The effect of Kinesio Taping on postural control in subjects with non-specific chronic low back pain

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ABSTRACT

Purpose: The aim of this study was to investigate the possible alterations in postural control during upright standing in subjects with non-specific chronic low back pain and the effect of Kinesio taping on the postural control.

Methods: Twenty subjects with non-specific chronic low back pain and twenty healthy subjects participated in this study. The center of pressure excursion was evaluated before the intervention for both groups, and immediately after intervention for the low back pain group. Independent sample t-test, Mann-Whitney test and repeated measure ANOVA were used for the statistical analysis of the data.

Results: There were significant differences in the center of pressure excursion between the low back pain group versus the healthy group. The results of the ANOVA demonstrated a statistically significant difference in the mean COP displacement and velocity before Kinesio Taping, immediately after, and 24 h after in the low back pain group.

Conclusions: There are poor postural control mechanisms in subjects with non-specific chronic low back pain. Kinesio taping seems to change postural control immediately and have lasting effects until the day after.

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1. Introduction

The control of upright standing is an absolute necessity for physical and everyday activities (Della Volpe et al., 2006; Claeyss et al., 2011). The human postural system is controlled by the coordination of the three sensory sources including visual, vestibular, and proprioceptive inputs. These systems provide information about the status and movements of the body in space and continuously transmit and generate enough force for the control and maintenance of balance in various situations (Brumagne et al., 2004; Prado et al., 2007). Therefore, it is conceivable that a disruption to any of these sensory systems will affect the output of the postural system.

Previous studies revealed that coordination of postural control in subjects with chronic low back pain may be affected by some components of these systems such as the physiology of afferent and efferent nerves (Gatti et al., 2011; Ruhe et al., 2011). Postural control deficits may play a role in recurrence of low back pain (Tsao et al., 2008).

Nies and Sinnott (Nies and Sinnott, 1991) found that, in general, the postural sway was significantly larger for the low back pain group compared to the control group. The majority of subjects swayed in the Mediolateral direction. The body sway depends more on complex motor skills than visual input. This impairment may lead to spinal injury as a result of the asymmetric distribution of mechanical forces and body weight. Previous studies recommend balance training in the rehabilitation program for improving postural control in these patients (Gatti et al., 2011).

Poor postural control mechanisms in subjects with low back pain are not yet fully understood (Ruhe et al., 2011). In some studies, proprioceptive input or sensory integration deficits have been suspected as the possible causes for balance impairments in
people with chronic low back pain although there is not sufficient evidence in this regard (Lin and Sun, 2006; Ruhe et al., 2011).

Since subjects with low back pain exhibit postural control impairment, researchers could find new insight for rehabilitation of postural control impairment in these patients, but few balance control studies have been performed on chronic low back pain patients and these studies have shown inconsistent results. The Kinesio Taping Method is one method that can improve postural control in these patients by several mechanisms including correcting muscle performance by strengthening weakened muscle, enhancing blood and lymph flow by removing tissue fluid or bleeding from beneath the skin via muscle movement, relieving pain by neurosensory suppression (Kase, 2003), and increasing proprioception by increased stimulation to cutaneous meano-receptors (Murray and Husk, 2001; Seo et al., 2016). However, Kinesio Taping has not been possible to demonstrate influence, over proprioception on low back in healthy subjects (Ruggiero et al., 2016).

To the extent of our knowledge, no studies have investigated the possible effect of Kinesio Taping on postural control in patients with low back pain. Therefore, the primary aim of the present study was to investigate the possible alterations in postural control during upright standing in patients with non-specific chronic low back pain compared to the control population. A secondary aim was to study the effect of the application of this taping method of the low back/pelvis area on the postural control in these patients.

2. Materials and methods

2.1. Study design and participants

The present study was conducted as repeated measures design with two groups for convenience sampling. Twenty (10 men, 10 women) non-specific chronic low back pain (NCLBP) patients and twenty (10 men, 10 women) healthy control subjects without a history of musculoskeletal disorders were compared in this study before intervention. They matched for age and BMI. All participants were recruited from referrals of local physiotherapy clinics in Shiraz. Non-specific low back pain is defined as pain in the area between the 12th rib and the gluteal folds. The age range of NCLBP patients was between 25 and 55 years (average age: 41.95 ± 5.46years; average BMI: 21.91 ± 2.6; average pain score: 47.25 ± 18.09 mm; average disability score: 20.91 ± 11.07) and that of the healthy subjects was between 25 and 55 years (average age: 35.95 ± 8.43years; average BMI: 22.44 ± 3.50).

