

INTRODUCTION

Neck pain is a common symptom treated in physical therapy practices, there is no exact and precise definition of it, although some authors describe it as a localized pain between the occiput and the third thoracic vertebra.[1,2] Most of the population, between 85% and 90%, has ever suffered this problem, producing disabilities in work activities, home and leisure.[3] Pransky[4] found high recurrence rates (the probability of recurrence of an episode in a year is a 26%) and high persistence (37% experienced reported pain for at least 12 months).[5]

Given these facts, the most appropriate intervention for individuals with neck pain remains a priority for researchers. One passive intervention used clinically in the management of patients with chronic mechanical neck pain is neuromuscular taping or Kinesio Taping. It was originally developed in Japan by Kase[6] and in recent years its use has become increasingly popular. Neuromuscular tape is a thin, pliable adhesive material that can be stretched up to 120% to 140% of its original length, making it more elastic than conventional tape.[7] Although physical therapists regularly use neuromuscular taping in clinical practice, particularly for sport injuries,[8] there has been collected a limited scientific evidence of its effectiveness. A few published case reports have suggested that Kinesio Taping may be beneficial in improving control and upper extremity function in children with neurological injury,[9] improving musculoskeletal function,[10] increase in the electrical activity of the vastus medialis maximal contractions during twenty-four hours after taping application,[11] decreasing pain and treating acute patellar dislocations,[12] and

reducing back pain[13-17]. More recently, several randomized clinical trials have suggested that Kinesio Taping may be effective for the treatment of shoulder pain,[18] acute whiplash[19] and, mechanical neck pain.[20] In patients with shoulder pain, Kinesio Taping immediately improved pain-free active shoulder range of motion but did not change pain or disability.[18] In individuals with acute whiplash, the application of Kinesio Taping slightly improved pain and cervical range of motion.[19] In patients with mechanical neck pain, the application of neuromuscular taping or cervical spine leads to reduction in pain and disability and increases in cervical range of movement (CROM).[20] Nevertheless, changes in these 3 studies were relatively small, which may indicate that the effects of Kinesio Taping are limited.

However, to date, no studies have evaluated the effects of neuromuscular taping in patients with chronic neck pain. The purpose of this study was to compare the immediate effects of a neuromuscular taping application to the cervical spine versus placebo tape application on neck pain, head position and cervical range of motion in patients with chronic mechanical neck pain.

METHODS

Study design

Randomized double-blinded clinical trial

Participants

Participants were patients with a primary complaint of mechanical idiopathic chronic neck pain, referred to physical therapy treatment at a private clinic of the main researcher. Mechanical neck pain was defined as generalized neck or shoulder pain caused by sustained neck postures, neck movement, or palpation of the cervical

musculature, more than 3 months pain evolution.[20] Exclusion criteria were as follows: (1) patients diagnosed with cervical osteoarthritis, (2) history of whiplash, (3) history of cervical surgery, (4) diagnosis of cervical radiculopathy or myelopathy, (5) patients who are carrying out another parallel treatment for the condition being treated, (6) patients who are taking any analgesic or anti-inflammatory drugs, (7) presence of any contraindications to the implementation of neuromuscular taping, (8) any tape allergy, and (9) being younger than 18 or older than 45 years of age. Informed consent was obtained from each patient before participation in the study, which was performed in accordance with the Helsinki Declaration. The study was approved by the Ethics and Research Committee of the University of Sevilla.

Outcome measures

The primary outcome measure was neck pain intensity and CROM and head position as secondary outcomes. Patients completed self-report measures at baseline and received a standardized history and physical examination by an experienced therapist. Demographic data, including age, gender, medical history, and location and nature of the symptoms, were collected. The outcome measures for this study consisted of a visual analogue scale (VAS) and cervical range of motion measurements. VAS (0, no pain; 10, maximum pain) was used to record the patient's current level of neck pain at resting state and during movement of the cervical spine (flexion, extension, bending and rotation). Reliability and validity testing of the VAS has been well documented in previous studies.[21,22] Cervical range of motion 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 buttocks positioned against the back of the chair. A cervical range of motion device was

placed on the top of the head, and the patient was asked to move the head as far as possible, without pain, in a standard fashion (flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation). Three trials were conducted for each direction of movement, and the mean values of the 3 trials were recorded for analysis.

