J Int Acad Phys Ther Res 2018; 9(4): 1619~1625
ISSN 2092-8475
www.iaptr.org
https://doi.org/10.20540/JIAPTR.2018.9.4.1619

Effect of Kinesio Taping and Proprioception Training on Pain, Neck Disability, Craniovertebral Angle, and Muscle Activity in Forward Head Posture

To examine the changes in pain, the severity of the neck disorder, craniovertebral angle, and muscle activity in young adults with forward head posture. 37 "N" University students in their 20s with forward head posture, including both male and female participants. Measurement of pain, NDI (neck disorder index) craniovertebral angle, and muscle activity were taken before and after the 6 week intervention period. The pain was measured using the visual analog scale. The severity of the neck disorder was measured using the NDI The craniovertebral angle was measured by taking a photo. The muscle activity was measured using surface electromyography. Neck posture correction exercises paired with proprioceptive training is the most effective intervention for reducing pain. Both neck posture correction exercises paired with Kinesio taping or proprioceptive training are effective interventions for addressing neck disability, craniocervical angle, and muscle activity. Neck posture correction exercises paired with Kinesio taping or proprioceptive training are more effective at addressing pain, neck disorder, craniocervical angle, and muscle activity than performing the neck posture correction exercises alone.

Key words: *Forward Head Posture, Neck Posture Exercise, Kinesio Taping, Proprioceptive Training, Pain, Neck Disability, Craniovertebral Angle, Muscle Activity*

Hyo Jin Yoo, MS[a]; Jung Hyun Choi, Ph.D, Prof.

[a]Auckland University of Technology, Auckland, Newzealand; [b]Namseoul University, Cheonan, Republic of Korea

Received : 03 August 2018
Revised : 10 September 2018
Accepted : 17 September 2018

Address for correspondence
Jung Hyun Choi, PT, Ph.D
Department of Physical Therapy, Namseoul University, Daehak-ro 91, Seonghwan-eup, Cheonan, Korea
Tel: 82-10-4933-8158
E-mail: rightimind@nsu.ac.kr

INTRODUCTION

Forward head posture (FHP) is the forward inclination of the head caused by cervical spine hyperextension, where the head is placed anterior to the trunk, protruding in the saggital plane, and is commonly referred to as "chin poking" [1]. FHP can occur due to the anterior translation of the head, lower cervical flexion, or an increase in upper cervical extension [1, 2]. Many studies suggest that FHP causes an increase in compression force to the cervical apophyseal joints as well as the posterior part of the vertebra [1-4] It is associated with shortening of the cervical spine extensor muscles as well as the upper trapezius and levator scapula alongside the lengthening of the cervical spine flexor muscles such as the sternocleidomastoid [5]. Such change to the length of connective tissue not only affects the strength but also causes significant neck pain [6, 7].

Postural correction exercises involving repeated cervical and scapular retractions are commonly used for managing neck disorders in order to rectify underlying pathomechanical problems as well as reduce upper trapezius muscle spasms [8]. The constant repetition of postural correction exercises allow the potential for a change in postural habits to develop [9] There have been many proposed effects of kinesio. tape including increased local circulation, reduction in local edema through decreasing exudative substances, improved blood circulation through muscle facilitation, positional stimulus of the skin, muscle as well as fascial structures and limiting the range of movement of affected tissues [10].

Current trends in passive intervention methods used by health practitioners for addressing neck disorders have shown a rise in popularity of various taping methods [10, 11]. As taping techniques have developed alongside other treatment methods for musculoskeletal disorders, the therapeutic effects such as restoring muscle function and assisting in postural alignment have proven to improve function without hindering movement or exercise [10]. Furthermore, additional theories have suggested that through continued stretching of the skin under the taped area, KT may cause external activation of cutaneous mechanoreceptors than could inhibit pain through the gate control theory [12]. Previous studies have shown that the application of KT significantly improved the pain levels and cortical motion in the following 24 hours of treatment in patients with whiplash-associated disorders [13]. Many studies have shown significant results with the use of PT. In one study, it was reported that through simple, eye-head/neck-upper limb co-ordination exercises, subjects were able to experience a dramatic reduction in pain [14]. Another study found that neck proprioceptive training was of benefit for headaches in the short term [15]. Overall, exercise programs tailored to rehabilitate cervical proprioception have been shown to improve joint position error as well. Such programs include gaze stability exercises, eye-head coordination and/or practice of relocation of the head on the trunk [14, 16].

