

The Effects of Kinesio Taping on Potential in Chronic Low Back Pain Patients Anticipatory Postural Control and Cerebral Cortex

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Abstract. [Purpose] This study aimed to examine the effects of kinesio tape applied to chronic low back pain (CLBP) patients on anticipatory postural control and cerebral cortex potential. [Subjects and Methods] Twenty patients whose low back pain had continued for more than 12 weeks were selected and assigned to a control group (n=10) to which ordinary physical therapy was applied and an experimental group (n=10) to which kinesio tape was applied. Anticipatory postural control was evaluated using electromyography, and movement-related cortical potential (MRCP) was assessed using electroencephalography. Clinical evaluation was performed using a visual analogue scale and the Oswestry disability index. [Results] According to the analysis results for anticipatory postural control, there were significant decreases in the transversus abdominis (TrA) muscle and the external oblique muscle in both groups. Among them, the TrA of the experimental group exhibited the greatest differences. According to the results of a between-group comparison, there was significant difference in the TrA between the two groups. There was also a significant decrease in the MRCP of both groups. In particular, changes in the movement monitoring potential (MMP) of the experimental group were greatest at Fz, C3, Cz, and C4. According to the between-group comparison, there were significant differences in MMP at F3, C3, and Cz. Both groups saw VAS and ODI significantly decrease. Among them, the ODI of the experimental group underwent the greatest change. [Conclusion] Kinesio tape applied to CLBP patients reduced their pain and positively affected their anticipatory postural control and MRCP.

Key words: Chronic low back pain, Kinesio taping, Movement related cortical potential

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INTRODUCTION

Low back pain is a common problem that more than 80% of people experience at least once in their lives¹⁾. If pain continues, mobility and stability decrease, muscle strength and coordination decrease, and changes in proprioception occur, which results in diverse problems such as somatic disorders²⁾. Brumagne et al. noted that changes in postural adjustment appeared³⁾. Radebold et al. also observed that muscle response patterns varied according to loads⁴⁾, and Risch reported that decreased activities due to pain caused the paraspinal muscles to weaken and pain to increase⁵⁾.

A diversity of physical therapy interventions for lumbar pain patients are currently in use. Among them, taping

therapy prompts or inhibits muscle mobility according to the direction of the muscle fibers^{6, 7)} and may change the output of motor neurons by activating afferent input from the skin^{8, 9)}. Castro-Sánchez et al. reported that the clinical value of taping applications was small, but they may reduce pain and disability¹⁰⁾. Paoloni et al. reported that muscle functions normalized and pain was alleviated when taping was applied¹¹⁾. Lee et al. reported that posterior pelvic tilt taping was effective in reducing sacroiliac joint dysfunction and medial buttock pain¹²⁾.

There is a considerable delay in anticipatory postural adjustment in lumbar pain patients during voluntary movement¹³⁾. To form such anticipatory postural adjustment, supplementary and primary motor areas are included¹⁴⁾. The MRCP can be used to analyze the cerebral cortex activity of the primary and supplementary motor areas¹⁵⁾. It is the record of the brain potential extracted from EEG in relation to voluntary movements¹⁶⁾. To date, no research has been done to examine the changes in brain waves after application of tape to lumbar pain patients. Accordingly, this study intends to look at changes in anticipatory postural

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control and cerebral cortex potential according to the application of kinesio taping.

SUBJECTS AND METHODS

Subjects

This study was performed with 20 chronic low back pain patients (CLBP) who had participated in a low back pain class and whose pain had continued for more than three months. The criteria for inclusion in this study were as follows: those whose low back pain had continued for more than 12 weeks; those who had not undergone lumbar region surgery as a result of orthopedic problems; those who did not have a structural malformation or other musculoskeletal disease; those whose skin was not sensitive to tapes; those who had not conducted exercises using the muscles of the lumbar spinal area for the past three months; those who had not experienced taping treatment before; those whose VAS and ODI scores were 6 or higher; and those who did not take adrenocortical hormone or pain alleviation medication. All of the subjects voluntarily consented to participate in this study. Data collection was initiated after approval was obtained from the Dongshin University Hospital Institutional Review Board. The general characteristics of the subjects are shown in Table 1.

