



Original Article

# Effects of kinesiology taping on trunk function, balance, and mobility in stroke patients: a pilot feasibility study

LING-YI LIAO, PT, MSc<sup>1, 2)</sup>, XIAO-HUA HE, MD, PhD<sup>3)</sup>, XI-ZE LI, PT<sup>1, 2)</sup>,  
YAN-LEI GE, PT, MSc<sup>1, 2)</sup>, QIANG GAO, MD, PhD<sup>1, 2, 4)\*</sup>

<sup>1)</sup> Department of Rehabilitation Medicine, West China Hospital, Sichuan University, 37 Guoxue Alley, Wuhou District, Chengdu, Sichuan Province 610041, China

<sup>2)</sup> Key Laboratory of Rehabilitation Medicine in Sichuan Province, West China Hospital, Sichuan University, China

<sup>3)</sup> Palmer College of Chiropractic Florida, USA

<sup>4)</sup> Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong Special Administrative Region, China

**Abstract.** [Purpose] This study aimed to explore whether trunk kinesiology taping (KT) can improve trunk function, mobility, and balance in post-stroke patients with hemiparesis. [Participants and Methods] We conducted a single-group pre-post design pilot feasibility study. Thirteen individuals with post-stroke hemiplegia were recruited for this study. All patients received therapeutic trunk KT on the skin, representing the direction of fibres of the trunk muscles underneath. We used the Trunk Impairment Scale (TIS) and Trunk Control Test (TCT) to measure trunk function, Fugl-Meyer assessment (FMA) for balance, limits of stability (LOS) to evaluate balance, and the modified Rivermead mobility index (MRMI) to assess mobility in post-stroke patients. All measures were assessed before and immediately after the intervention. [Results] No adverse effects were found and all patients completed the trial. Compared to the baseline, TIS scores were significantly increased after KT, whereas no changes in TCT score were detected. The directional control of LOS was significantly improved, while no significant changes were seen in the other parameters of LOS, FMA-balance, and MRMI scores. [Conclusion] The results of this investigation show that trunk KT has immediate effects that improve certain trunk functional and balance parameters in stroke patients.

**Key words:** Stroke, Kinesiology taping, Balance

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## INTRODUCTION

The lifetime risk of stroke is around 25% after the age of 25 in both men and women worldwide, and the highest risk is estimated in China (39.3%) according to the Global Burden of Disease Study<sup>1)</sup>. Dysfunction of trunk function is a common disorder in stroke patients which has a considerable impact on the patient's postural control, balance, and mobility<sup>2-5)</sup>. Recent evidence suggests that the delayed activation and weakness of the trunk muscles<sup>4, 6-8)</sup> along with decreased trunk performance<sup>9)</sup> were associated with poor motor functional outcomes. Trunk control is considered as a key predictor of functional outcomes and the length of hospital stay after stroke<sup>10)</sup>. Stabilization training<sup>11, 12)</sup> and core stability training<sup>4, 13, 14)</sup> are generally employed to help improve trunk performance.

Kinesiology taping (KT) is one of the most widely used clinical interventions for musculoskeletal disorders. However, it is a relatively new therapeutic modality in the field of neurorehabilitation<sup>15)</sup>. It can be longitudinally extended to 55–60% of its

\*Corresponding author. Qiang Gao (E-mail: gaoqiang\_hxkf@163.com)

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original extent and has hyposensitivity for skin<sup>15</sup>). It has previously been observed that KT can relieve pain<sup>4, 15, 16</sup>), decrease swelling<sup>17</sup>), and achieve and maintain preferred body alignment by providing proprioceptive feedback<sup>16, 18–20</sup>). Based on these reported effects of KT, we hypothesized that KT could be used on trunk muscles to facilitate the trunk function and further improve balance and mobility in patients with hemiplegia. The main goal of this study was to explore the changes in trunk function after trunk KT in post-stroke patients. The effects on balance and functional mobility were also examined.

## PARTICIPANTS AND METHODS

A pre-post, single-group feasibility study approach was designed to explore the effectiveness of trunk KT on trunk function, balance and motor ability in subacute stroke patients.

Thirteen post-stroke patients with hemiplegia who were hospitalised in the rehabilitation medicine centre, West China Hospital, Sichuan University between November 2018 and June 2019 were recruited in this study. G\*Power 3.1.9.4 (Institute of Psychology in Christian-Albrechts-University of Kiel, Kiel, Germany) was used for the sample size estimation<sup>21</sup>). Calculations were based on the Trunk Impairment Scale (TIS) from group parameters as described by Haruyama et al.<sup>4</sup>), using a two-tailed paired t-test, the desired power of 80%, and an  $\alpha$  level of 0.05. These assumptions were generated a sample size of 12 patients.