The purpose of this study was to investigate the effect of various intervention methods such as neck posture correction exercise, kinesio taping, and proprioception training on the neck disorder, pain, craniovertebral angle, and muscle activity due to forward head posture.

SUBJECTS AND METHODS

Subjects

A total of 37 subjects, including male and female, were selected, all of whom were "N" University students in their 20s. Individuals who displayed a craniovertebral angle 〉 53° when sitting, had a history of cervical trauma or surgery, an NDI score 〉 15 (non-severe symptoms), and experienced non-chronic neck pain or headaches within the previous six months (〈 5 on VAS, 〈 2 days/week, 〈 3 hours/day) were excluded from the study [17].

The subjects were divided into a neck exercise group (NE, n=12), a neck exercise with taping group (NEKT, n=12), and a neck exercise with proprioceptive training group (NEPT, n=13). All participants were instructed about potential risks and experimental design, and were provided with an informed consent form to sign prior to participation, with the knowledge that they could withdraw at any time.

Intervention

All groups performed warm up, cool down, and neck posture correction exercises. The warm up exercises consisted of static stretching with active ROM exercises for the neck, shoulder and upper extremity for 10 minutes. The cool down exercises included static stretching for 5 minutes. Interventions were performed individually at the time of convenience to the subject. The exercises were supervised by the same physiotherapist.

For wall exercises, subjects were instructed to stand with one leg placed in front of the other. Furthermore, the arms and torso were levelled and the chest faced towards the wall. The front knee is bent and the back leg is kept straight. Subjects were instructed to take turns with both sides. Initially, 30 repetitions are conducted for each side for a total of 60 reps. Every consequent week, an additional 10 reps are added to each side for a total addition of 20 reps. For the head exercises, subjects were instructed to lie prone with the stomach on a gym ball and forearms placed on the ground. In this position, subjects were asked to extend their heads as much as possible so that the folding of the cervical vertebra could be felt. Initial reps would begin at 30 reps and every subsequent week, an additional 10 reps were added to the program. For the roll exercises, subjects were instructed to lie supine with a gym ball underneath their backs and legs extended straight. This posture was maintained for 10 minutes without change during the 6 week intervention period.

Kinesio Taping

Kinesio Tape was applied with the mechanical correction technique and 33% tension [18]. Subjects were instructed to flatted their back (thoracic extension) and the tape was applied on both sides of the spine from the spinous process of T1 to T12. Then the subject was instructed to fully depress and retract the shoulder, whereupon tape was applied on both sides obliquely from the acromion process to the spinous process of T12 [19]. The tape was replaced every three day during the intervention period [20].

Proprioception training

The proprioceptive training program included head relocation practice, gaze stability, eye-follow and eye/head coordination exercises [16]. First, subjects were instructed to lie supine while the head was moved through passive motion. During movement, subjects were instructed to maintain their gaze on a fixed target and keep awareness on the different

Table 1. Intervention protocol

Group	Warm Up	Intervention	Cool Down
NE	static stretching + active ROM exercise for neck, shoulder, and upper extremity (10 min.)	1. Wall Exercise (10 min.) 2. Head Exercise (10 min.) 3. Roll Exercise (10 min.)	static stretching (5 min.)
NEKT		1. Wall Exercise (10 min.) 2. Head Exercise (10 min.) 3. Roll Exercise (10 min.) 4. Kinesio Tape replaced every three days	
NEPT		1. Wall Exercise (5 min.) 2. Head Exercise (5 min.) 3. Roll Exercise (5 min.) 2. Proprioceptive Training(15 min.)	

NE: neck exercises, NEKT: neck exercises with kinesio taping,
NEPT: neck exercises with proprioceptive training

positions of the head. Second, Subjects were instructed to perform the following movements both sitting and standing, whilst equipped with special goggles that restricted peripheral vision through opaque lenses, with a clear central point of 0.5 mm that adjusted so as each subject had unobstructed foveal vision.Then a 6 week intervention period [21] followed whereupon each group performed 3 sessions a week (30 minutes per session) for the duration of the study.

