

Clinical and radiological outcomes of kinesiotopeping in patients with chronic neck pain: A double-blinded, randomized, placebo-controlled study

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ABSTRACT

Objectives: In this study, we aimed to evaluate the efficacy of kinesiotopeping (KT) in patients with chronic non-specific neck pain (NSNP) in terms of pain, disability, cervical range of motion (ROM), and cervical lordosis.

Patients and methods: Between October 2013 and March 2014, a total of 50 patients (10 males, 40 females; mean age 35.1±9.9 years; range, 17 to 62 years) with chronic NSNP were randomized into the KT (n=25) or the sham KT intervention (n=25) groups. Both groups were additionally given a therapeutic exercise (TE) program. The Visual Analog Scale (VAS) and Neck Disability Index (NDI) scores and ROM measurements were recorded at baseline, at the end of treatment, and at one month. Lateral cervical digital radiographs were analyzed by the Cobb, posterior tangent and effective lordosis methods at baseline and at one month after the treatment.

Results: There was a statistically significant decrease in the VAS scores compared to baseline in the KT group. The NDI scores significantly decreased in both groups. The patients in the KT group experienced a significant increase in all planes of cervical ROM after the treatment. Cervical radiographs revealed a significant increase in the Cobb and posterior tangent angles only in the KT group.

Conclusion: Our study results suggest that KT significantly improves VAS, NDI scores, ROM and cervical lordosis angles. The combination of TE and KT is useful in reducing pain and disability and improving ROM and cervical lordosis loss in patients with chronic NSNP.

Keywords: Cervical lordosis, kinesiotopeping, neck pain.

Neck pain is one of the most common musculoskeletal disorders, second only to low back pain.^[1] The one-year prevalence rates for neck pain range between 30 and 50% in the general and workforce population;^[2] vast majority of cases are chronic non-specific neck pain (NSNP). Natural history of NSNP is mostly favorable, but recurrences are common and more than one-third of the patients develop chronic symptoms over time which, in

turn, lead to increase in healthcare costs and work absenteeism.^[1]

Various conservative treatment methods are used in the management of NSNP. Therapeutic exercise (TE) is an essential part of rehabilitation protocol in NSNP as emphasized in the reviews supporting the use of TE in the management of NSNP.^[2,3] Kinesiotopeping (KT) has been increasingly used in the conservative management of musculoskeletal disorders. It was

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originally developed by Dr Kenzo Kase, a certified KT practitioner, and is the application of an elastic therapeutic tape to provide protection, support and improvement at the applied area in the body.^[4,5] The kinesiotape differs from conventional tapes in terms of texture and elasticity. It is air-permeable, water-resistant, and stretchable longitudinally up to 40% of its resting length.^[4] These features provide multiple day wear time and constant pulling force to the skin applied. This pulling force to the skin on which kinesiotape is applied is postulated to improve blood and lymphatic circulation, leading to improvement in pain and edema, besides proprioceptive facilitation and relaxation of muscles.^[5,6]

In recent years, KT has been increasingly used in the management of various musculoskeletal conditions, both for the rehabilitation of several pain syndromes and for sports-related purposes with various regimens of applications.^[6,7] However, the evidence to support its efficacy in the treatment of neck pain is lacking. Identifying the efficacy of KT is essential to use it as a part of routine clinical practice for the purpose of decreasing disability and the economic burden resulting from NSNP.

Patients with NSNP frequently refer to the outpatient clinics with a radiological examination report which reveals the loss of cervical lordosis. The literature about the correlation between cervical lordosis and neck pain is complicated.^[8] Although there is still an ongoing debate and we are still far away from drawing a conclusion regarding the association of cervical lordosis with neck pain, in a recent study Gao et al.^[9] reported that the degree of disc herniation, thus, pain and cervical spinal cord compression were inversely correlated to cervical lordosis. The literature investigating the effect of conservative treatments on cervical spine alignment is lacking. Besides, little is known about the correlation of clinical outcome with alignment of cervical spine;^[8,9] therefore, in the present study, we aimed to investigate the effect of KT on cervical lordosis in patients with neck pain. Our primary objective was to evaluate the efficacy of KT in terms of pain and disability in patients with NSNP.