Methods

Using a card with even and odd numbers, the subjects were randomly and equally assigned to a control group and an experimental group. The two groups received ordinary pain therapy. For ordinary physical therapy, a hot pack (20 minutes), ultrasound (1.5 W/cm², five minutes, Jireh Medical, Korea), and transcutaneous electrical nerve stimulation (4 pps, 15 minutes, Hanawoo Medical, Korea) were applied to the L1–2 and L4–5 areas for 40 minutes each time, three times per week, for a total of twelve weeks. Placebo tape was applied to the control group, and kinesio tape was applied to the experimental group. The same therapist conducted the kinesio taping, and tape with tension in the evaluated direction was applied. As the tape (5 cm wide and 5 cm thick), a waterproof, porous, and adhesive product was used. The experimental group used the kinesio tape in a sitting position. Four blue “I” strips were stretched and overlappingly attached to the lumbar area with the maximum pain in a star shape¹⁰. For the control group, one inelastic “I” strip was attached transversely to the lumbar area with the maximum pain. The two groups were instructed to leave the tapes attached in situ until the next intervention.

Regarding anticipatory postural adjustment, the anticipatory muscle contraction initiation time of the trunk according to upper extremity movement was examined. For the measurement of the muscle contraction initiation time, a surface EMG (BTS Pocket EMG, BTS S. P. A., Milan, Italy) was used.

The electrodes were attached to the deltoid anterior (DA), the transversus abdominis (TrA), the External Oblique (EO) of the nondominant side. The subjects sat comfortably in a chair and placed their arms beside their trunk, side by side. They then raised their nondominant hand, and returned it to

Table 1 . Characteristics of study participants

Parameters	Control (n=10)	Experimental (n=10)
Age (years)	51.3 ± 3.7	53.6 ± 2.1
Sex (male/female)	4/6	5/5
Height (cm)	158.3 ± 5.2	165.82 ± 6.5
Weight (kg)	65.1 ± 8.6	71.3 ± 9.3
BMI (kg/m ²)	22.17 ± 4.75	21.45 ± 3.13
Pain duration (months)	12.4 ± 4.1	13.2 ± 3.4

All data are expressed as means with standard deviation (M ± SD)

the starting point as fast as possible when the signal sounded for 1 second. With the DA as the standard, the preceding contraction was expressed as a minus value, and the next contraction was expressed as a plus value. The sample collection rate was 1,000 Hz, and filtering was 20 to 500 Hz.

Changes in cerebral cortex potential were measured using a QEEG-8 (LEX3208, Laxtha Inc., Korea). Based on the international 10–20 system, the active electrodes were attached to the F3, Fz, F4, C3, Cz, and C4 areas of the cerebral cortex. The ground electrode and the reference electrodes (A1, A2) were attached to the mastoids. The subjects' postures and motions were the same as those during anticipatory postural control. With the initiation of electromyography DA signals that started with the motions as the standard, MRCP was divided into readiness potential (RP), –600 ms to –500 ms, motor potential (MP) at –100 ms to 0 ms, and movement monitoring potential (MMP) at 0 ms to 1 s; the maximum values of each section were recorded¹⁷. Brain wave signals prior to the attachment of the tape and 12 weeks after the attachment of the tape were measured. In order to prevent eye blinking and movement of pupillae, a mark was made 2 m to the front of the subjects, and the subjects were instructed to look at the marked point. The sampling rate for data collection was set at 256 Hz, and the band-pass filter was analyzed at 4 to 50 Hz. For the clinical evaluation of pain, a visual analogue scale was used¹⁸. For the functional performance evaluation of ordinary life, the ODI was used¹⁹.

Statistical analysis was performed using SPSS 12.0 for Windows. Changes within each group after taping were analyzed using a paired t-test. Changes between the groups were analyzed using an independent t-test. The statistical significance level was set at $\alpha=0.05$.