Criteria for selecting the participants were as follows: (i) left or right hemiplegia resulting from ischaemic or haemorrhagic stroke confirmed by magnetic resonance imaging or computed tomography; (ii) the first incidence of stroke must have been more than 3 weeks but less than 6 months; (iii) patients must have the ability of understanding instructions and communicating, a Mini-Mental State Examination score greater than 21/30; (iv) ability to stand for at least 30 seconds; (v) signed informed consent to participate in the study.

Individuals were excluded as follows: (i) a history of other neurologic diseases, such as Parkinson disease; (ii) lower extremity surgery or fracture; (iii) age 80 years or above; (iv) participation in interventional clinical trials; (v) a history of allergy to KT.

All patients in the rehabilitation medicine centre were screened as candidates. The patients who met the criteria were requested to sign the consent form and to participate in the clinical trial. Ethical approval was obtained from the Biomedical Ethics Committee of West China Hospital, Sichuan University. The protocol of this study was registered with the Chinese Clinical Trial Registry (registration number: ChiCTR1900022112).

The intervention was performed by a certified physical therapist, who was experienced in KT and received detailed instructions. The therapeutic trunk taping aimed to improve the neuromuscular function and provide mechanical support to the trunk muscles according to Lee et al.<sup>17</sup>) (Fig. 1).

Tapes of 5 cm width (KT TAPE<sup>®</sup>, KT Health LLC, American Fork, UT, USA) were used on patients. The first step in the process was to use an alcohol swab to clean the area to be taped, and patients were posited by the proper posture to tape. The taping was performed on the skin above the main abdominal muscles and the erector spinae muscle<sup>17</sup>). For the rectus abdominis muscle, the I-type KT was used from the 5th to 7th costal cartilages and the xiphoid process to the inferior margin of pubis on the side-lying position with trunk extension. Similarly, the I-type KT was taped from the inguinal region to the level of T12 for external oblique muscle, and from the xiphoid process to the anterior superior iliac spine for the internal oblique muscle in the same position. In the sitting position, the I-type KT was taped from the transverse process of T12 to the posterior superior iliac spine for the erector spinae muscle. All KT strips were applied with minimal (<50%) tension on the bilateral side of trunk.

Patient demographic information and clinical characteristics including age, gender, weight, height, side of the lesion, onset information, and type of stroke were collected.

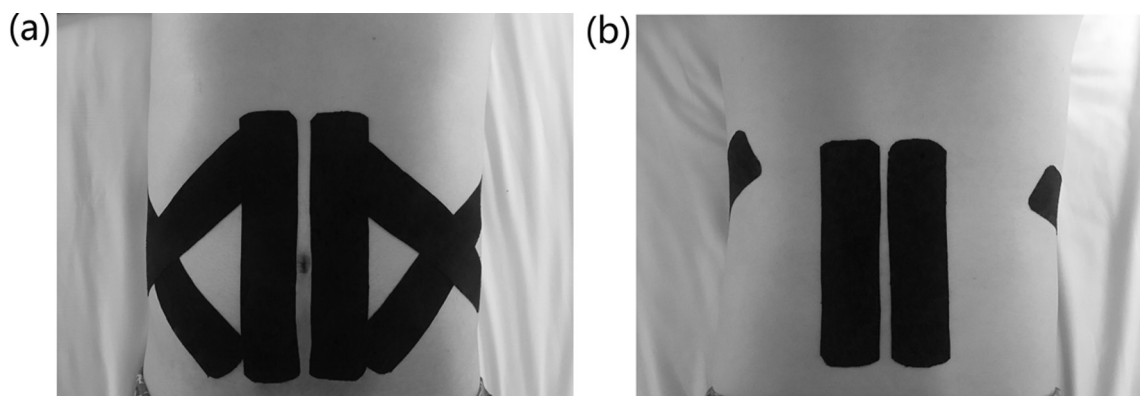


Fig. 1. Kinesiology taping for patients.

To assess trunk function, TIS and its subscales (including static sitting balance, dynamic sitting balance, and trunk coordination) were used as the primary outcome measures<sup>22</sup>. The total TIS score is a maximum of 23 points, with a higher score indicating better trunk function<sup>23</sup>.

