and the 4th evaluation, after the athletes were subject to an exercise program for ankle instability.
j.Plex < SN;
k. Plex > SN;
l. Plex = SN.

Table 3. Wilcoxontest-statistical data

Reach	Anterior direction				Postero-medial direction				Postero-lateral direction				Composite score			
Statist	**SN-Vbase**	**KT-SN**	**Plex-KT**	**Plex-SN**	**SN-Vbase**	**KT-SN**	**Plex-KT**	**Plex-SN**	**SN-Vbase**	**KT-SN**	**Plex-KT**	**Plex-SN**	**SN-Vbase**	**KT-SN**	**Plex-KT**	**Plex-SN**
Z	-0.507	-0.676	-2.197	-1.778	-0.507	-2.366	-1.014	-1.014	-1.014	-1.521	0	0	-0.676	-2.371	-0.845	-1.183
Asymp. Sig. (2-tailed)	0.612	0.499	0.028	0.075	0.612	0.018	0.31	0.310	0.31	0.128	1	1	0.499	0.018	0.398	0.237
Exact Sig. (2-tailed)	0.688	0.578	0.031	0.094	0.688	0.16	0.375	0.375	0.375	0.156	1	1	0.578	0.016	0.469	0.297
Exact Sig. (1-tailed)	0.344	0.289	0.016	0.047	0.344	0.008	0.188	0.188	0.188	0.078	0.531	0.531	0.289	0.008	0.234	0.148
Point Probability *(p)*	0.055	0.055	0.008	0.016	0.055	0.008	0.039	0.039	0.039	0.023	0.063	0.063	0.055	0.008	0.047	0.039

Legend:
SN-Vbase - correlation between the base values measured on the 1st and the 2nd evaluation without any specific program for ankle instability.
KT-SN - correlation between the measurement in 3rd , after KinesioTape ®, and the 2nd assessment, without any specific program for ankle instability.
PLEX-KT - correlation between the measurement in the 4th assessment, when the athletes were subject to an exercise program for ankle instability, and 3rd after using KinesioTape®.
Plex-SN - correlation between 2nd evaluation without any specific program for ankle instability, and the 4th evaluation, after the athletes were subject to an exercise program for ankle instability.

In other study results [25,26,28], at the beginning of any muscular training, an improvement in the inter and intramuscular coordination is obtained. This increment is due to an increase of motor unit recruitment with higher ability for muscle contraction and force generation. These adaptations occur in the first 20 to 35 days of practice [25,27] and are based on neuromuscular adjustments that consist of higher velocity in nervous transmission in both efferent and afferent paths [30].

One of the study limitations was the absence of a non-treatment period between the KT application and the execution of the exercise plan. This period could allow better observation regarding the long effect of KT application that could be wrongly interpreted in this study as an exercise plan effect.

Statistical analysis supports the conclusion advanced, because the correlation value which features between the two methods (application tape and the exercise plan) has values of $p > 0.05$, except in the anterior direction, where the statistical results of $p = 0.01$ showed that exercise plan was most beneficial for athletes, in relation to the use of KT when measured with the Y-Test. Again, this value was not very reliable because there was no non-treatment period between the KT application and the execution of the exercise plan, so we could have wrongly interpreted this value as an exercise plan effect.

The differences reported in this study, with respect to the anterior, posteromedial reach and composed score, correspond to a decrease of the risk injury [20,22] associated with the application of KT. The effect of the exercise plan remains inconclusive. One thing could be responsible for this effect. The application of the KT was made during normal athlete activity, with the changes being assumed to result from the combined effect of the KT and the normal activity. When KT phase stops and the exercise plan starts, even being a specific plan, it increases the activity level but probably does not have a significant influence on the joint stability process itself. This idea highlights the need for a deeper consideration of what is an IFT specific exercise.

Therefore, the suggestions for future studies are the use of a larger sample study, adding a control group of athletes without IFT, and separate unilateral IFT from bilateral IFT athletes, adding a non-treatment phase between the end of the KT programme and the start of the specific exercise plan for ankle instability.

4. CONCLUSION

A tendency for a functional improvement of the ankle instability in the study population seems to be associated with the use of KT, with a consequent decrement of risk of re-injury. Differences between the use of KT and the exercise plan for the recovery of ankle instability was inconclusive.

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CONSENT

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all procedures have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki, and was approved by the ethical board of Escola Superior de Saúde da Cruz Vermelha Portuguesa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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