RESULTS

According to the analysis of changes in muscle contraction initiation time related to movement during upper extremity flexion, there were significant decreases in the TrA and EO in both groups ($p<0.05$). Among them, the greatest changes were in the TrA of the experimental group ($p<0.01$). According to the between-group comparison, there was a significant difference in the TrA of the experimental group ($p<0.05$) (Table 2).

As for the changes in the MRCP, the MRCP was signifi-

Table 2. Changes in the muscle activity times in each group (M ± SD)

Parameters	Control		Experimental	
	Pre	Post	Pre	Post
DA	0	0	0	0
TrA	41.53 ± 9.27	33.87 ± 9.61*	44.53 ± 7.51	21.74 ± 6.34**#
EO	56.26 ± 10.12	50.16 ± 9.62*	58.12 ± 9.53	50.32 ± 9.97*

A paired t-test was conducted to examine changes in the groups' muscle contraction initiation times (*p<0.05; **p<0.01), and an independent t-test was carried out to compare changes in the groups' muscle contraction initiation times (#p<0.05).

DA, deltoid anterior; TrA, transversus abdominis; EO, external oblique

Table 3. Changes in MRCP control and experimental groups (M ± SD)

Parameters		F3	Fz	F4	C3	Cz	C4
Control							
RP	Pre	7.61 ± 3.47	7.72 ± 3.86	8.45 ± 4.43	10.10 ± 4.70	11.21 ± 4.13	10.78 ± 4.59
	Post	7.12 ± 3.35	6.51 ± 3.73*	7.58 ± 4.18	10.12 ± 4.35	9.87 ± 3.45*	9.28 ± 3.44
MP	Pre	12.12 ± 4.75	13.64 ± 5.36	13.08 ± 5.43	15.15 ± 6.07	16.45 ± 5.78	14.74 ± 5.43
	Post	11.64 ± 4.64	12.26 ± 5.34*	12.68 ± 4.72	14.67 ± 4.78	14.58 ± 5.43*	13.13 ± 5.62*
MMP	Pre	14.78 ± 4.12	16.72 ± 4.36	15.38 ± 4.43	17.61 ± 5.70	18.57 ± 3.36	16.38 ± 4.43
	Post	14.06 ± 4.37	14.54 ± 5.34*	14.67 ± 4.74	16.62 ± 4.32	16.64 ± 5.51*	15.91 ± 4.94
Experimental							
RP	Pre	6.74 ± 4.23	7.14 ± 4.07	8.67 ± 4.38	11.12 ± 4.45	12.17 ± 3.89	11.42 ± 4.67
	Post	6.11 ± 4.35	6.12 ± 3.42*	7.86 ± 4.24	10.63 ± 4.35	11.05 ± 5.28*	11.02 ± 3.57
MP	Pre	13.14 ± 4.05	13.86 ± 5.14	13.41 ± 4.78	15.75 ± 5.72	16.84 ± 5.27	15.13 ± 5.15
	Post	10.84 ± 4.35*	11.56 ± 5.24*	10.88 ± 4.47*	12.63 ± 4.35*	13.51 ± 5.25*	13.48 ± 4.85
MMP	Pre	13.91 ± 4.45	16.42 ± 4.49	15.56 ± 5.16	17.26 ± 5.24	17.87 ± 4.54	17.03 ± 4.75
	Post	11.21 ± 4.14#	13.42 ± 5.27**	12.87 ± 4.43*	13.63 ± 4.16**#	13.94 ± 5.34**#	13.89 ± 4.64**

A paired t-test was conducted to compare changes prior to and after the application of tape in each group (*p<0.05, **p<0.01), and an independent t-test was carried out to compare changes after the application of tape between the two groups (#p<0.05). RP, readiness potential; MP, motor potential; MMP, movement monitoring potential

Table 4. Changes in VAS and ODI scores for each group (M ± SD)

Parameters	Control		Experimental	
	Pre	Post	Pre	Post
VAS	7.71 ± 0.61	5.14 ± 0.95*	7.83 ± 0.38	5.07 ± 0.78*
ODI	15.43 ± 4.34	11.34 ± 3.32*	16.32 ± 5.13	10.75 ± 4.73**

A paired t-test was conducted to compare changes prior to and after taping in each group (*p<0.05, **p<0.01).

