J. Phys. Ther. Sci. 34: 252–256, 2022

The Journal of Physical Therapy Science

Original Article

Effects of truncal taping on center of gravity sway: comparison of different trunk muscle masses

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Abstract. [Purpose] Taping is a therapeutic technique used to prevent and treat sporting injuries and other conditions. This study aimed to clarify how kinesio taping versus non-elastic taping of the trunk affects postural control. [Participants and Methods] Thirty-three healthy male participants were included in this study. Participants were assigned to low or high trunk skeletal muscle mass groups. Main outcomes of path length and area representing the center of gravity sway were measured using a Zebris FDM-S system in three conditions: control, kinesio taping, and non-elastic taping. Tapes were applied to the rectus abdominis, external oblique, and erector spinae muscles. The measured limb position was seated on a balance cushion. [Results] The area of the low trunk mass group differed significantly between kinesio and non-elastic taping. However, the path length of the low trunk mass group and path length and area of participants with high trunk mass did not differ significantly between groups. [Conclusion] This study's findings indicated that two types of taping methods affected the area of gravitational sway in healthy adult males with a low trunk muscle mass.

Key words: Kinesio taping, Trunk muscle, Center of gravity sway

(This article was submitted Oct. 27, 2021, and was accepted Jan. 1, 2022)

INTRODUCTION

There are two types of taping: kinesio taping using kinesio tape and white taping using no elastic tape. Kinesio taping (KT) is a commonly used therapeutic modality in sports medicine. There are many proposed benefits of KT, including improvement of muscle function, facilitation of blood circulation, pain relief, joint conformity correction, and extension of therapeutic effect[1]. The effect of white taping is to intentionally limit the range of motion using a non-elastic tape. Therefore, white taping (WT) is often used for the treatment of patients with chronic ankle instability[2]. Poor posture that deviates from normal alignment changes the imbalance of the trunk muscles. This change can lead to increased stress on the spine and localized muscle tension, which may lead to the development of disorders[3]. Moreover, Poor posture can affect posture control because it changes the position of the center of gravity[4]. A previous study reported that pelvis-concentrated exercise programs improve posture alignment and foot-base pressure in healthy adult males[5]. Furthermore, changes in posture, such as backward pelvic tilt and kyphosis alignment, are related to the back muscles in elderly females[6]. In addition, a previous study reported that lower limb and trunk muscle function (abdominal muscles) diminishes in individuals with a history of chronic back pain and is associated with decreased trunk stability[7]. Therefore, physical therapy of the trunk muscles is important for

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the prevention of disability. Recently, stabilization and core conditioning have been used to train the trunk muscles. These are based on the perception of one's own physical performance and involve intentional movements. Therefore, we focused on a treatment method that involves the application of tapes. We believe that taping is less affected by the patient's ability because the therapist can use the tape on the muscles necessary for movement. Therefore, we suggest that taping will allow us manage patients who have difficulty understanding detailed training instructions.

Previous studies on taping the trunk have reported its effect on walking function and balance ability during standing and sitting in patients with stroke[8, 9], others have described its effect on pain in patients with chronic low back pain[10, 11], and its effects on muscle thickness and muscle endurance in healthy adults[12, 13]. However, no study has clarified the effects of taping on postural control in healthy adult male individuals. In the present study, we will focus on the trunk muscles by using the sitting posture, because this posture is less affected by the lower limbs. We suggest that a stable sitting posture would be less affected by postural control using the trunk since the test was conducted on healthy adult male subjects. Therefore, referring to previous studies, we used a balance cushion to create an unstable seating surface to increase the swaying during the sitting posture, which would facilitate the influence of postural control on the trunk[14]. The center of gravity sway test using a sway meter is used to evaluate postural balance. The test records and analyzes the body sway in an upright posture (center of pressure [COP] sway), and is used to objectively evaluate the static balance of the body[15]. The indicators of postural sway in the COP sway test include path length and area. Path length is the total distance travelled by the COP during the measurement time. Path length is the total distance traveled by the COP during the measurement time. Area is the area of the outermost contour where the COP moved. Both indicate the degree of sway[16].

Based on the above, we examined how taping to the trunk affects swaying of the center of gravity when holding an end-sitting posture on an unstable seating surface. To examine the effects of different types of taping, we compared KT and WT. By clarifying this, we believe that taping can be used to treat patients with poor posture and balance caused by disorders of the trunk muscles, and to prevent these disorders.