PATIENTS AND METHODS

In this double-blinded, randomized, placebo-controlled study, 80 consecutive patients aged between 18 and 40 years presenting to our outpatient clinic with chronic neck pain with a duration of more than three months were screened between October 2013 and March 2014. Patients were evaluated by physical

and neurological examination and other indicated diagnostic tests including electrodiagnostic tests and laboratory investigations to screen for eligibility. A total of 50 patients (10 males, 40 females; mean age 35.1±9.9 years; range, 17 to 62 years) with chronic NSNP and with no neurological findings were included in the study. Patients with cervical radiculopathy or myelopathy, thoracic outlet syndrome, inflammatory rheumatic disorder or previous history of cervical and/or head trauma (whiplash injury), neck surgery and physical therapy in the past three months were excluded. To provide blindness in patients, only subjects with no experience of KT application were recruited. Patients with a previous history of KT application to any site of the body for any reason were also excluded from the study. A written informed consent was obtained from each patient. The study protocol was approved by the Fatih Sultan Mehmet Training and Research Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Clinical and radiological assessments

Demographic data including age, sex, body mass index (BMI), and duration of symptoms were recorded. The Visual Analog Scale (VAS) scale (0-10 cm) was used to evaluate the level of neck pain. The patients were asked to complete the Neck Disability Index (NDI) (0-50) to measure self-perceived disability. Active cervical range of motion (ROM) was assessed with the patient sitting comfortably on a chair, with both feet flat on the floor, hips and knees at 90° of flexion, and recorded by inclinometer in each direction: flexion, extension, right lateral flexion, left lateral flexion, right rotation and left rotation. Cervical VAS, NDI scores, and ROM measurements were collected at baseline, at the end of the treatment, and at one month by the same investigator blinded to the group allocation.

Lateral cervical digital radiographs were obtained at baseline and at one month after the study. All radiographs were obtained, while the patient stood up in neutral position, at a source-subject distance of 72 inches, with C4 vertebrae in the center of the image, using the Siemens Multix® digital radiography imaging unit (Siemens, Germany and Konica Minolta, Japan). The radiographs were stored on a Syngo Digital Picture Archiving and Communications System (PACS) imaging program (Extreme PACS, Ankara, Turkey). All radiographs were analyzed by two radiologists on two separate occasions who were blinded to the clinical findings and group allocations of the patients by three



Figure 1. Lateral cervical radiographs showing measurement of cervical lordosis angles with (a) Cobb, (b) tangent, and (c) effective lordosis methods.

separate methods: Cobb method, posterior tangent method, and effective lordosis.^[10-12] In Cobb method, the angle was measured between two straight lines drawn tangentially to the inferior endplate of second cervical vertebra (C2) and seventh cervical vertebra (C7) (Figure 1a). To calculate the angle between two lines which are tangent to posterior bodies of C2 and C7 vertebra constituted the posterior tangent method (Figure 1b). If the angle was lordotic, it was accepted as positive and if the angle was kyphotic, then it was considered as negative in posterior tangent method. Lastly, the effective lordosis obtained with drawing a straight line from the posterior-caudal side of the C2 vertebral body to the posterior-caudal side of the C7 vertebral body (Figure 1c). Therefore, if there was no

bony structure projecting into the spinal canal which disrupts this line (i.e., hypertrophic-degenerative changes of vertebral body, disc-osteophyte complexes, calcified ligaments), effective lordosis was accepted as maintained; otherwise, effective lordosis was considered lost.

KT and sham KT interventions

The patients were randomized into the KT (n=25) or the sham KT intervention (n=25) groups. Kinesiotape which is a waterproof and self-adhesive tape (KinesioTex Gold; Kinesio Holding Corp., NM, USA) with a width of 5 cm and a thickness of 0.5 mm was used in both groups. The KT group received a standardized therapeutic KT application which