Head position was assessed by measuring the craniocervical angle: the angle between the horizontal line through C7 and a line extending from the spinous process of the seventh cervical vertebra to the tragus.[23] Side-view pictures of each subject were taken in both sitting and standing positions, in order to assess head position. A digital camera with 18-55 mm zoom lens was mounted on a tripod; the base of the camera was set at the height of the subject's shoulder and the subject in the center of the viewfinder. The tragus of the ear and the spinous process of the 7th cervical vertebra was clearly marked with a red dermal pencil. Craniocervical angle was assessed in two different positions: a relaxed sitting position and a relaxed standing position, in a standard protocol. Details of this protocol can be found elsewhere.[24,25]

A picture of the lateral view of each subject was taken in both positions. The measurements were acquired by an assessor blinded to the subjects' diagnosis using AutoCad® 2007. The assessor performed the measurement three times and the mean values of the 3 trials were recorded for analysis. A previous article supported the high reliability of this procedure (intraclass correlation coefficient = .88).[26]

Reliability testing of the CROM device in previous studies indicates intraclass correlation coefficients ranging from 0.63 to 0.9 and interclass correlation coefficients ranging from 0.8 to 0.87.[27,28]

Pain, craniocervical angle and cervical range-of-motion data were collected at baseline and immediately after the Kinesio Tape application, by an assessor blinded to the treatment allocation of the patients. Patients were blinded to the treatment allocation and uninformed of what intervention the other group would receive. Therefore, this was a double blinded study.

Allocation

Following the baseline examination, patients were randomly assigned to receive neuromuscular taping to the cervical spine (experimental group) or a placebo neuromuscular tape application (sham group). Concealed allocation was performed using a computer-generated randomized table of numbers, created prior to the start of data collection by a researcher not involved in the assessment or treatment of patients. Individual, sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. A second therapist, blinded to baseline examination findings, opened the envelope and proceeded with treatment according to the group assignment. The randomization sequence was guarded by an external consultant, who guaranteed its concealment from all participants in the study; subjects, evaluators and therapist in charge of the interventions. All patients received the Kinesio Tape application the day after the initial examination by the primary author, a certified Kinesio Tape practitioner, who was blinded to patient information.

Procedures

The tape (Cure Tape) used in this study was waterproof, porous, and adhesive. Its color was beige. Tape with a width of 5 cm and a thickness of 0.5 mm was used in

both groups. The tape measure was the distance from the acromion process to the hairline at the base of the occiput. The experimental group received a standardized therapeutic Kinesio Tape application described by Kenzo Kase.[7,29] The layer was a Y-strip placed on upper trapezium muscle and applied from the insertion to origin with paper-off tension. Patients were sitting for the application of the Kinesio Tape. A trained physiotherapist applied the tape: the base of the tape was applied just distal and anterolateral to the edge of the acromion process (FIGURE 1A). Each tail of the strip (Y-strip, 2-tailed) was applied with the patients' neck in a position of cervical contralateral side bending and rotation. The superior "Y" tail was applied to the hairline at the base of the occiput (FIGURE 1B). and the inferior "Y" tail to the spinous process of the fourth- fifth cervical vertebra (FIGURE 1C). The paper-off tension tape was applied with approximately 15% stretch. Both upper trapezius muscles were taped.

The sham group received a placebo Kinesio Tape application. The placebo taping consisted of one Y-strip (same material as the real application), applied with no tension. For the placebo taping, the cervical spine of the participants was placed in a neutral position. The base of the tape was applied to acromion process. The superior "Y" tail was applied to the upper-cervical region and the inferior "Y" tail was applied to the spinous process of fourth- fifth cervical vertebra. Both tape applications looked very similar, but the placebo group had no tension applied to the cervical structures

Sample-size determination

The sample-size calculation was performed using the Spanish software EPIDAT Version 4.0 (Xunta de Galicia, Santiago de Compostela, Spain). The calculation was based on an increase in the differences between proportions ($p_1 = p_2$) of the

variables of about 40%, alpha of 0.05 and beta of 80%. The estimated sample size was 30 patients per group.