The inclusion criteria were localized back pain lasting more than 3 months, pain radiating no further than the buttock, no previous history of sciatica or other radicular involvement, and at least 30 on the 100-mm numerical rating scale (NRS).

The exclusion criteria included the history of neurological signs such as sensory deficits, motor paralysis, vestibular system impairment, dizziness, and medication with known effects on balance. Also included were the history of spinal surgery, rheumatic diseases, diabetes, mental disorders, pregnancy, lower extremity injuries, and neuromuscular diseases.

Control subjects had no experience of any low back pain during 6 months prior to testing and no evidence of gait, postural, or musculoskeletal abnormality. All participants gave their informed consent to the protocol approved by the Ethics Committee of Shiraz University of Medical Sciences.

2.2. Taping techniques

We used X application Kinesio Taping (KT) technique, suggested by Kase et al. (Kase, 2003), and applied it for 24 h only in the low back pain group. Standard 2-inches (5 cm) Kinesio 3NS Tex Tape (NST-05002, made in Korea) was used for all participants. The base of the tape was applied inferior to the greater trochanter with no tension. We asked the patient to move into lateral flexion to the opposite side; the Kinesio I strip was applied with moderate tension (50%) over the tensor fascia lata and over the posterior superior iliac spine when it reached the lateral border of erector spine muscle. We asked the patient to move into lateral flexion to the same side, the remaining tape was brought towards the posterior inferior angle of the thoracic ribs using light tension (10–15%) and secured there. The same technique was applied for the opposite site (See Fig. 1). The Kinesio Tape was immediately removed if the skin became itchy. In the present study, other treatments or home exercises were not used to treat the low back pain group.

2.3. Outcomes measures

The outcome measures for this study consisted of postural control measurements. Center of Pressure (COP) excursion as a measure of postural control in standing was evaluated by an instrumented force plate system (Kistler Instrument®, Switzerland). The COP data was sampled at 100 Hz and force plate movements were described in terms of X and Y. Movement forward and backward was measured along the Y-axis, and lateral movement was measured along the X-axis. The antero-posterior (AP) and medio-lateral (ML) displacements (mm) of COP were stored for analysis. Raw data were exported to Visual 3D® software and filtered using a fourth order low-pass Butterworth filter with a cut off frequency of 6 Hz.

The COP parameters were standard deviation (SD) of displacement in antero-posterior (SDy) and mediolateral direction
(SDx)(mm), Root Mean Square Velocity (RMS) antero-posterior (RMSVy) and medio-lateral (RMSVx) and total (RMSVt)(mm/s).

Each participant was recorded on the force plate for two trials of 20 s while completing four tasks: standing barefoot in a double leg stance with eyes open and closed (task 1 and task 2) and in a single leg stance (dominant leg) with eyes open and closed (task 3 and task 4). During the two-legged stance condition, they were instructed to stand comfortably with normal posture, placing their feet approximately at pelvis width with arms hanging loosely by their sides. While standing with eyes open they were asked to focus on a target placed at eye level 2 m in front of them. The dominant leg test was conducted with the non-dominant knee flexed 90° while the dominant lower extremity supported the subject’s weight in the standing position. The order of these four tasks was determined randomly by simple randomization the numbers 1 through 4 were written on cards hidden in envelopes that the subject was asked to select at random in order to determine the sequence of postural tasks. Postural stability measurements were recorded before the intervention for both groups, immediately, and one day (24hr) after the intervention for LBP group.

2.4. Statistical analysis

The data was analyzed using SPSS, version 16. Kolmogorov-Smirnov test was used to determine the normality of the variance of COP variables. Normally distributed data was described as mean and standard deviation; otherwise the data was presented as frequency, median, range, and analyzed non-parametrically. Data was compared between groups with independent t-test and Mann Whitney U tests. Within group differences the LBP group tests times (before, immediately and after) the intervention were evaluated using a repeated measure ANOVA. The significant level was set at 0.05.

3. Results

All participants were able to stand 20s during the four conditions. No adverse effects to Kinesio Taping were observed. There were no significant differences between the two groups regarding the anthropometric data (See Table 1).

3.1. Postural control and low back pain

The LBP group showed more displacement and velocity compared to the healthy group. There was a significant difference between the groups the velocity of COP in the ML direction, the SD displacement of COP in the AP direction during single leg stance with eyes closed, and velocity of COP in ML direction in single leg stance with eyes open.

3.2. Kinesio Taping and postural control in low back pain patients

The repeated measure ANOVA for within group differences shows that immediately after KT the velocity of COP in the Total direction and SD displacement of COP in the AP direction during single leg stance with eyes closed was significantly reduced in the LBP group in relation to baseline (See Table 2).