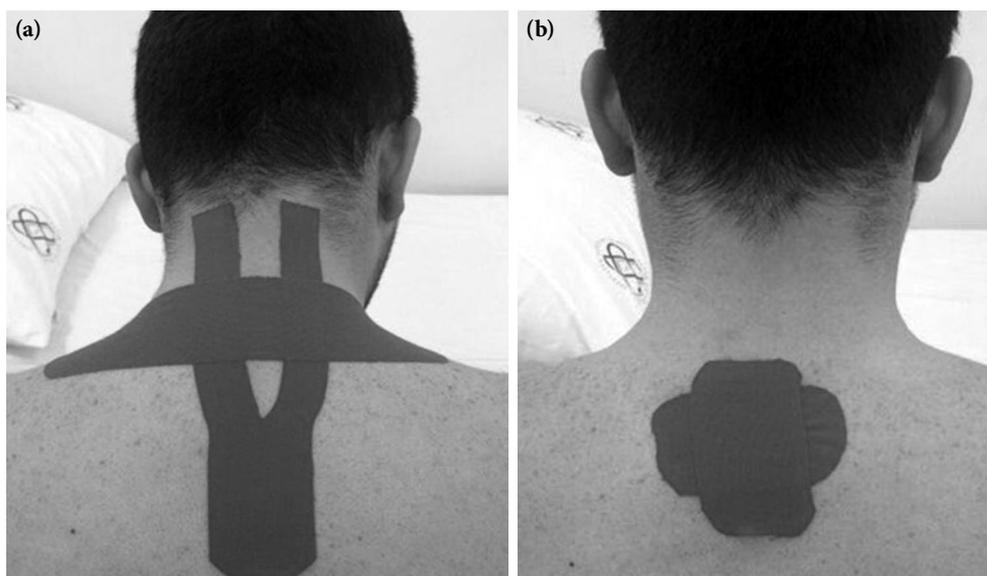


Figure 2. Kinesiotaping application. (a) Kinesiotaping with slight tension (b) Sham kinesiotaping.

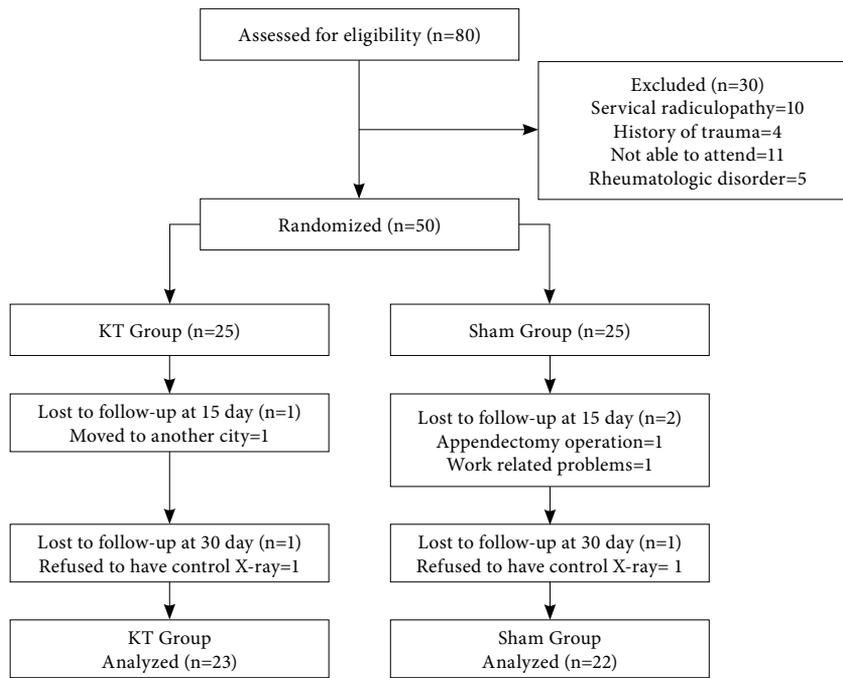


Figure 3. Study flowchart.
KT: Kinesiotaping.

consists of a combination of facilitation and pain-relieving techniques. The first layer was a Y-strip placed over the posterior cervical extensor muscles (longissimus cervicis) which was applied from the insertion of muscle to origin in order to facilitate the muscle. Each tail of the Y-strip was applied with the patients’ neck in a position of cervical flexion and contralateral rotation. Center of the overlying I-strip tape was placed over the mid cervical region while the tape is slightly stretched (Figure 2a). The sham group received a sham KT application (Figure 2b). The sham taping consisted of two I-strips applied without

tension on the seventh cervical spinous process, while the patient was sitting in a neutral position. Taping was applied by a certified KT practitioner to all patients in both groups three times a week for a total of two weeks.