Statistical analysis

Data were analyzed with SPSS statistical package (17.0 version). Mean values of the craniocervical angle, all cervical motions, and summation of the results of VAS (results of VAS for each movement were combined to form a single variable) were calculated. Key baseline demographic variables were compared between groups using independent *t* tests. *T* test were used to examine the effects of the treatment on pain, head position and cervical range of motion (flexion, extension, rotation, or lateral-flexion), the dependent variables, with group (experimental or placebo) used as the between-groups variable and time (baseline and immediate posttreatment) as the within-group variable. The hypothesis of interest was the group-by-time interaction at an a priori alpha level equal to .05.

RESULTS

Sixty consecutive patients were screened for possible eligibility criteria. Sixty patients (mean \pm SD age, 30 \pm 5 years; 59% female) satisfied the eligibility criteria, agreed to participate, and were randomized into the real neuromuscular tape (n = 30) or the sham neuromuscular tape (n = 30) intervention. The reasons for ineligibility can be found in (FIGURE 2), which provides a flow diagram of patient recruitment and retention. Baseline characteristics between the groups were similar for all variables (TABLE 1).

The group-by-time interaction for the *t*-test was statistically significant for pain recorded by visual analogue scale as the dependent variable ($t = 6,160$; $P = .00$),

indicating that patients receiving neuromuscular taping experienced a significant decrease in pain immediately postapplication. Patients in the experimental group obtained a similar improvement in pain to those in the control group ($t = 6.575$; $P = .00$).

No significant group-by-time interactions were found for head position measured using cranio-cervical angle with the patients sitting ($t = -.210$; $P = .83$) and with the patients standing ($t = 1.274$; $P = .21$).

No significant group-by-time interactions were found for cervical spine range of motion for flexion ($t = -.456$; $P = .65$), extension ($t = -1.601$; $P = .01$), left latero flexion ($t = -.199$; $P = .85$) and right ($t = -1.796$; $P = .08$) and left ($t = -.090$; $P = .9$) rotation. The group-by-time interaction was statistically significant for right latero flexion ($t = -2.258$; $P = .03$) range of motion.

TABLE 2 summarizes within- and between-group differences, with associated 95% confidence intervals for immediate posttreatment for pain, head position and cervical range-of-motion measurements.

DISCUSSION

Several publications discuss the influence of neuromuscular taping applied in different areas of the body. Perez[30] showed how neuromuscular tape application on peroneal and triceps did not change plantar pressure significantly. Even so, Halseth[14] concluded that Kinesio Taping did not improve ankle proprioception in healthy individuals, and therefore did not produce changes in posture. Simsek[31] suggested that Kinesiotaping improved sitting position in cerebral palsy children, changing head alignment and hand and foot position.

The results of the current study demonstrated that patients with chronic mechanical neck pain who received neuromuscular taping exhibited statistically significantly improvement in neck pain immediately following application of the tape. However, the improvement was likely placebo non-tensioned neuromuscular tape application. Our results agree with previous case series that also found a decrease in pain after the application of neuromuscular taping. [10,19]

The results of the present study also challenge the importance of the presence of convolutions in Kinesio Taping for effectiveness of treatment in people with chronic neck pain. According to the creators of the Kinesio Taping Method[6] these convolutions increase blood and lymphatic flow, and aid in reducing pain.

Therefore, applying proper tension is one of the key factors for effective treatment.[6]

However, the outcome with convolutions was not superior to the control group and so the improvement seen in both groups cannot be due to tape tension. The results of the present study challenge the theory that these convolutions are part of the mechanism. The results of this trial are consistent with the results of two other trials that evaluated the use of Kinesio taping in people with chronic low back pain.[32,33]

The current study suggests that neuromuscular taping was as effective as placebo tape for decreasing neck pain in individuals presenting with chronic mechanical neck pain. One possible mechanism by which taping induced this change may be related to the neural feedback provided to the patients, which can facilitate their ability to move the cervical spine with a reduced mechanical irritation on the soft tissues. In addition, the tape might have created tension in soft tissue structures that provide afferent stimuli, facilitating a pain-inhibitory mechanism and thereby reducing the pain levels of the patients.[18]