Outcome Measure

Visual Analogue Scale (VAS)

The VAS was used in order to assess the pain experienced by each subject. The line was 10cm long in length. The subject was instructed to indicate the intensity of pain felt on the line which was then converted into a score.

Neck Disability Index (NDI)

The NDI was used in order to assess severity of neck disability. The questionnaire is composed of a total of 10 questions. Of the 10, 7 examine functional activities, 2 inquire about symptoms, and the last question assesses concentration. Each question has 6 answer options which pertain to a level of severity (0–5) and subjects are instructed to select one answer per question. The NDI score in calculated by multiplying the summation of all the answers by 2 and should fall in a range between 0–100. A high score therefore indicates a greater disability experienced by the patient.

CVA Measure

CVA measurement was carried out by taking a digital photo from a side view of the subject while seated. Subjects were instructed to organize their hair so that the ears were clearly visible. The spinous process of C7 was palpated and a marker was then attached. The camera was set and fixed on a tripod. In order to ensure a natural posture of the head, the self balance posture was performed. The self balance posture is achieved by instructing subjects to start off by performing end range flexion and extension, gradually reducing the range of movement, until the subject reaches a comfortable position. The natural position was maintained by instructing subjects to maintain eye contact with themselves through a mirror.

Surface Electromyography (sEMG)

The Delsys–Trigno Wireless EMG (Trigno EMG Sensor, Deisys Inc., Boston, USA) system which is a bipolar surface EMG (sEMG), was used in order to measure the muscle activity of the sternocleidomastoid (SCM) and upper trapezius (UP). Areas of electrode placement were cleaned to insure proper adhesion to the skin of the subject. Pre–gelled Ag/AgCl electrodes were placed parallel to the direction of the muscle fibers and a reference electrode was placed contralateral to the acromion process. For measurement of the SCM, the electrodes were placed halfway between the mastoid and the manubrium. For measurement of the UP, the electrodes were placed halfway between the spinous process of C7 and the acromioclavicular joint. Measurement of muscle activity was only conducted on the dominant side.

The EMG signals were pre-amplified(common mode rejection ratio: 93 dB; input impedance: 109 ohms; gain: 23) at the surface of the skin. The raw EMG signals were then amplified again for a total gain of 4000, which were transmitted though optical fibers at a sampling rate of 5 KHz and sent to a multichannel Neogenix main receiver. Using specially developed software he EMG signal was band pass-filtered at 10-500 Hz through a digital high-pass Butterworth filter which converted the signal from analog to digital at a sampling rate of 1000 Hz. The signal was also fully rectified.

The reference condition recorded before the experiment included the mean EMG activity recorded whilst subjects maintained their arm at the final target position with a load of 1 kg for 5 seconds. The mean normalized EMG activity was calculated from three distinct phases: pre-movement(from beginning of muscle activation to beginning of movement), acceleration (from the beginning of movement to the end of hand acceleration), and deceleration (from the beginning of hand deceleration to the end of movement). Acceleration and deceleration of the hand was chosen as these two phases of end point control where the ultimate goal was to achieve the task.

Data analysis

Data analysis was conducted using SPSS Ver. 22.0. The Kolmogorow-Smirnov Test was used to assess the distribution of the subjects and the one-way ANOVA was used to assess homogeneity.

The paired t-test was used in order to analyze the pre- and post-intervention difference in VAS, NDI, as well as CVA within the three groups. The MANOVA test was used in order to determine the average in difference amongst the three different intervention groups. The Scheffe method was used to identify statistical significance. Statistical significance was set as α = .05.

RESULTS

The three groups significant decrease in VAS ($p<.05$). NEPT was the only intervention of all the groups that had a statistically significant effect on VAS by comparison ($p<.05$) (Table 3).

NEKT and NEPT a statistically significant decrease in NDI, NE did not ($p<.05$). NEKT and NEPT had more of a statistically significant effect on NDI in comparison to NE ($p<.05$) (Table 3).

NEKT and NEPT indicated a statistically significant increase in CVA within the group ($p<.05$). NEKT and NEPT were more effective interventions for increasing CVA while NE was not ($p<.05$) (Table 3).

NEKT and NEPT indicated a statistically significant decrease for both the SCM and UT EMG ($p<.05$). Upon comparison between the groups, it revealed that for the SCM, the NEKT and NEPT were more effective in decreasing SCM EMG than NE ($p<.05$) (Table 3).