Our hypothesis was that path length and area would decrease in the KT condition due to improved trunk muscle function, while both path length and area would increase in the WT condition due to restricted trunk muscle movement caused by immobilized joints.

PARTICIPANTS AND METHODS

Thirty-three healthy male participants were included in this study. The mean age, height, body weight, body mass index (BMI), and trunk skeletal muscle mass (TSMM) were 21.4 ± 1.8 years, 173.0 ± 5.2 cm, 69.1 ± 9.7 kg, 23.1 ± 2.9 kg/m^2, and 24.6 ± 2.2 kg, respectively. Participants with a history of skin disease and back pain were excluded. Written informed consent was obtained from all participants. This study was approved by the Ethics Committee of the International University of Health and Welfare (Approval No. 18-Io-155).

The body composition was analyzed using a multifrequency bioelectrical impedance analysis body composition analyzer (InBody 520, InBody, Tokyo, Japan). The body weight, BMI, and TSMM of the participants were also evaluated.

The measurements were obtained under three conditions: control, KT and WT. The tapings were performed by the same investigator, and the measurements were made in a random order. The 50 mm × 31.5 m Kinesio-tape (Nitoms Inc, Tokyo, Japan) was used for KT, and the 50 mm × 12 m CB-tape (Nitoms Inc, Tokyo, Japan) was used for WT. As in previous studies, the tapes were applied to the rectus abdominis, external oblique, and erector spinae muscles (Fig. 1a–c)[17, 18]. The tape applied to the rectus abdominis muscle was located along the muscle line, 2 cm lateral and 1 cm inferior to the xiphoid process. The tape on the external oblique muscle was applied 3 cm within the lower end of the 11th rib to the inside of the anterior superior iliac spine. The tape on the erector spinae muscle extended diagonally outward from the fifth lumbar vertebra to the 12th thoracic vertebra. The length of the tape was 20 cm for both KT and WT, and the elongation rate was set at 10% for KT (If you are using 20 cm tape: 20 cm + 20 cm × 0.1=22 cm).

a. rectus abdominis b. external oblique muscle c. erector spinae muscles

Fig. 1. Method of application of tapes for different muscles.

The path length and area, which indicate the degree of sway of the center of gravity, were used as the main outcome measures[19]. The center of gravity sway was measured using the Zebris FDM-S system (Zebris Medical GmbH, Am Galgenbuhl, Germany). A Zebris plate was placed on a 30 cm high platform set on an elevating bed, with a balance cushion on the plate (Fig. 2). In order to remove the influence of the lower limbs and focus on the trunk muscles, the participants were asked to sit on the balance cushion with their hip and knee joints at 90 degrees. Their arms folded across the chest, and the central part of both the thighs was banded to prevent shaking. The participants were instructed to keep their legs off the platform and to focus on markings at the eye level in front of them (Fig. 3). The values obtained at 30 sec were used.

Statistical tests were performed using SPSS version 25.0 for Windows (SPSS Inc, Chicago, IL, USA). The Shapiro–Wilk normality test was used for the path length and area for all the three conditions. If data normality was verified, a one-way repeated measures analysis of variance (ANOVA) was conducted. If normality was not identified, a Friedman test was performed. The groups were compared using the Bonferroni method ($p<0.016$). Statistical significance was set at $p=0.05$, except for the Bonferroni method. The participants were classified into two groups based on the corrected trunk skeletal muscle mass (CTSMM), which was calculated by adjusting the mean value of TSMM by the square of height to take into account the effect of body size[20]. The body composition of 111 healthy adult males were measured using InBody were used as reference values. The age, height, weight, BMI, and TSMM were 19.4 ± 1.2 years, 171.8 ± 5.5 cm, 65.0 ± 7.9 kg, 22.0 ± 2.5 kg/m^2, and 23.6 ± 2.2 kg, respectively, and the CTSMM was 8.0 ± 0.6 kg/m^2. Using these values as the reference values, 14 patients with low values were considered as the low CTSMM group and 19 patients with high values were considered as the high CTSMM group. The path length and area in the control, KT, and WT conditions were compared between the two groups.

RESULTS

Path length and area of the 14 low CTSMM groups are shown in Table 1 for the control, KT, and WT groups, respectively. Since normality was confirmed for both total Path length and area, one-way analysis of variance repeated measures was performed. There was no significant difference in total trajectory length ($p=0.100$). There was a significant difference in circumferential area ($p=0.034$) and a significant difference between KT and WT ($p=0.019$) in the subtest.