After 24 h SD displacement of COP in ML direction in single leg stance with eyes open was significantly reduced in the LBP group in relation to immediately after the KT application (See Table 2).

After 24 h velocity of COP in AP and Total directions and SD displacement of COP in AP direction during single leg stance with eyes closed was significantly reduced in the LBP group in relation to baseline (See Table 2).

4. Discussion

The results of the current study showed that the coordination of postural control is impaired in subjects with NCLBP and these subjects exhibited a more significant displacement in the AP direction and velocity of COP in the ML direction than healthy subjects. These results are supported by previous studies that showed that chronic LBP subjects swayed more in the AP direction during standing with greater COP speed than healthy subjects (Lafond et al., 2009). In contrast with the results of the current study, Min Kyun Sohn et al. (Sohn et al., 2013) reported that subjects with low back pain had more instability in the ML direction.

The study of Mann et al. (Mann et al., 2010) and Mientjes (Mientjes and Frank, 1999) showed that the LBP group presented higher displacement of COP in the AP and ML direction during standing with eyes open and closed. The findings of the present study showed no significant differences in displacement of COP in the ML direction between eyes open and closed. This may be since the authors selected young patients with acute LBP or only female subjects while the present study sample was composed of both male and female subjects with NCLBP with an average age of 40. The difference between postural task protocols may also have been a factor.

Braga et al. (Braga et al., 2012) analyzed the average speed of displacement of COP between healthy and LBP subjects. They found no significant difference between groups, while the current study did find a significant difference in the average speed of displacement between healthy and LBP subjects. The current study did not support the findings of Braga et al. This is most likely due to their selection of only female subjects, the evaluation of only double leg stance with eyes open, and difference in parameters of COP between studies. Harringe et al. (Harringe et al., 2008) reported that there was a significant difference between the LBP group and the multiple injury group (LBP and lower extremity injury) in the velocity measurements in ML direction.

It has been argued that postural control dysfunction in LBP patients may be due to altered proprioceptive feedback from the lumbar spine (Popa et al., 2007). Della Volpe et al. (Della Volpe et al., 2006) found that postural stabilization under altered proprioceptive input or sensory integration conditions caused increased AP sway for LBP patients and an increase in visual dependency during quiet standing. These observations are evident by poor performance in repositioning tests and decreased postural control under vibratory perturbation effects in LBP patients (Brumagne et al., 1999, 2000).

Some researchers asserted that increased imbalance and abnormal muscular activities of flexor and extensor spinal muscles may be the reason for AP sway, since pelvic and hip muscular functions were maintained in patients with LBP (Sohn et al., 2013).

Pain can be a contributing factor to changes in postural control (Brumagne et al., 2008). Muscle pain may cause a marked reduction in position sense through an increased presynaptic inhibition of muscle afferent neurons at the spinal level (Della Volpe et al., 2006). In the present study, LBP subjects swayed more in the AP direction.
direction and compensated their instability in ML direction; therefore, the velocity of COP in ML was significantly less in the LBP group compared to the healthy group with eyes open. However, when eyes were closed, LBP subjects could not compensate their instability in the ML direction. Resulting in an increase in velocity of COP in ML with eye closed compared to healthy subjects. Mientjes et al. (Mientjes and Frank, 1999) and Della Volpe et al. (Della Volpe et al., 2006) did not observe any notable abnormalities in static balance among individuals with lumbar pain. This data were supported by the present study since this study presented no significant difference between the groups during double leg stance.

Depend on previous studies NCLBP revealed a larger displacement in AP direction and larger velocity of COP relative to the healthy subject during standing when challenging conditions are met but no significant difference between the groups during double leg stance and these findings were supported by present study. Balance dysfunction in NCLBP may be due to altered proprioceptive inputs, pain, and abnormal muscular activities of spine. Our results supported the hypothesis that postural control is impaired in NCLBP.

Other results of the present study demonstrated that the application of Kinesio Tape in NCLBP patients exhibited statistically significant improvements in postural control immediately following the application of Kinesio Tape by decreasing the displacement and velocity of COP compared to baseline.

No studies to date have evaluated the effect of Kinesio Tape on postural control in patients with NCLBP but some studies showed the efficacy of Kinesio Tape on the reduction of pain, disability, and increased range of motion of the lumbar spine in subjects with LBP (Kim et al., 2002; Lee and Yoo, 2011a, 2011b; Lee et al., 2011; Yoshida & Kahanov, 2007).

