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EFFECTS OF KINESIO® TAPING ON DYNAMIC POSTURAL CONTROL FOLLOWING FATIGUE INDUCTION

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Graphical abstract

Characteristics (n = 32)	Group A (n = 16) m (SD)	Group B (n = 16) m (SD)	Sig
Age (years)	21.00 (1.46)	21.13 (1.5)	0.81
Body weight (kg)	65.8 (7.12)	65.38 (7.24)	0.86
Height (m)	1.71 (0.06)	1.71 (0.06)	0.93
BMI (kg/m²)	21.95 (1.98)	21.74 (1.90)	0.77

Abstract

This study aimed to determine the effects of Kinesio® taping (KT) on dynamic postural control following fatigue induction. It is hypothesized that the application of KT limits the effects of fatigue on dynamic postural control. This study used a randomized controlled trial recruited 32 male recreational athletes, randomized to one of the two groups (Group A: KT and fatigue and Group B: KT and no fatigue). Fatigue was induced using the adapted Functional Agility Short Term Fatigue Protocol (FAST-FP). The rectus femoris of quadriceps, biceps femoris of the hamstring and medial gastrocnemius of the dominant leg were taped. The dynamic postural control was assessed pre and post fatigue. A significant interaction was observed between the group and time for the anterior-posterior position ($p=0.03$, $\eta p2=0.21$) while non-significant interaction was observed in the lateral symmetry ($p=0.84$, $\eta p2=0.001$). A significant main effect of time was observed for anterior-posterior position ($p>0.05$, $\eta p2=0.15$) while non-significant for the lateral symmetry ($p=0.65$, $\eta p2=0.007$). For the main effect of the two groups was not significant for the anterior-posterior position ($p=0.42$, $\eta p2=0.02$) and lateral symmetry ($p=0.73$, $\eta p2=0.004$). In conclusion, the diminishing effect of fatigue on the anterior-posterior position was observed. Moreover, KT application does not limit the effects of fatigue on the dynamic postural control.

Keywords: Dynamic postural control, fatigue, kinesio taping

1.0 INTRODUCTION

Sports activities play an important role in today's society as it not only improve health [1], but also benefit the community, sports club, and businesses [2]. Regrettably, as more people become involved in sports, the prevalence of sports-related injuries also increased. The increase of sports-related injury hospitalizations cause a severe burden on the economy, health system and decline quality of life [2].

Sports injury does not appear to be caused by a single risk factor. There are an internal factor, external factor and inciting event that contribute to injury [3]. In this study, the focus is an internal factor, namely fatigue as the cause of injury. It is well documented that fatigue caused various diminishing effects to sports performance [4–6] that will lead to declining of the physical performance. Literature has found that fatigue impairs the postural control [7], an important component that act to stabilize the joint during athletics manoeuvre [8, 9]. In addition, fatigue also increased the risk of sports injury [8, 10]. Therefore, strategies for injury prevention and health promotion are needed.

Nowadays, sports injuries have received a primary interest by means of both treatment and rehabilitation as well as prevention strategies. The past decades have shown an increased interest in Kinesio Taping (KT) [11]. However, various literature has provided contradictory findings of the benefits [11–14]. The benefits of KT on dynamic postural control following fatigue induction were still understudied. Therefore, the objective of this study was to determine the effect of KT on dynamic postural control following fatigue induction.

2.0 METHODOGOLY

2.1 Study Design

This study used a single-blinded, randomized-controlled trial design with pretest and posttest measurements. Participants were randomly assigned to either one of the two groups: Group A (tape was applied, and participants were exposed to fatigue), Group B (tape was applied, and participants were not exposed to fatigue) using sequentially numbered, opaque and sealed envelopes. Ethics approval was obtained. This study was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12614001204639).

2.2 Participants

Male recreational athletes ranging from 18 to 25 years old were recruited. In this study, recreational athletes were defined as people who undertake sports for leisure [15] and do not represent any college, national, or international teams [16]. Participants with histories of developing pain in the lower limbs because of motor vehicle accidents, sports injuries, and assaults to the lower limb, those who have been diagnosed with musculoskeletal, vestibular, and neurological disorder, and those on medication were excluded.

2.3 Procedure

All participants signed the consent form before data collection. Firstly, all participants were provided an explanation and written summary of the experimental procedure. Secondly, participants' demographic data were taken. Next, participants were applied with KT before proceeding to the familiarization and warming-up session. Participants then performed the dynamic postural control test. Fatigue was induced to participants in Group A. After the completion of the fatigue induction, the measurements similar to the pretests were repeated. The time for each test from the end of the fatigue induction protocol was kept less than 15 seconds. For Group B, fatigue induction protocol was replaced by a rest period of three minutes before proceeding to posttest measurements [17].