Determining the mechanisms by which Kinesio Taping works is admittedly beyond the scope of this study. Nevertheless, a few hypotheses will be proposed to form the basis for possible future study into the mechanism of action for this intervention. In the current study, the main difference between interventions was the presence of tension in the neuromuscular tape for the experimental group compared to an absence of tension for those in the sham group. Further, it is also possible that tape provided afferent stimuli, facilitating pain inhibitory mechanisms (gate control theory), thereby reducing the patients' pain levels. The gate control theory of Melzack and Wall in 1965,[34,35] describes the modulation of sensory nerve impulses and inhibition mechanisms at the central nervous system. It further proposes that the neural mechanisms in dorsal root of the spinal cord function as a gate, which can increase or decrease the flow of nerve impulses from the peripheral fibers to cells of the spinal cord, which project into the brain. Subsequently, the new theory of "neuromatrix", [36,37] also includes central neural processes to the brain. In this sense, the tape (neuromuscular tape or sham tape) may help modulating sensory input, causing a constant proprioceptive stimulation while the patient wearing it, the continuous proprioceptive information cut nociceptive sensation, "close the door".

The current results agreed those previously reported for patients with acute whiplash,[19] although the reduction in neck pain was greater in the current study. Saavedra-Hernandez [20] suggested that Kinesio Tape and cervical spine thrust manipulation had similar effects for reducing pain and disability. However, they did not include a control group; so, they cannot exclude the possibility that changes for both interventions were due to placebo effects or the natural history of the condition.

Thelen et al [18] also found that Kinesio Taping improved pain-free shoulder range of motion in patients with shoulder pain but had no effect on spontaneous pain or function.

This study also demonstrated that patients with chronic mechanical neck pain who received neuromuscular taping did not exhibit statistically significant improvements in cervical range of motion immediately following application of the tape. This result is agreed those previously reported for patients with acute whiplash,[19] and with mechanical neck pain,[20] in which the improvement was small and may not be clinically meaningful.

Salvat et al.[17] confirmed it, showing that Kinesio Taping did not improve lumbar flexion.

Finally, this study demonstrated that patients with chronic mechanical neck pain who received neuromuscular taping did not exhibit statistically significant changes in head position immediately following application of the tape.

Our results agree with one of the most updated systematic reviews of randomized trials which showed that the effects of Kinesio taping were no greater than a sham taping.[38]

Future studies are needed to further elucidate the clinical effects, as well as mechanisms of action, of Kinesio Taping in patients with chronic mechanical neck pain.

There limitations of the current study should be recognized. We used a sample of convenience from one clinic, which may not be representative of the entire population of patients with chronic mechanical neck pain. We only investigated the immediate results of neuromuscular tape application and, therefore, cannot make inferences relative to long-term effects. Further, therapists often use a multimodal

approach to the management of patients with chronic mechanical neck pain and would not solely use neuromuscular taping as an isolated intervention. The effects of neuromuscular taping, when used in combination with other interventions, cannot be deduced from the current study. We suggest that future studies investigate if neuromuscular taping enhances outcomes when added to interventions with already proven efficacy, such as active exercise.

CONCLUSION

Patients with chronic mechanical neck pain receiving an application of neuromuscular taping, applied on upper trapezius muscle bilaterally with proper tension, did not exhibit statistically significant improvements immediately following application of the neuromuscular taping in cervical range of motion and craniocervical angle. However, patients with mechanical neck pain who received and application of neuromuscular taping with proper tension or sham neuromuscular taping exhibited similar reductions in neck pain intensity. Future studies should investigate if neuromuscular taping provides enhanced outcomes when added to physical therapy interventions with proven efficacy or when applied over a longer period.

KEY POINTS

Findings: Patients with chronic mechanical neck pain receiving an application of neuromuscular taping exhibited statistically significant improvements in pain levels immediately following application of the tape. However, the improvement was likely sham neuromuscular taping.

Implications: The results of this study provide preliminary evidence for the application of neuromuscular taping in the management of patients with chronic mechanical neck pain.

Caution: We used a single application of tape, with follow-up immediately after application. Also, the generalizability of the results should be interpreted with caution as all patients were treated by the same therapist.