cantly decreased with regard to the RP; MMP was significantly decreased at the Fz and Cz; and MP was significantly decreased at the Fz, Cz, and C4 in the control group after the application of tape compared with the baseline measured in both groups (p<0.05). In the experimental group, MRCP was significantly decreased with regard to the RP at Fz and Cz; MP at F3, Fz, F4, C3, and Cz; and MMP at F3, Fz, F4, C3, Cz, and C4 (p<0.05). In particular, the changes at Fz, C4, Cz, and C4 in the experimental group were greatest (p<0.01). According to the comparison of MRCP changes between the two groups, there were significant differences in the MMP at F3, C3, and Cz (p<0.05) (Table 3).

According to the clinical evaluation results after the application of kinesi taping, VAS and ODI scores signifi-

cantly decreased (p<0.05), and the most significant changes were observed in the ODI of the experimental group (p<0.01) (Table 4).

DISCUSSION

As low back pain progresses into a chronic condition, muscle strength, endurance, and flexibility of the trunk are reduced, limiting one's range of motion. As a result, low back pain patients' levels of participation in everyday and social activities decrease, and their quality of life is thus reduced²⁰.

Swift movement of the extremities triggers postural sway of the whole body. At this point, postural sway is ad-

justed by anticipatory activation of postural control muscles by the basal ganglia, the supplementary motor area, and the primary motor area in the opposite side of agonists and by providing agonist contraction timing²¹). This response, which is planned in advance in the central nervous system, is called anticipatory postural adjustment. However, chronic low back pain patients have problems with anticipatory postural control due to changes in their muscle coordination adjustment and neural transmission resulting from pain³). In addition, Wand et al. observed that CLBP patients underwent cerebral cortical changes due to pain²²). Accordingly, using the muscle contraction initiation time of the trunk, MRCP activity of the cerebral cortex, and clinical evaluation (VAS and ODI), this study examined how the application of kinesio tape affected CLBP patients' anticipatory postural adjustments and movement-related MRCP.

Muscle contraction initiation time consists of premotor reaction time, which is the stage prior to muscle contraction in EMG after stimuli have been provided, and motor reaction time, which is the period of time from when a muscle contracts to the time point when actual joint movement occurs²³). In this study, kinesio tape was applied, and anticipatory postural adjustments in the trunk muscles (TrA and EO) were examined. Both groups experienced TrA and EO contraction after deltoid muscle contraction. In an experiment using normal subjects, Hodges et al. noted that trunk muscle contraction always preceded movements of the extremities²⁴). However, in this study, trunk muscle contraction occurred after movements of the extremities. This result is consistent with those of Urquhart et al., who reported that when CLBP patients moved their extremities, their trunk muscles were not activated compared with those of normal subjects and that CLBP patients experienced a delay in postural adjustment²⁵). In addition, when compared between before and after the experiment, the groups' muscle contraction initiation times significantly decreased. In particular, the experimental group's TrA muscle contraction initiation time change was larger than that of the control group. This suggests that CLBP patients' trunk muscle initiation time was delayed by more than in ordinary subjects, but after kinesio taping, the trunk muscle contraction response time in these patients improved.

The area related to MRCP is associated with the primary motor area (M1) and the supplementary motor area (SMA)¹⁵). In order to examine cerebral cortical activity as a result of applying kinesio tape, this study investigated MRCP. In the control group, the RP and MMP activities at Fz and Cz and MP activity at Fz, Cz, and C4 were significantly decreased. In the experimental group, the RP activity at Fz and Cz; MP activity at F3, Fz, F4, C3 and Cz and MMP activity at F3, Fz, F4, C3, Cz, and C4 were significantly decreased. In particular, the experimental group's MMP activity most greatly decreased. When comparing the two groups, the experimental group's MMP activity decreased by significantly more than the control group's MMP activity. This result showed that the MRCP of CLBP patients decreased after the application of kinesio tape. Jacobs et al. compared the MRCP of CLBP patients and normal subjects and reported that MRCP activity increased more in CLBP

patients than in normal subjects²⁶). David et al. measured MRCP that appeared in movements that were made for the first time and in experienced movements and reported that MRCP activity was lower in experienced movements²⁷). In other words, kinesio tape that was applied to CLBP patients continuously provided feedback to the cerebrum and reduced MRCP activity.