Exercise program

All patients in both groups were given the same TE program consisting of cervical ROM, stretching, and isometric neck exercises. All patients were instructed about the exercise program by the same physiotherapist and performed the exercises under supervision at each

TABLE 1 Baseline demographic characteristics of patients											
	KT Group (n=23)					Sham Group (n=22)					p
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	
Age (year)				32	19-53				34	23-61	0.437*
Sex											0.602†
Female	19	82.6				17	76.2				
Male	4	17.4				5	23.8				
BMI (kg/m ²)				21	17-34				24	18-51	0.138*
Duration (month)			4.6±1.4					4.4±1.5			0.264**
Effective lordosis (%)				15	65.2				16	72.7	0.775†

KT: Kinesiotaping; BMI: Body mass index; SD: Standard deviation; Min-Minimum; Max: Maximum; * Mann-Whitney U test; ** Independent samples t-test; † Chi-square test.

visit for KT (three times a week). For the other days of the week, they were instructed to do the same exercise program once a day at home and assured to do the program by query at each visit and continue TE after the treatment.

Statistical analysis

Study power analysis was performed using the G*Power version 3.1.9.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The sample size was calculated based on a previous study by Chung and Jeong,^[13] assuming that alpha (α) is 0.05 and power is 0.80. Using one-sided independent samples t-test, minimum of 21 subjects were determined for each group. Considering possible dropouts, 25 patients were recruited to each group. Change in VAS scores for pain was used for this calculation with an effect size of d:0.8.

Statistical analysis was performed using the Number Cruncher Statistical System (NCSS) version 07.1.21 (NCSS LLC, Kaysville, UT, USA) and Power Analysis and Sample Size (PASS) version 8.0.16 software (NCSS LLC, Kaysville, UT, USA). Distribution of data was analyzed using the Shapiro-Wilk test. Continuous variables were expressed in mean \pm standard deviation (SD) or median (min-max), while categorical variables were expressed in as number and frequency. Categorical variables were compared using the chi-square test and Fisher’s exact test, while intra-group comparisons of categoric variables were analyzed using the McNemar test. Continuous variables were compared using the Mann-Whitney U test or independent samples t-test, where appropriate. The inter-group comparisons were analyzed using the Friedman test, followed by Wilcoxon signed-rank test with Bonferroni correction or repeated measures of analysis of variance (ANOVA), followed by Bonferroni post-hoc test, where appropriate. A *p* value of <0.05 was considered statistically significant.

RESULTS

The patients received either KT or sham KT. None of the patients received other therapy regimens or medication during follow-up. No side effects were observed in any of the patients during the treatment and follow-up periods. A total of 45 patients (n=23 in KT group and n=22 in sham KT group) completed the study. The study flow chart is shown in Figure 3. There was no statistically significant difference between

TABLE 2
Visual Analog Scale and Neck Disability Index scores at baseline, after the treatment (Day 14), and at one month

	Baseline (T0)			14 th day (T1)			30 th day (T2)			Post Hoc test
	Mean \pm SD	Median	Min-Max	Mean \pm SD	Median	Min-Max	Mean \pm SD	Median	Min-Max	
Visual Analog Scale (0-10cm)										
Kinesiотaping		5	4-8		2	0-8		2	0-8	<0.001†
Sham		4	4-8		3	0-8		1	0-10	0.836†
<i>p</i> (between groups)		0.441*			0.965*			0.670*		
Neck Disability Index (0-50)										
Kinesiотaping	32.6 \pm 13.1			28.2 \pm 16.0			29.1 \pm 15.8			<0.001‡
Sham	35.7 \pm 14.0			27.6 \pm 11.2			31.5 \pm 14.2			0.006‡
<i>p</i> (between groups)		0.459**			0.899**			0.643**		

SD: Standard deviation; Min-Minimum; Max: Maximum; * Mann-Whitney U test; ** Independent samples t-test; † Friedman t-test; ‡ Repeated measures of ANOVA.

the two groups at baseline in terms of demographic characteristics, duration of symptoms, and ratio of patients having effective lordosis on radiographs (Table 1).

Baseline (T0), at the end of treatment (Day 14) (T1), and at one-month (T2) scores of VAS, NDI, and cervical ROM, and the results of post-hoc analysis are shown in Table 2 and Table 3, respectively. There was a statistically significant decrease in the VAS scores in KT group and a significant decrease in pain was achieved at the end of the treatment with an ongoing decrease after the treatment, also reaching a significant level at one month. However, no statistically significant decrease was achieved in terms of pain scores in the sham KT group. The NDI scores significantly decreased in both KT and sham KT groups compared to baseline ($p < 0.001$ and $p = 0.006$, respectively) at the end of the treatment and also at one month. Intra- and inter-group comparisons of VAS scores and NDI scores at T0, T1, and T2 are presented in Table 2.