The Path length and area of the 19 patients in the high CTSMM group are shown in Table 2 for the control group, KT group, and WT group, respectively. Since normality was confirmed for the Path length, one-way analysis of variance was performed and no significant difference was found ($p=0.501$). Since normality was not confirmed for area, Friedman test was performed; however, no significant difference was found ($p=0.486$).

Fig. 2. Environment settings.

Fig. 3. Measurement position.

Table 1. Path length and area for 14 participants in low corrected trunk muscle mass (CTSMM) group

	Control	KT	WT
Path length (mm)	332.1 (219.1–384.2)	295.4 (177.4–329.2)	285.4 (211.2–328.2)
Area (mm^2)	63.3 (43.4–78.1)	53.3 (37.4–71.8)*	74 (49.9–108.9)*

Median (1st quartile–3rd quartile) $p<0.05$.
*: Significant difference between KT and WT ($p<0.016$).
KT: kinesio taping; WT: white taping.

Table 2. Path length and area for 19 participants in high corrected trunk muscle mass (CTSMM) group

	Control	KT	WT
Path length (mm)	294.7 (221.3–323.5)	324.5 (256.1–351.5)	271.2 (235.5–357.2)
Area (mm^2)	52.6 (34.7–69.4)	48.9 (42.6–78.6)	67.1 (51.7–80.8)

Median (1st quartile–3rd quartile) p<0.05.
KT: kinesio taping; WT: white taping.

DISCUSSION

In this study, the effects of KT and WT on center-of-gravity sway were examined by classifying the participants into low and high CTSMM groups considering the effect of body size. From previous studies, it has been reported that both total trajectory length and circumferential area are smaller in younger age groups, and that total trajectory length and circumferential area are smaller after training the trunk muscles, which is necessary to improve stability during posture maintenance. Therefore, it is thought that the decrease in center of gravity sway is related to the improvement of stability[21)]. KT affects the skin, muscle, and fascia due to the elasticity of the tape, and KT can reproduce the slippage between fascia and subcutaneous tissue at the level of the superficial fascia during muscle contraction[22)]. It has also been reported that constant stimulation of skin receptors by KT application to the skin increases sensory feedback in the area of KT application[23)]. In addition, the effects of KT on the trunk in healthy adults have been reported[13)]. On the other hand, since WT is non-elastic, it restricts the movement of the affixed area. Furthermore, non-elastic taping has been reported to decrease the amplitude of the Hoffman reflex (H-reflex) in surface electromyography, which may cause changes in eigenreceptive sensation and a decrease in sensory input[24)]. The results of this study suggest that the activity of the trunk muscles in the end-sitting posture in an unstable environment, focusing on the trunk, may have improved and the circumferential area decreased in KT compared to WT due to the improvement of muscle movement and sensory input as described in previous studies. The WT was used in this study to fixate muscles, not joints. In this study, the WT was used to fixate the muscle, not the joint, and the area may have increased compared to the KT due to the participants' inability to contract the muscle properly and a decrease in sensory input as described in previous studies. There was no significant difference in Path length among the control, KT, and WT groups. In the previous studies, as mentioned above, the interpretation of the decrease in both area and Path length has been described, but there is no unified view on the interpretation of the decrease in either of them. Therefore, we think it is necessary to examine the number of participants and the outcomes in order to evaluate the stability of the trunk in the future.

In addition, the reason for the change in center of gravity sway in the low CTSMM group compared to the high CTSMM group may be that the low trunk muscle mass makes the participants rely on taping during movement. This suggests that taping may have an effect on the change in center of gravity sway. Although no study has strictly examined the center-of-gravity sway in healthy adults with different trunk muscle mass, some studies have shown the effect of taping in patients with reduced trunk function due to disabilities, such as patients with stroke [8, 9)]. Therefore, we believe that the lower the trunk muscle mass, the more susceptible the patient is to external influences from taping, and the lower the trunk muscle mass, the more susceptible the patient may be even among healthy adult males.

The limitations of this study are the small number of participants and the fact that it is unclear whether taping to the trunk really affects the muscles because electromyography and other methods were not used. In the future, we would like to increase the number of participants and verify whether the change in center of gravity sway is due to the trunk muscles or not. We will also examine relevant gender and age differences.

In this study, we examined the effects of KT on the trunk in an unstable end-sitting posture and on the center-of-gravity sway during WT implementation. The results showed that KT may affect the reduction of the center-of-gravity sway compared to WT in healthy adult males with low trunk muscle mass.

Funding and Conflict of interest
The authors declare no conflicts of interest associated with this manuscript.

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