Results from the current study support the hypothesis that a detonizing application of KT on a muscle, as it was used in these studies, could lead to an increase in ROM and therefore may regulate the tone of a muscle (Kase et al., 1996). The elasticity of the KT allows for overall joint movement, creating a deformation of the skin and an increase in cutaneous mechanoreceptor response. This stimulation activates nerve impulses causing local depolarization, to travel along afferent fibers to the central nervous system and strengthen the weakened muscles (Kase et al., 1996). This activation of the nervous system may assist postural alignment. Thus, KT application might improve the function of erector spinal and gluteus medius muscles, causing a reduction of postural sway. Pain might be a confounding factor for variability in postural task and could induce a loss of normal variability of postural strategy. This decrease in variability of postural strategy might increase further back problems (Brech et al., 2012). The cutaneous stretch stimulation provided by KT may interfere with the transmission of mechanical and painful stimuli by delivering afferent stimuli that facilitates pain inhibitory mechanisms (Kim et al., 2002). Pain reduction by KT application may improve postural control in patients with low back pain.

Despite the unknown proprioceptive effects of Kinesio Tape, it has been suggested as a possible proprioceptive facilitator through the increase of cutaneous stimulation received from the KT (Murray and Husk, 2001). The first study was conducted in 2001 by Murray et al. (Murray and Husk, 2001), and showed a positive effect of KT on ankle proprioception in healthy subjects. Halseth et al. (Halseth et al., 2017) have shown that KT application may improve postural control in subjects with low back pain.

### Table 2

Comparison of the mean COP displacement and velocity before, immediately, and 24 h after KT between the LBP group and healthy subjects. Healthy (HL, n = 20), Low Back Pain (LBP, n = 20).

<table>
<thead>
<tr>
<th></th>
<th>Double leg stance with eyes open</th>
<th>Double leg stance with eyes closed</th>
<th>Single leg stance with eyes open</th>
<th>Single leg stance with eyes closed</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>LBP P-value</td>
<td>HL P-value</td>
<td>LBP P-value</td>
<td>HL P-value</td>
</tr>
<tr>
<td>SD displacement (AP)</td>
<td>Before 4.13 ± 2.09</td>
<td>3.50 ± 1.80</td>
<td>0.767</td>
<td>4.62 ± 2.56</td>
</tr>
<tr>
<td></td>
<td>Immediate 5.58 ± 4.80</td>
<td>–</td>
<td>–</td>
<td>4.66 ± 4.35</td>
</tr>
<tr>
<td></td>
<td>After 24 Hours 4.82 ± 1.96</td>
<td>–</td>
<td>–</td>
<td>4.69 ± 4.46</td>
</tr>
<tr>
<td></td>
<td>RM ANOVA 0.288</td>
<td>–</td>
<td>–</td>
<td>0.652</td>
</tr>
<tr>
<td>SD displacement (ML)</td>
<td>Before 4.11 ± 2.09</td>
<td>3.50 ± 1.80</td>
<td>0.767</td>
<td>4.62 ± 2.56</td>
</tr>
<tr>
<td></td>
<td>Immediate 5.58 ± 4.80</td>
<td>–</td>
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<td></td>
<td>After 24 Hours 4.82 ± 1.96</td>
<td>–</td>
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<td>4.69 ± 4.46</td>
</tr>
<tr>
<td></td>
<td>RM ANOVA 0.288</td>
<td>–</td>
<td>–</td>
<td>0.652</td>
</tr>
<tr>
<td>RMS velocity (AP)</td>
<td>Before 6.93 ± 6.74</td>
<td>5.84 ± 2.57</td>
<td>0.503</td>
<td>5.62 ± 1.03</td>
</tr>
<tr>
<td></td>
<td>Immediate 11.26 ± 13.26</td>
<td>–</td>
<td>–</td>
<td>6.11 ± 6.11</td>
</tr>
<tr>
<td></td>
<td>RM ANOVA 0.188</td>
<td>–</td>
<td>–</td>
<td>0.842</td>
</tr>
<tr>
<td>RMS velocity (ML)</td>
<td>Before 7.79 ± 2.90</td>
<td>6.79 ± 1.85</td>
<td>0.204</td>
<td>8.29 ± 2.92</td>
</tr>
<tr>
<td></td>
<td>Immediate 10.29 ± 6.76</td>
<td>–</td>
<td>–</td>
<td>7.80 ± 2.29</td>
</tr>
<tr>
<td></td>
<td>After 24 Hours 8.99 ± 3.23</td>
<td>–</td>
<td>–</td>
<td>8.40 ± 2.22</td>
</tr>
<tr>
<td></td>
<td>RM ANOVA 0.244</td>
<td>–</td>
<td>–</td>
<td>0.705</td>
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<tr>
<td>RMS velocity (Total)</td>
<td>Before 9.27 ± 4.97</td>
<td>8.86 ± 2.90</td>
<td>0.750</td>
<td>14.94 ± 16.99</td>
</tr>
<tr>
<td></td>
<td>Immediate 16.77 ± 6.11</td>
<td>–</td>
<td>–</td>
<td>9.35 ± 2.21</td>
</tr>
<tr>
<td></td>
<td>After 24 Hours 10.16 ± 2.64</td>
<td>–</td>
<td>–</td>
<td>9.93 ± 3.82</td>
</tr>
<tr>
<td></td>
<td>RM ANOVA 0.059</td>
<td>–</td>
<td>–</td>
<td>0.184</td>
</tr>
</tbody>
</table>