To identify other functional outcomes, the following parameters were used: trunk control test (TCT), limits of stability (LOS), Fugl-Meyer assessment (FMA)-balance (scored up to 14), and the modified Rivermead mobility index (MRMI). The TCT was used to assess trunk function as well<sup>24</sup>. Both the validity and reliability of the TCT have been demonstrated in stroke patients<sup>22, 24</sup>. The LOS was used to assess standing balance which was assessed by the Balance Manager (NeuroCom® International Inc., Clackamas, OR, USA). Five dependent variables of the LOS (reaction time [RT], movement velocity [MVL], endpoint excursions [EPE], max excursions [MXE] and directional control [DCL]) were calculated. The balance subscale of FMA was used to assess the sitting and standing balance. It consists of eight items, scored from 0 to 14 points. The MRMI is a reliable tool to evaluate mobility in post-stroke patients<sup>25</sup>, which consists of eight activities including abilities of transfers, sitting, standing, walking, and stair climbing resulting in a maximum to 40 points.

Assessments were carried out by another therapist for bias control. Patients were evaluated and re-evaluated immediately before and after the KT application.

Data management and analysis were performed using SPSS version 24.0 (SPSS Inc., Chicago, IL, USA). The results are presented as mean ± standard deviation (SD). The normality of data distribution was calculated using the Shapiro-Wilk test and Q-Q plots. A paired t-test was used to evaluate intragroup changes in continuous variables. The Wilcoxon signed-ranks test was employed to compare the ordinal variables (TIS, TCT, FMA-balance, and MRMI). In all the analyses, significance levels were set at the 5% level.

## RESULTS

Eight male patients and 5 female patients (mean age 45.08 ± 16.73) participated in the study. Table 1 shows the general characteristics of the participants. No adverse effects were associated with KT.

Table 2 demonstrates the comparison of outcome measures before and after the KT application. There were significant differences in TIS total score (p=0.024, 95%CI 1.80 to 3.87) and dynamic sitting balance score subscale (p=0.024, 95%CI 1.34 to 2.66) after taping. However, no significant changes were observed in the TCT score (p=0.180, 95%CI -2.62 to 10.95) after the treatment. Trunk KT improved DCL of standing balance from baseline by 13.69% (p=0.010, 95%CI 5.02 to 22.36), although there were no significant improvements in any other LOS parameters (p>0.05) or FMA-balance (p=0.157, 95%CI 1.04 to 2.62). Similarly, there was no increase in the MRMI score detected (p=0.102, 95%CI -0.19 to 1.52).

## DISCUSSION

The function and stability of the trunk are essential for balance, mobility, gait, and activities of daily living<sup>6, 26, 27</sup>. Previous studies have shown that trunk function along with trunk muscle strength, activities, and postural control are impaired in stroke patients<sup>28</sup>. This study showed that KT application on the trunk could improve TIS scores and DCL in LOS immediately, suggesting that trunk KT application may be an effective intervention for trunk function and postural control in stroke patients, at least in the short term.

As the primary outcome, the total TIS score showed a significant increase, an indication of improvements in overall trunk function. Cerebral ischaemia and haemorrhage can cause injury of the corticospinal tract or cortical-reticulospinal tract connected with the reticular formation of the brain stem<sup>29</sup>. The damage of these structures that belong to the medial motor system affects the postural tension of core muscles and sensory integration, leading to dysfunction of trunk control. Trunk function is the basis of postural control, which is positively correlated to the motor and transfer function in stroke patients<sup>30</sup>. Rojhani-Shirazi et al. reported that cutaneous mechanoreceptors could be stimulated by continuously taping over the skin, thus increasing information integration by inputting more sensory signals to the central nervous system<sup>31</sup>. Callaghan's research also demonstrated that taping could increase sensory input and modulate the electrical activities of neurons in several

**Table 1.** Characteristics of participants

Characteristics	
Gender (Male/Female)	8/5
Age (years)	45.08 ± 16.73
Time since stroke onset (days)	83.17 ± 49.42
Type of stroke (ischemia/hemorrhage)	9/4
Paretic side (left/right)	7/6
Weight (kg)	70.33 ± 5.54
Height (cm)	167.67 ± 9.95