2.4 Kinesio Tape Applications

KT was applied to the rectus femoris of the quadriceps, biceps femoris of the hamstring, and the medial gastrocnemius of the dominant leg. The tape was applied in accordance with the "Y" techniques proposed by Kase *et al*. [18]. This technique was selected to achieve the muscle facilitation stimulus effects. The tape was fixed from the origin to the insertion direction. Moderate tension (50% of the available tape length) was provided on the tape.

2.5 Familiarization and Warming-Up Session

All participants were exposed to a warm up session for five minutes and stretching of the major muscle of the lower limb with 15-second holds and three-repetition for each.

2.6 Dynamic Postural Control

To measure the dynamic postural control, a pressure-sensitive treadmill was used (Zebris FDM-T Treadmill System®, Isny, Germany). The procedure of the test was adapted from Kalron, Dvir, Givon, Baransi and Achiron [19]. Participants were asked to start jogging at their preferred speed to measure the dynamic postural control. The test recording time was set to one min. The treadmill presented a continuous trace of the CoP trajectory for jogging postural control that termed as the "butterfly parameters". The "butterfly parameters" were divided into anterior-posterior position and lateral symmetry. The anterior-posterior position defines the shift of the CoP anteriorly and posteriorly. The zero position is the heel strike. The lateral symmetry defines the left and right shift of the CoP. A negative value indicates a shift to the left side, and a positive value a shift to the right side. The zero position indicates the centre of the presentation. The lower values for the tests reflect better dynamic postural control.

2.7 Exposure to Fatigue

Fatigue was induced to the participants of Groups A using an adapted Functional Agility Short-Term Fatigue Protocol [20]. The participants' maximum vertical jump was recorded prior to fatigue protocol. First, the participants performed three consecutive vertical jumps. Next, they performed a series of steps up and down a 30 cm box for 20 seconds at 220 beats per minute (b/m). After that, the participants performed three consecutive squatting at 90° knee flexion. Finally, they performed the L-Drill, which consisted of three cones that were set in an "L" shape, 4.05 meters apart. From the starting cone, the participants sprinted back and forth to the first cone. Then, ran around the first cone and cut inside to the second cone. The participants ran around the second cone from the inside to the outside and sprinted around the first cone and back to the starting cone. Completing the four tasks (vertical jumps, stepping up and down, squatting, and L-Drill) counted as one set of the protocol. This set was repeated until maximal fatigue was achieved. Fatigue criteria were manifested by the participants who achieved less than 90% of the maximal jump on all three vertical jumps for two consecutive fatigue sets [20].

2.8 Statistical Analyses

Mixed between–within subjects analysis of the variance was used to compare the means of the groups to determine whether a significant difference existed between the groups. The statistical power was set at 90% while effect size at 0.25 and $p<0.05$.

3.0 RESULTS

The baseline characteristics of the study participants are illustrated in Table 1. No significant differences in demographic characteristics were observed among the groups ($p>0.05$).

Table 1 Characteristics of Participant (n = 32) at Baseline

Characteristics (n = 32)	Group A (n = 16) m (SD)	Group B (n = 16) m (SD)	Sig
Age (years)	21.00 (1.46)	21.13 (1.5)	0.81
Body weight (kg)	65.8 (7.12)	65.38 (7.24)	0.86
Height (m)	1.71 (0.06)	1.71 (0.06)	0.93
BMI (kg/m²)	21.95 (1.98)	21.74 (1.90)	0.77

Note. *Significant at $p < 0.05$.

A mixed between–within subjects analysis of the variance was conducted to explore the effects of KT on the participants' dynamic postural control following fatigue induction and non-fatigue. Participants were divided into two groups (Group A: KT and fatigue and Group B: KT and no fatigue). The results were illustrated in Table 2.

Table 2 Butterfly Parameters between Two Groups across Two-Time Periods

Butterfly Parameters		**Group A (n = 16) m (SD)**	**Group B (n = 16) m (SD)**	**Sig.**
Anterior-Posterior Position (mm)	Pre	180.50 (27.11)	179.81 (23.86)	0.42
	Post	196.00 (28.84)	181.63 (29.48)	
Differences		-15.5	-1.82	
Sig.		0.002*	0.69	
Lateral Symmetry (mm)	Pre	-5.75 (30.25)	-9.25 (27.43)	0.73
	Post	-8.00 (19.51)	-10.13 (20.01)	
Differences		2.25	0.88	
Sig.		0.69	0.83	

Note. *Significant at $p<0.05$.