DISCUSSION

The aims of the present study were to observe the effects of different methods of FHP intervention on pain, neck disability, CVA, and muscle activity of the UP and SCM as well as determine which intervention was most effective. Furthermore, this study aimed to build a base for physiotherapists who would wish to prescribe effective and efficient exercise programs for patients with FHP.

The three groups significant decrease in VAS ($p<.05$). NEPT was the only intervention of all the groups that had a statistically significant effect on VAS by comparison ($p<.05$) The results of this study

Table 2. Characteristics of subjects

	NE	NEKT	NEPT
Age (years)	21.47±3.01	21.79±2.98	22.13±4.23
Height (cm)	164.09±7.19	167.65±8.69	165.65±5.69
Weight (kg)	65.67±10.07	65.39±10.49	67.09±11.07

NE: neck exercises, NEKT: neck exercises with kinesio taping,
NEPT: neck exercises with proprioceptive training

Table 3. Pre– and Post–Intervention Change in VAS, NDI, CVA, and EMG amongst the groups

Variables	Group	PreMean±SD	PostMean±SD		p	post hoc
VAS[cm]	NE	4.52 ± 0.87	3.27 ± 0.36	Group	.08	b〉a c〉a
	NEKT	4.62 ± 0.37	2.97 ± 0.73 †	Pre–Post x Group	.12	
	NEPT	5.12 ± 1.37	3.07 ± 0.71 †	Pre–Post	.01*	
NDI[score]	NE	9.17 ± 5.17	8.78 ± 1.71	Group	.03*	b〉a c〉a
	NEKT	9.87 ± 6.17	6.97 ± 1.37 †	Pre–Post x Group	.02*	
	NEPT	9.27 ± 3.17	7.21 ± 0.31 †	Pre–Post	.00*	
CVA[deg]	NE	47.32 ± 5.97	52.5 ± 2.61	Group	.04*	b〉a c〉a
	NEKT	48.97 ± 4.01	58.3 ± 3.74 †	Pre–Post x Group	.09	
	NEPT	49.19 ± 3.47	59.4 ± 4.39 †	Pre–Post	.02*	
EMG(SCM)[mV]	NE	43.71 ± 2.93	35.72 ± 4.31	Group	.03*	b〉a c〉a
	NEKT	45.30 ± 2.37	34.67 ± 5.57 †	Pre–Post x Group	.09	
	NEPT	44.29 ± 4.08	33.78 ± 6.18 †	Pre–Post	.00*	
EMG(UT)[mV]	NE	5.72 ± 1.73	4.91 ± 0.42	Group	.01*	b〉a c〉a
	NEKT	4.94 ± 0.23	3.22 ± 0.61 †	Pre–Post x Group	.12	
	NEPT	5.17 ± 0.73	3.65 ± 0.17 †	Pre–Post	.00*	

* – expressed as p 〈 .05, † – paired t–test p〈.05
(a) NE: neck exercises, (b) NEKT: neck exercises with kinesio taping,
(c) NEPT: neck exercises with proprioceptive training
SCM: sternocleidomastoid, UT: upper trapezius

show that NEPT is effective for pain relief. This result is in line with the findings of previous studies [14, 16, 22]. However, even with the successful outcome of many studies the exact cause and effect is difficult to pinpoint. It could be suggested that proprioceptive training addresses pain indirectly by reinstating healthy neuromuscular motor patterns as well as increasing the sensory input [23, 24].

NEKT and NEPT a statistically significant decrease in NDI, NE did not(p〈.05). NEKT and NEPT had more of a statistically significant effect on NDI in comparison to NE (p〈.05). A follow–up post–hoc analysis was able to show that both NEKT and NEPT were more effective than NE alone. With KT, the significant increase may be attributed to the KT stretching the skin and activating cutaneous mechanoreceptors [25]. This would effectively send a stream of signals to adjust joint movement and adjustment. The improvement in NDI through PT may be attributed to increased proprioceptive capa–bilities reducing the limitations normally experienced by the subject.