The two groups exhibited significantly different changes in VAS and ODI. This result suggests that application of physical therapy and kinesio tape reduces pain and affects functional performance capabilities. In particular, the experimental group's VAS significantly decreased. This result can be explained by the fact that kinesio taping increases the circulation of blood and lymphatic fluid and continuously stimulates the neurological system, reducing pain and positively affecting ODI, which is a functional evaluation²⁸).

Skin adhesion of kinesio tape is believed to cause information to be sent to the cerebrum that results in continuous contraction of muscle and to create stable muscle tension by repetitively causing muscle contraction and relaxation²⁹). It also increases the space between the skin and the muscles, reducing pressure, and increases lymphatic circulation, decreasing pain, and thereby improving muscle function³⁰).

According to the results of this study, the CLBP patients experienced an imbalance in anticipatory postural adjustment together with pain and MRCP overactivity, and due to such problems, their functional movements were negatively affected. The application of kinesio tape reduces pain in CLBP patients, and such reduced pain positively affects their anticipatory postural adjustment. In addition, the repetitive feedback formation of the cerebrum through the taping triggers a decrease in MRCP, positively influencing functional movements.

REFERENCES

- 1) O'Sullivan PB: Lumbar segmental instability: clinical presentation and specific stabilizing exercise management. *Man Ther*, 2000, 5: 2–12. [[Medline](#)] [[CrossRef](#)]
- 2) Koumantakis GA, Watson PJ, Oldham JA: Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain. *Phys Ther*, 2005, 85: 209–225. [[Medline](#)]
- 3) Brumagne S, Janssens L, Janssens E, et al.: Altered postural control in anticipation of postural instability in persons with recurrent low back pain. *Gait Posture*, 2008, 28: 657–662. [[Medline](#)] [[CrossRef](#)]
- 4) Radebold A, Cholewicki J, Panjabi MM, et al.: Muscle response pattern to sudden trunk loading in healthy individuals and in patients with chronic low back pain. *Spine*, 2000, 25: 947–954. [[Medline](#)] [[CrossRef](#)]
- 5) Risch SV: Lumbar strengthening in chronic low back pain patients. Physiologic and psychological benefits. *Spine*, 1993, 18: 232–238. [[Medline](#)] [[CrossRef](#)]
- 6) Morrissey D: Proprioceptive shoulder taping. *J Bodyw Mov Ther*, 2000, 4: 189–194. [[CrossRef](#)]
- 7) Tobin S, Robinson G: The effect of McConnell's vastus lateralis inhibition taping technique on vastus lateralis and vastus medialis obliquus activity. *Physiotherapy*, 2000, 86: 173–183. [[CrossRef](#)]
- 8) Simoneau GG, Degner RM, Kramper CA, et al.: Changes in ankle joint proprioception resulting from strips of athletic tape applied over the skin. *J Athl Train*, 1997, 32: 141–147. [[Medline](#)]
- 9) McNair PJ, Heine PJ: Trunk proprioception: enhancement through lumbar bracing. *Arch Phys Med Rehabil*, 1999, 80: 96–99. [[Medline](#)] [[CrossRef](#)]
- 10) Castro-Sánchez AM, Lara-Palomo IC, Matarán-Peñarocha GA, et al.: Kinesio taping reduces disability and pain slightly in chronic non-specific low back pain: a randomised trial. *J Physiother*, 2012, 58: 89–95. [[Medline](#)]