The patients in the KT group experienced a significant increase in all planes of cervical ROM after treatment. A significant increase was achieved only in cervical extension, right lateral flexion, and left rotation ROM in the sham KT group. Intra- and inter-group comparisons of ROM angles at T0, T1, and T2 are presented in Table 3.

Cervical radiographs obtained at one month revealed a statistically significant increase in the Cobb and tangent angles compared to baseline in the KT group ($p = 0.035$ and $p = 0.048$, respectively). However, no statistically significant change was detected in the Cobb and tangent angles in the sham KT group (Table 4). The ratio of the patients having effective cervical lordosis at baseline was 67% in the KT group and 73% in the sham KT group, while the ratio of the patients having effective lordosis at one month was 80% in the KT group and 77% in the sham KT group. Although the increase in the ratio of patients having effective cervical lordosis was higher in the KT group, no statistically significant difference was found between the two groups.

TABLE 3
Cervical range of motion angles at baseline, after the treatment (Day 14), and at one month

	Baseline (T0)	14 th day (T1)	30 th day (T2)	<i>p</i> (within groups)**	Post Hoc test
	Mean±SD	Mean±SD	Mean±SD		
Flexion					
Kinesiotaping	45.8±12.9	52.0±14.1	54.1±14.3	0.002	T0<T1, T0<T2
SHAM	51.9±15.8	54.7±13.0	55.6±11.5	0.209	-
<i>p</i> (between groups)*	0.172	0.543	0.748		
Extension					
Kinesiotaping	51.1±2.1	58.6±2.0	63.3±2.2	<0.001	T0<T1<T2
SHAM	47.8±2.1	57.1±1.9	60.6±1.5	0.004	T0<T1, T0<T2
<i>p</i> (between groups)*	0.924	0.942	0.384		
R lateral flexion					
Kinesiotaping	29.4±2.2	36.1±1.9	35.8±2.1	0.003	T0<T1, T0<T3
SHAM	29.3±2.2	31.2±2.0	35.3±2.4	0.045	T0<T2
<i>p</i> (between groups)*	0.857	0.266	0.874		
L lateral flexion					
Kinesiotaping	33.3±1.5	39.4±1.6	40.2±1.9	0.002	T0<T1, T0<T2
SHAM	36.8±1.7	38.7±1.4	34.6±2.0	0.135	-
<i>p</i> (between groups)*	0.079	0.897	0.081		
R rotation					
Kinesiotaping	70.6±16.3	78.5±13.7	85.5±18.7	0.005	T0<T1, T0<T2
SHAM	84.76±18.5	92.5±11.1	91.56±15.0	0.393	-
<i>p</i> (between groups)*	0.01	0.02	0.315		
L rotation					
Kinesiotaping	67.1±19.2	76.0±18.0	84.7±20.3	<0.001	T0<T1<T2
SHAM	81.1±16.5	91.6±9.2	91.8±16.4	0.009	T0<T1, T0<T2
<i>p</i> (between groups)*	0.014	0.002	0.271		

SD: Standard deviation; * Independent samples t-test; ** Repeated measures of ANOVA.

TABLE 4
Cervical Cobb and tangent angles at baseline (T0) and at one month (T2)

	Kinesiотaping (n=23)				Sham (n=22)				<i>p</i>
	n	%	Median	Min-Max	n	%	Median	Min-Max	
Cobb angle T0 (°)			14.5	-18.3-50.0			9.4	-5.7-42.8	0.571*
Cobb angle T2 (°)			14.6	-0.60-42.1			14.8	0.5-27.0	0.506*
<i>p</i>			0.035				0.807		
Tangent angle T0 (°)			24	-17.2-49.6			13.1	-0.5-58.5	0.976*
Tangent angle T2 (°)			23.9	-6.4-56.4			20.2	-5.3-41.7	0.521*
<i>p</i>			0.048				0.916		
Effective lordosis T0	15	65.2			16	72.7			0.775†
Effective lordosis T2	18	78.2			17	77.2			0.5†
<i>p</i>			0.5‡				1.0‡		

Mann-Whitney U test; † Chi-square test; ‡ McNemar test.