NEKT and NEPT indicated a statistically significant increase in CVA within the group (p〈.05). NEKT and NEPT were more effective interventions for increas–ing CVA while NE was not (p〈.05). It can be under–stood that KT could have helped reduce FHP (increase CVA) by aiding weakened muscles as well as mechanically correcting the poor posture [26]. Similarily, PT may have corrected the CVA by encouraging healthy neuromuscular motor patterns as well as increasing the sensory input [23,24].

NEKT and NEPT indicated a statistically significant decrease for both the SCM and UT EMG (p〈.05). Upon comparison between the groups, it revealed that for the SCM, the NEKT and NEPT were more effective in decreasing SCM EMG than NE(p〈.05). Some studies have shown that KT can alter muscle activity through direction–dependent effects [27, 28, 29]. The application of KT in this study combined with the neck posture correction exercises may attribute to the effectiveness of this intervention. While studies seem to advocate that proprioceptive training is effective for both increasing [30] as well as decreasing [31] muscle activity, in the case of this study, the decrease in muscle activity may be attributed to PT returning healthy neuromuscular patterns in the subjects.

Many measures were taken to ensure that the study was removed of constant error and bias. However, in pursuing this study, there were some limitations that could not be corrected. The first was regarding the times when subjects attended intervention sessions were varied and could not be controlled at the risk of the subject being unable to attent the session at all. The second was regarding the small number of participants and the unequal distribution of individuals amongst the groups. Thirdly, the study was unable to prevent subjects from participating in or performing private exercises for the neck when individuals were on their own time. Should future studies pursue additional study in this area, it would be advised to further categorize the subjects and recruit a greater number so as to provide a more detailed analysis with results that can be generalized to the wider public. Furthermore, it would also be advised that future studies investigate the long-term effects of these interventions by implementing a longer intervention period as well as taking follow-up measurements after the intervention period has passed.

CONCLUSION

Both neck posture correction exercises paired with kinesio taping or proprioceptive training are effective interventions for addressing neck disability, craniocervical angle, and muscle activity. Neck posture correction exercises paired with kinesio taping or proprioceptive training are more effective at addressing pain, neck disorder, craniocervical angle, and muscle activity than performing the neck posture correction exercises alone.

REFERENCES

1. Bryden L, Fitzgerald D. Craniofacial dysfunction and pain: manual therapy, assessment and management. Oxford: Butterworth-Heinemann; 2001.
2. Enwemeka CS, Bonet IM, Ingle JA, Prudhithumrong S, Ogbahon FE, Gbenedio NA. Postural correction in persons with neck pain (II. Integrated electromyography of the upper trapezius in three simulated neck positions). J Orthop Sports Phys Ther 1986; 8(5): 240-2.
3. Konttinen YT, Kosk IH, Santavirta S, Hukkanen M, Soinila S. Disorders of the cervical spine diagnosis and medical management. Philadelphia: WB Saunders Company; 1994.
4. Bonney RA, Corlett EN. Head posture and loading of the cervical spine. Appl Ergon 2002; 33(5): 415-7.
5. Kendall F, McCreary E, Provance P, Rodgers MM, Romani WA. Muscles testing and function, with posture and pain. Philadelphia: Lippincott Williams & Wilkins; 2005.
6. Hakala PT, Rimpel AH, Saarni LA, Salminen JJ. Frequent computer-related activities increase the risk of neck-shoulder and low back pain in adolescents. Eur J Public Health 2006; 16(5): 536-41.
7. Auvinen J, Tammelin T, Taimela S, Zitting P, Karppinen J. Neck and shoulder pains in relation to physical activity and sedentary activities in adolescence. Spine 2007; 32(9): 1038-44.
8. Mclean L. The effect of postural correction on muscle activation amplitudes recorded from the cervicobrachial region. J Electromyogr Kinesiol 2005; 15(6): 527-35.
9. Morningstar M. Cervical curve restoration and forward head posture reduction for the treatment of mechanical thoracic pain using the pettibon corrective and rehabilitative procedures. J Chiropr Med 2002; 1(3): 113-5.
10. Mohammed RA, Bashir A. Clinical practice and effectiveness of kinesio taping for lower limb musculoskeletal disorder: A systematic appraisal. Inter J Sci Res. 2017; 6(3): 1630-44.
11. Saavedra-Hernández M, Castro-Sánchez A, Arroyo-Morales MA, Cleland JC, Lara-Palomo I,Fernández-De-Las-Peñas C. Short-term effects of kinesio taping versus cervical thrust manipulation in patients with mechanical neck pain: a randomized clinical trial. J Orthop Sports Phys Ther 2012; 42(8): 724-30.
12. Yoshida A, Kahanov L. The effect of kinesio taping on lower trunk range of motions. Res Sports Med 2007; 15(2): 103-12.
13. Gonzalez-Iglesias J, Renandez-de-las-Penas C, Cleland J, Huijbregts P, Del Rosario Gutierrez-Vega M. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. J Orthop Sports Phys Ther 2009; 39(7): 515-21.
14. Humphreys BK, Irgens PM. The effect of a rehabilitation exercise program on head repositioning agency and reported levels of pain in chronic neck pain subjects. J Whiplash Relat Disord 2002; 1(1): 99-112.
15. Kay TM, Gross A, Goldsmith CH, Rutherford S,