SD: Standard deviation; AP: Anteroposterior; ML: Mediolateral; RMS: Root Mean Square; LBP: Low Back Pain Group; HL: Healthy Group. RM: Repeated measures. Values are given as mean ± standard deviation, when used the parametric test, and given as mean ± standard deviation (min.-max.) when used the non-parametric test. Difference within group: *P < 0.05.
et al., 2004), based on the study design of Murray et al., showed no such effects and therefore presented contradictory outcomes. Thus, it is reasonable to believe the KT may influence the cutaneous feedback in the lumbar spine and enhance proprioceptive inputs. On the other hand, proprioceptive input from the muscles of the legs and trunk play an important role in maintaining postural stability (Popa et al., 2007), suggesting that balance dysfunction in NCLBP may be due to altered proprioception feedback from the lumbar spine (Brumagne et al., 2008). KT application may improve the postural control in NCLBP through increased proprioception.

Another theory about how Kinesio Taping improves lumbar muscle function, could be its effect over muscle fatigue. Kinesio Taping appears to decrease the time it takes to reach muscle failure, suggesting that it influences processes that lead to muscle fatigue (Alvarez-Alvarez et al., 2014).

Previous studies have shown that applying Kinesio Tape on the lumbar spine in LBP patients improved disability, pain, muscle strength, range of motion of the spine, and improvement in proprioceptive inputs in other musculoskeletal disorders. The present study showed improved lumbopelvic postural control in NCLBP after the application of Kinesio Tape, however further research is needed.

This study showed subjects with non-specific chronic low back pain has an increased postural sway in the anterior-posterior direction and velocity of COP in the medial-lateral direction with a greater dependence on visual input under single leg stance conditions in relation to healthy individuals of a similar age.

After the application of KT, persons with non-specific chronic low back pain experienced significantly improved postural control.

One limitation of our study is that we did not assess alterations in proprioceptive input or pain before and after the KT application both could help explain how Kinesio Taping produces the results that were observed over displacement and velocity of COP. This study would have benefited from a control group of LBP who did not receive treatment, however, the main task to improve the accuracy of the discussion and results was incorporate a comparative group with low back pain who did not receive the treatment, in our study it wasn’t possible and we assume that is a limitation.

Another limitation of this study was the limited duration of the follow-up. In addition, we did not assess electromyography muscular activity of hip abductor or erector spine muscles. In our study, we assessed only one particular application of KT, which can be considered a limitation, and of course, there are several methodologies for applying KT that may provide additional input to answer the hypothesis of this study. Therefore, further research is needed to assess the effect of Kinesio Taping in LBP on postural control, other variables such as proprioception for longer time periods and/or in combination with exercise programs, and the testing of other KT applications that can improve proprioceptive inputs.

Also future research comparing young with LBP patients with patients of older age and with higher disability would further test the proposed hypothesis hopefully leading to a more complete understanding of the mechanisms behind altered postural control in order to create better interventions for individuals with LBP.

5. Clinical implication

The present findings suggest that COP measurements may aid as an objective tool in assessing the progress, treatment, and rehabilitation of postural control in subjects with non-specific chronic low back pain.

The use of Kinesio Taping can improve the postural control of these subjects and can be used in physical therapy programs for the improvement of postural control.

Informed consent

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation Ethics Committee in medical research of the Shiraz University and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients included in the study.

Conflicts of interest

Author Soheila Abbasi declares that he has no conflict of interest.

Author Zahra Rojhani Shirazi declares that he has no conflict of interest.

Author Esmaeil Shokri declares that he has no conflict of interest.

Author Francisco García-Muro San José declares that is a Certificated Kinesio Taping instructor and member of the Kinesio Taping Association International Research Committee.

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