- [CrossRef]
- 11) Paoloni M, Bernetti A, Fratocchi G, et al.: Kinesio taping applied to lumbar muscles influences clinical and electromyographic characteristics in chronic low back pain patients. *Eur J Phys Rehabil Med*, 2011, 47: 237–244. [Medline] [CrossRef]
 - 12) Lee JH, Yoo WG: Application of posterior pelvic tilt taping for the treatment of chronic low back pain with sacroiliac joint dysfunction and increased sacral horizontal angle. *Phys Ther Sport*, 2012, 13: 279–285. [Medline] [CrossRef]
 - 13) Hodges PW, Richardson CA: Altered trunk muscle recruitment in people with low back pain with upper limb movement at different speeds. *Arch Phys Med Rehabil*, 1999, 80: 1005–1012. [Medline] [CrossRef]
 - 14) Viallet F, Massion J, Massarino R, et al.: Coordination between posture and movement in a bimanual load lifting task: putative role of a medial frontal region including the supplementary motor area. *Exp Brain Res*, 1992, 88: 674–684. [Medline] [CrossRef]
 - 15) Ikeda A, Shibasaki H: Invasive recording of movement-related cortical potentials in humans. *J Clin Neurophysiol*, 1992, 9: 509–520. [Medline] [CrossRef]
 - 16) Siemionow V, Yue GH, Ranganathan VK, et al.: Relationship between motor activity-related cortical potential and voluntary muscle activation. *Exp Brain Res*, 2000, 133: 303–311. [Medline] [CrossRef]
 - 17) Yoshida S, Nakazawa K, Shimizu E, et al.: Anticipatory postural adjustments modify the movement-related potentials of upper extremity voluntary movement. *Gait Posture*, 2008, 27: 97–102. [Medline] [CrossRef]
 - 18) Boonstra AM, Schiphorst Preuper HR, Reneman MF, et al.: Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. *Int J Rehabil Res*, 2008, 31: 165–169. [Medline] [CrossRef]
 - 19) Monticone M, Baiardi P, Vanti C, et al.: Responsiveness of the Oswestry Disability Index and the Roland Morris Disability Questionnaire in Italian subjects with sub-acute and chronic low back pain. *Eur Spine J*, 2012, 21: 122–129. [Medline] [CrossRef]
 - 20) Bowman JM: The meaning of chronic low back pain. *AAOHN J*, 1991, 39: 381–384. [Medline]
 - 21) Massion J, Ioffe M, Schmitz C, et al.: Acquisition of anticipatory postural adjustments in a bimanual load-lifting task: normal and pathological aspects. *Exp Brain Res*, 1999, 128: 229–235. [Medline] [CrossRef]
 - 22) Wand BM, Parkitny L, O'Connell NE, et al.: Cortical changes in chronic low back pain: current state of the art and implications for clinical practice. *Man Ther*, 2011, 16: 15–20. [Medline] [CrossRef]
 - 23) Schmidt RA, Lee TD: *Motor Control and Learning a Behavioral Emphasis*, 3rd ed. Champaign: Human Kinetics, 1999.
 - 24) Hodges P, Cresswell A, Thorstensson A: Preparatory trunk motion accompanies rapid upper limb movement. *Exp Brain Res*, 1999, 124: 69–79. [Medline] [CrossRef]
 - 25) Urquhart DM, Hodges PW, Alen TJ, et al.: Abdominal muscle recruitment during a range of voluntary exercises. *Man Ther*, 2005, 10: 144–153. [Medline] [CrossRef]
 - 26) Jacobs JV, Henry SM, Nagle KJ: Low back pain associates with altered activity of the cerebral cortex prior to arm movements that require postural adjustment. *Clin Neurophysiol*, 2010, 121: 431–440. [Medline] [CrossRef]
 - 27) David JW, Paul SH, Martin B, et al.: Preliminary evidence for reduced cortical activity in experienced guitarists during performance preparation for simple scale playing. *Music Perform Res*, 2012, 5: 2–11.
 - 28) Yoshida A, Kahanov L: The effect of kinesio taping on lower trunk range of motions. *Res Sports Med*, 2007, 15: 103–112. [Medline] [CrossRef]
 - 29) Kottke, FJ, Lehmann JF: *Krusens Handbook of Physical Medicine and Rehabilitation*, 4th ed. Philadelphia: Saunders, pp 250–251.
 - 30) Fu TC, Wong AM, Pei YC, et al.: Effect of Kinesio taping on muscle strength in athletes—a pilot study. *J Sci Med Sport*, 2008, 11: 198–201. [Medline] [CrossRef]