Voth S, Hoving JL, Brønfort G, Santaguida PL. Exercises for mechanical neck disorders. Cochrane Database Syst Rev 2015; 28(1): CD004250.
16. Revel M, Minguet M, Gergory P, Vaillant J, Manuel JL. Changes in cervicocephalic kinesthesia after a proprioceptive rehabilitation program in patients with neck pain: a randomized controlled study. Arch Phys Med Rehabil 1994; 75(8): 895-9.
17. Jull G, Falla D, Vicenzino B, Hodges PW. The effect of therapeutic exercise on activation of the deep cervical flexor muscles in people with chronic neck pain. Man Ther 2009; 14(6): 696-701.
18. John L, Karin S. Kinesiology Taping The Essential Step-By-Step Guide: Taping for Sports, Fitness and Daily Life – 160 Conditions and Ailments. Canada; Robert Rose Incorporated: 2014.
19. Shaheen AF, Villa C, Lee YN, Bull AM, Alxander CM. Scapular taping alters kinematics in asymptomatic subjects. J Electromyogr Kinesiol 2013; 23(2): 326–33.
20. Sawant SA, Desai MS, Kumar A. Immediate and long term effect of kinesio taping on cervical core in forward head posture: one week follow up study. Int J Physiother Res 2017; 5(6): 2521-6.
21. Chiu TT, Lam TW, Tai-Hing H, Anthony JA. Randomized Controlled Trial on the Efficacy of Exercise for Patients with Chronic Neck Pain. Spine 2004; 30(1): E1–E7.
22. Jull G, Falla D, Treleaven J, Hodges P, Vicenzino B. Retraining Cervical Joint Position Sense: The Effect of Two Exercise Regimes. J Orthop Res 2007; 25(3): 404–12.
23. Sterling M, Jul lG, Vicenzino B, Kenardy J, Darnell R. Development of motor system dysfunction following whiplash injury. Pain 2003; 103(12): 65-73.
24. Van Dillen LR, Maluf KS, Sahrmann SA. Further examination of modifying patient-preferred movement and alignment strategies in patients with low back pain during symptomatic tests. Man Ther 2007; 14(1): 52-60.
25. Murray HM. Kinesiotaping, muscle strength and ROM after ACL-repair. J Orthop Sports Phys Ther 2000; 30(1): 7–14.
26. Shih HS, Chen SS, Cheng SC, Chang HW, Wu PR, Yang JS, Lee YS, Tsou JY. Effects of kinesio taping and exercise on forward head posture. J Back Musculoskelet Rehabil 2017; 30(4): 725–733.
27. Christou EA. Patellar taping increase vastus medialis oblique activity in the Presence of patellofemoral pain. J Electromyogr Kinesiol 2004; 14(4): 495–504.
28. McConnell J. The management of chondromalacia patellae: a long term solution. Aust J Physiother 1986; 32(4): 215–23.
29. Tobin S, Robinson G. The effect of McConnell's vastus lateralis inhibition taping techniqueon vastus lateralis and vastus medialis obliques activity. Physiotherapy 2000; 86(4): 173–83.
30. Proske U, Wise AK, Gregory JE. The role of muscle receptors in the detection of movements. Prog Neurobiol 2000; 60(1): 85-96.
31. Gandevia SC, Phegan CM. Perceptual distortions of the human body image produced by local anaesthesia, pain and cutaneous stimulation. J Physiol 1999; 15(514): 609–16.