DISCUSSION

The results of the current study demonstrated that patients in whom KT was applied exhibited a significant improvement in neck pain both at the end of the treatment and at one month of follow-up. Our results are consistent with a previous study including patients with acute whiplash injury.^[14] González-Iglesias et al.^[14] evaluated immediate and 24-h follow-up results of single cervical KT and reported a statistically significant improvement in neck pain after KT. Similarly, Saavedra-Hernández et al.^[15] reported a reduction in pain with cervical KT in patients with mechanical neck pain. Pain modulation via the gate control theory is one of the proposed theories of mechanism for action of KT.^[16] We observed pain reduction in the KT group, while no significant reduction in neck pain was achieved in the sham group. The tape applied by tension in the KT group might have provided afferent stimuli, facilitating a pain inhibitory mechanism and, thereby, reducing the pain levels of the patients. Significant improvements in disability measures were also achieved both in the KT and sham KT groups with no significant difference between the two groups. Previous studies have shown that TE is effective in decreasing disability in individuals with NSNP.^[2,17,18] According to the results of the current study, KT in conjunction with the TE provided no further improvement in self-reported disability measures compared to sham group which received TE alone.

The patients receiving KT application had a significant increase in the cervical ROM in all planes. This finding is consistent with the literature showing an improvement in ROM after KT.^[14,18,19] Only small

and clinically insignificant changes in cervical ROM were detected in studies evaluating the short-term effects of KT in whiplash^[14] and mechanical neck pain.^[15] However, the ROM improvements achieved in our study were meaningful, which was reported to range between 3.6° and 6.5°.^[20] A clinically significant increase in cervical ROM in our study is most likely related to multiple and longer period of applications of KT. The probable mechanism underlying this improvement is positive neural feedback provided by KT which facilitates mobility of cervical spine.

This study showed the cervical lordosis angles measured by Cobb and posterior tangent methods were significantly improved in the group receiving KT application. However, there was no significant change regarding effective lordosis. This difference may be the result of the quantitative nature of the Cobb and posterior tangent methods. On the other hand, since the effective lordosis is considered the associated impinging disc-osteophyte complexes toward the spinal canal, demonstration of the improvement in cervical lordosis may be more difficult through this method. There was no significant improvement in cervical lordosis in the sham group both regarding cervical lordosis angles and effective lordosis. The Cobb and posterior tangent methods are reliable quantitative methods for evaluation of cervical sagittal spinal curvature.^[20] On the other hand, the effective lordosis measurement is a simple and reliable method determining both overall alignment of the cervical spine, as well as impinging structures ventral to the spinal cord.^[12] The loss of normal cervical lordosis encountered in cervical spine radiographs has been hypothesized to contribute to decrease the ROM,

precipitate pain, and lead to other health problems, although, many researches have underlined the lack of any distinct correlation between loss of cervical lordosis to symptomatology.^[21,22] Wu et al.^[23] reported a significant relation between the improvement of the Cobb angle and recovery rate of cervical pain in patients with stand-alone titanium cage after anterior cervical discectomy and fusion. They claimed that preservation of the cervical lordosis would be more important for the long-term clinical outcome than cage subsidence itself. The literature about the impact of conservative treatment of NSNP on cervical lordosis is scarce. Shilton et al.^[24] investigated change in cervical lordosis in patients after four weeks of cervical spinal manipulation. The intervention consisted of spinal manipulation applied to cervical region twice per week and they reported no significant change in lordosis between baseline and four-week follow-up. Two different prospective, non-randomized, controlled trials were conducted by Harrison et al.^[25,26] in which 30 patients with NSNP were enrolled in each study, an increase in cervical lordosis after spinal manipulative therapy combined with cervical traction was observed and this increase was found to be associated with reduced pain. The authors used a standardized radiographic positioning protocol in the aforementioned studies such as the Cobb and posterior tangent angle measurements, as in our study. Furthermore, to the best of our knowledge, the effect of KT on cervical lordosis has not been investigated, yet.

The main limitation of the present study is its relatively small sample size. In addition, we added an exercise program to both groups and, therefore, we were unable to specifically analyze the results of KT alone, besides clinical and functional evaluation.

In conclusion, our study results suggest that KT significantly improves VAS and NDI scores, ROM measurements, and cervical lordosis loss according to the Cobb and posterior tangent methods. The combination of TE and KT can be used in reducing pain and improving disability, ROM, and cervical lordosis loss in patients with chronic NSNP. Nonetheless, further large-scale, prospective, randomized, placebo-controlled studies are needed to confirm these results.

Declaration of conflicting interests

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