3.1 Anterior-Posterior Position

A significant interaction was observed between the groups and time [$F(1, 30) = 5.08$, $p = 0.03$, and $\eta_p^2 = 0.21$] and main effect of time [$F(1, 30) = 0.86$, $p > 0.05$, and $\eta_p^2 = 0.15$]. The main effect comparing the anterior-posterior position of the two groups was not significant [$F(3, 68) = 0.67$, $p = 0.42$, $\eta_p^2 = 0.022$]. The mean difference was -15.5 reflecting that fatigue significantly caused the CoP to shift anteriorly ($p > 0.002$). Although Group A (196.00 ± 28.84) attained higher post anterior-posterior position mean compared to Group B (181.63 ± 29.48), no statistical significance was found ($p = 0.42$).

3.2 Lateral Symmetry

A non-significant interaction was observed between the group and time [$F(1, 30) = 0.41$, $p = 0.84$, and $\eta_p^2 = 0.001$] and main effect of time [$F(1, 30) = 0.21$, $p = 0.65$, $\eta_p^2 = 0.007$]. The main effect comparing the lateral symmetry of the two groups was not significant [$F(1, 30) = 0.12$, $p = 0.73$, $\eta_p^2 = 0.004$]. Fatigue caused the CoP to shift to the left indicated by the more negative mean in post lateral symmetry value in Group A (-8.00 ± 19.51) with a difference of 2.25. However, no significant were observed ($p = 0.69$). Similarly, Group C also showed a shift of CoP to the left (-10.13 ± 20.01) with a difference of 0.88 but not statistically significant ($p = 0.83$). The lateral symmetry between the two groups was not significant ($p = 0.73$).

4.0 DISCUSSION

The dynamic postural control is an important component that act to stabilize the joint during athletics manoeuvre such as in sports including judo, dance, tennis, badminton and basketball [9]. The findings of this study suggested that the anterior-posterior position and lateral symmetry are not affected by fatigue. The CoP slightly shifted anteriorly following fatigue induction. This indicated that fatigue induction slightly increased postural sway.

Literature has stated that fatigue reduced postural control, and this was evident by postural sway [21] that increase the risk of sports injury [7]. Possible explanations for fatigue hampered postural control were, fatigue compromised the input to the sensory cortex that caused by increased in the metabolites concentration [22]. Therefore, less information were provided to maintain the centre of mass within the base of support [7] and consequently impaired dynamic postural control. Moreover, fatigue also caused inefficiency in muscle force production [23]. It was well documented that optimal postural control requires efficient force production [7]. Therefore, fatigue may impair the dynamic postural control.

The findings were partly corroborated a previous study that found fatigue caused anterior displacement of CoP [21]. The shift of CoP to the anterior direction following fatigue induction may have several explanations. Postural sway is a compensatory mechanism to generate more important sensory input flow [24]. A study suggested that it is an adaptive process to cope with the impaired ability of the fatigued leg to control efficiently the posture [25]. Vuillerme *et al*. (2002) suggested that the anterior CoP displacement may be caused by an increase of the intrinsic toe flexors action in maintaining balance [26]. Another study also proposed that anterior CoP displacement may be the consequences of plantar and dorsiflexors muscle fatigue as these muscles play a dominating role in controlling of AP movements [27].

The findings suggested that KT application does not limit the effects of fatigue on dynamic postural control. It is hypothesized that KT application provide stimulus to the muscle and provide stimulus to mechanoreceptors to increase proprioception [18]. The contradictory findings may be explained by the deficiency of the KT to provide stimulus as well as to increase force exertion to correct dynamic postural control. Consequently, it is insufficient to reduce the risk of sports injury and increase sports performance [28, 29].

5.0 CONCLUSION

Fatigue caused the CoP to shift more anteriorly and to the left but did not cause significance deviation of the CoP. KT application did not limit the effects of fatigue on dynamic postural control. Therefore, KT application did not was insufficient to reduce the risk of sports injury and increase sports performance. One imitation of this study can be highlighted here. The 'butterfly parameters' did not provide information such as postural sway velocity and CoP excursion area causing direct comparison to other studies are not possible. The findings may suggest the application of KT to the athletes as it provides a slight improvement of the dynamic postural control that may be beneficial during sports activities and rehabilitation. These findings may provide the impetus for designing intervention specifically to preserve or increase dynamic postural control following fatigue.

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