**Table 2.** Results of comparison of outcome measures before and after the intervention

Outcome measures	Pre	Post	D	95%CI	Comparison
TIS-total	12.67 ± 2.88	15.50 ± 2.26	2.83 ± 0.98	1.80 to 3.87	p=0.024 <sup>a, *</sup>
TIS-subcales					
Static sitting balance	5.33 ± 1.63	5.50 ± 1.22	0.17 ± 0.41	-0.26 to 0.60	p=0.317 <sup>a</sup>
Dynamic sitting balance	5.33 ± 1.97	7.33 ± 1.86	2.00 ± 0.63	1.34 to 2.66	p=0.024 <sup>a, *</sup>
Trunk coordination	2.00 ± 1.10	2.67 ± 1.21	0.67 ± 0.82	-0.19 to 1.52	p=0.102 <sup>a</sup>
TCT	67.83 ± 31.17	72.00 ± 30.98	4.17 ± 6.42	-2.62 to 10.95	p=0.180 <sup>a</sup>
FMA-balance	9.17 ± 1.17	9.50 ± 1.38	0.33 ± 0.52	1.04 to 2.62	p=0.157 <sup>a</sup>
LOS					
RT (sec)	1.08 ± 0.27	0.99 ± 0.28	-0.10 ± 0.22	-0.33 to 0.14	p=0.416 <sup>b</sup>
MVL (deg/sec)	2.28 ± 1.03	2.16 ± 0.79	-0.12 ± 0.51	-0.66 to 0.42	p=0.590 <sup>b</sup>
EPE (%)	51.92 ± 14.84	54.98 ± 12.58	3.06 ± 5.47	-2.68 to 8.80	p=0.228 <sup>b</sup>
MXE (%)	65.48 ± 15.49	68.96 ± 16.57	3.48 ± 4.23	-0.96 to 7.92	p=0.100 <sup>b</sup>
DCL (%)	50.44 ± 14.19	64.13 ± 13.26	13.69 ± 8.26	5.02 to 22.36	p=0.010 <sup>b, *</sup>
MRMI	31.33 ± 5.92	32.00 ± 6.36	0.67 ± 0.82	-0.19 to 1.52	p=0.102 <sup>a</sup>

Mean ± SD.

TIS: Trunk Impairment Scale; TCT: trunk control test; FMA: Fugl-Meyer assessment; LOS: limits of stability; RT: reaction time; MVL: movement velocity; EPE: endpoint excursions; MXE: max excursions; DCL: directional control; MRMI: modified Rivermead mobility index.

D: Mean difference of the change score; CI: confidence interval.

<sup>a</sup> Results of the Wilcoxon signed-ranks test.

<sup>b</sup> Results of the paired t-test.

\*p<0.05. Variation means difference between pretreatment and posttreatment.

encephalic regions<sup>20</sup>). Multiple sensory inputs play an important role in posture control, especially somatosensory (70%)<sup>32</sup>). Therefore, a possible explanation for the improvement of trunk control in this study may be due to increased activation in the cutaneous mechanoreceptors provided by trunk KT which promotes sensory integration for core stability in stroke patients. It also may contribute to the improved DCL in LOS after trunk KT in this study.

However, no significant difference in static sitting balance or trunk coordination among the subscales was observed. Previous studies reported that the static balance subscale shows a ceiling effect<sup>11, 33</sup>) and low internal validity<sup>34, 35</sup>). After regular exercise, some studies reported improvements in trunk coordination in terms of TIS<sup>11, 33</sup>), while others demonstrated none<sup>4, 12</sup>). Moreover, Verheyden et al. indicated that in TIS, static sitting balance appeared easier to improve than the other 2 subscales<sup>9</sup>). Therefore, these results are likely to be related to the reasons why no significant changes were found in these subscales in this study.

A recent meta-analysis also demonstrated that KT is more effective than routine rehabilitation for balance function in stroke rehabilitation programmes<sup>5</sup>). Lee et al. found that trunk KT could immediately improve both centre of pressure (COP) path length and COP velocity<sup>17</sup>). Consistent with the literature, this study found that participants who reported using trunk KT also improved in reaction time (RT), movement velocity (MVL) and range (endpoint excursions, EPE; max excursions, MXE) of LOS. These results further corroborate the findings of the previous studies to a great deal. There were no significant differences in these parameters, as well as mobility (MRMI score), here. A possible explanation for these results may be the lack of adequate time for an intervention.

To the best of our knowledge, this is the first study to investigate the immediate effects of trunk KT on trunk function, balance, and mobility in stroke patients. Moreover, this study supports the fact that KT acts on the skin rather than the muscles. The trunk tape over the skin could stimulate cutaneous mechanoreceptors to provide more information for sensory integration, which may modulate the electrical activity of neurons in the same region of trunk as in the brain<sup>20, 31</sup>).

Immediate positive effects were found on the dynamic sitting balance of TIS and DCL of standing balance after KT application on bilateral trunk muscles. The trunk KT was effective in improving trunk function and balance in stroke patients. However, the major limitations of this study are the short duration of KT application, small sample size, and lack of control group. Further studies are needed in order to validate the long-term effects of trunk KT on functional activities in post-stroke patients.

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## Conflict of interest

We declare that we have no conflicts of interest in this work.

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