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TABLE 1. Baseline demographics for both groups*

	Control Group	Experimental Group	<i>P</i> Values
Gender (male/female)	12/18	12/18	1.0
Age (y)	30.5 ± 6.21	29.6 ± 3.8	0.49
Neck pain [†]	6.2 ± 5.4	6.9 ± 5.5	0.84
Craniocervical in sitting position	48.3 ± 6.4	49.9 ± 6	.33
Craniocervical in standing position	49.6 ± 5.6	51,2 ± 5.2	0.16
Cervical range of motion, deg			
Flexion	56.5° ± 8.6°	60.6° ±12.4°	0.14
Extension	68.1° ± 12.5°	70.6° ±10.2°	0.4
Right lateral flexion	43.6° ± 7.6°	43° ± 10°	0.76
Left lateral flexion	46.9° ± 7°	40.4° ± 10.8°	0.53
Right rotation	75.7° ± 18.3°	72.5° ± 20.5°	0.52
Left rotation	64.9° ± 22.6°	62.7° ± 21.6°	0.7

*Data are mean ± SD except for gender. No difference between groups

[†] Measured with VAS (0, no pain; 10, worst pain imaginable)

TABLE 2. Baseline, immediate posttreatment, and changes scores for neck pain and cervical range motion*

Outcome/Group	Baseline	Immediate Post treatment	Within-Group Change Scores	Between-Group Difference in Change Scores
Pain (0-10 points)				0.6 (-0.1, 1.8)
Experimental	6.9 ± 5.5	0.6	0.00 (2.4, 4.5)	
Control	6.2 ± 5.4	0.3	0.00 (2.7, 4.5)	
Craniocervical in sitting position				0.7 (-2.7, 3.9)
Experimental	49.9 ± 6.1	50.1 ± 6.9	0.8 (-2.1, 1.7)	
Control	48.3 ± 6.4	49.5 ± 5.9	0.1 (-2.6, 0.3)	
Craniocervical in standing position				0.8 (-2.3, 2.9)
Experimental	51.2 ± 5.2	50.6 ± 5.3	0.2 (-3.7, 1.6)	
Control	49.6 ± 5.6	50.3 ± 5.0	0.1 (-2.4, 0.3)	
Cervical flexion (deg)				1.8 (-1.7, 9)
Experimental	60.6 ± 12.4	61.2 ± 10.8	0.6 (-3.4, 2.1)	
Control	56.5 ± 8.6	57.6 ± 9.9	0.4 (-3.8, 1.7)	
Cervical extension (deg)				0.4 (-3.6, -7.6)
Experimental	70.6 ± 10.2	72.3 ± 9.8	0.1 (-3.9, 0.5)	
Control	68.1 ± 12.5	70.3 ± 11.7	0.06 (-4.6, 0.1)	
Cervical right lateral flexion (deg)				0.6 (-2.9, 4.9)
Experimental	42.9 ± 10	45.2 ± 8.2	0.03 (-4.3, -2)	
Control	43.6 ± 7.6	44.2 ± 6.9	0.5 (-2.5, 1.2)	
Cervical left lateral flexion (deg)				0.3 (-2.4, 6.5)
Experimental	40.4 ± 10.8	48.5 ± 8.9	0.8 (-2.2, 1.8)	
Control	46.9 ± 7.0	46.5 ± 8.5	0.7 (-1.7, 2.3)	
Cervical right rotation (deg)				0.9 (-1.5, 18.2)
Experimental	72.5 ± 20.5	77.7 ± 20.3	0.08 (-11.2, .7)	
Control	75.7 ± 18.3	69.1 ± 18.7	0.06 (-.5, 13.7)	
Cervical left rotation (deg)				0.7 (-14.2, 1.8)
Experimental	62.7 ± 21.6	62.9 ± 23.6	0.9 (-5.7, 5.2)	
Control	64.9 ± 22.6	64.9 ± 23.7	0.0 (56.4, 73.2)	

* Values are expressed as mean ± SD for baseline and immediate posttreatment and as mean (95% confidence interval) for within- and between-group change scores.

FIGURE 1 The placement of the neuromuscular taping with tension



FIGURE 2. Flow-diagram of subjects throughout the course of the study.

