GAVIN PUBLISHERS

Journal of Yoga, Physical Therapy and Rehabilitation

Sarig Bahat H, et al. Yoga Phys Ther Rehabil: YPTR-148.

DOI: 10.29011/YPTR-148. 000048

Research Article

The Potential Effect of Cervical Taping on Pain, Disability and Kinematics in Patients with Chronic Neck Pain - A Quasi-Experimental Study

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Citation: Sarig Bahat H, Feigelson E, Vulfsons S (2018) The Potential Effect of Cervical Taping on Pain, Disability and Kinematics in Patients with Chronic Neck Pain - A Quasi-Experimental Study. Yoga Phys Ther Rehabil: YPTR-148. DOI: 10.29011/YPTR-148. 000048

Received Date: 08 December, 2017; **Accepted Date:** 29 December, 2017; **Published Date:** 09 January, 2018

Abstract

Purpose: To evaluate the effects of elastic therapeutic cervical taping on patients with chronic neck pain.

Methods: This study was a non-controlled, quasi-experimental pre-post quantitative research study design. Intervention included application of elastic tape over the posterior cervical extensor muscles from insertion to origin on patients with chronic neck pain. Patients were assessed pre-taping, immediately post-taping, and one-week post-taping. Patients did not receive any additional therapy during the week of the study. Self-reported measures included pain intensity measured by the Visual Analogue Scale (VAS), disability measured by the Neck Disability Index (NDI), and the Tampa Scale of Kinesiophobia (TSK) to assess fear of movement or re-injury. Objective kinematic outcome measures included cervical range of motion, velocity, smoothness, and accuracy of cervical motion. These were collected using the neck virtual reality system designed to evaluate neck kinematics impairments.

Results: Twenty-seven individuals with neck pain (13 men; 14 women), with a mean age of 45.22±16.61 years participated; 24 (89%) completed the study protocol. Results showed significant pre- to post-taping differences in pain intensity ($p<0.001$), ROM ($p<0.05$), and neck motion accuracy error ($p<0.05$) in all directions excluding flexion. Changes in VAS and ROM exceeded MDC/MCID. Cohen's d results demonstrated a medium effect size immediately post-intervention and a large effect size one week after intervention

Conclusion: This quasi-experimental study may suggest cervical taping could be beneficial in reducing pain and increasing mobility for short-term relief in patients with chronic neck pain. Current results are limited in lack of control and further randomized controlled trials are essentially needed to investigate taping's effectiveness in comparison to control or other existing interventions.

Keywords: Chronic Neck Pain; Kinematics; Taping; Velocity; Virtual Reality

Introduction

Therapeutic taping has been in common clinical use for decades for various purposes. Traditionally for stabilization or support, it has been used in cases of ankle sprains/instability, patellofemoral pain syndrome and knee injuries [1,2]. The original material used for taping was rigid, not elastic, in order to provide stabilization to the strapped joint [2]. More recently, elastic taping materials have been introduced to the field, along with theories as to their potential effectiveness in alleviating pain, reducing inflam-

mation, facilitating muscle activity and performance, and even facilitating lymphatic drainage (http://kinesiotaping.com/). Unfortunately, many of these statements are yet to be based on scientific evidence.

The clinical use of taping seems less popular in the neck region than in the peripheral joints [2], in spite of neck pain being very common. Neck pain affects 30-50% of the general population annually [3,4] and comprises approximately 25% of the patients receiving physiotherapy in outpatient clinics [5]. Physical impairments associated with neck pain can include decreased Range of Motion (ROM) [5,6], decreased strength [7], reduced deep flexors endurance [8,9], and impaired sensorimotor control [10-12].

Strong evidence exists to support active exercises for neck pain in the long term, and in combination with manual therapy for the short term [13]. We were unable to find a systematic review that examined taping for neck pain specifically, but there are systematic reviews which examine the available literature for elastic taping in musculoskeletal disorders [1,14]. These systematic reviews could not recommend elastic taping use due to the lack of high-quality RCTs [14]. This clearly emphasizes the need for more specific research of taping for neck pain [1]. The objective of this study was to evaluate the short-term effect of elastic taping on pain intensity, disability and neck motion kinematics in patients with chronic neck pain.

Materials and Methods

This was a quasi-experimental pre-post quantitative research study design. Based on the hierarchy of evidence developed by Moore, McQuay and Gray (1995) as described by Holm (2001) [15,16], an evidence from a well-designed non-randomized trial with single group pre- post-test can be almost as accurate as a Randomized Controlled Trial (RCT) for showing causation [17].

Ethics approval was obtained from the ethics committee, the Faculty of Social Welfare and Health Sciences at the University of Haifa, and from the Ethics Review Board at Rambam Health Care Campus Helsinki Committee. This study was registered in the NIH trials registry (ClinicalTrials.gov PRS), ID Number: NCT02915887.

Participants

A convenient sample of 27 individuals, 13 males and 14 females, was recruited via electronic media. Inclusion criteria were (a) chronic neck pain (>3 months), with or without referral to the upper limb; (b) age of 18 years or more; (c) pain intensity≥ 20% on Visual Analogue Scale (VAS). Subjects were excluded if they had; attended physiotherapy in the previous 2 months; a known skin allergy to taping materials; evidence for active vestibular disorders; systemic conditions that may affect performance such as Rheumatic Arthritis, Diabetes Mellitus, neurological disorders, head injuries, spinal surgeries; inability to provide informed consent, and pregnancy.

Intervention

Intervention included elastic taping to the neck region as demonstrated in Figure 1.

Two strips of Kinesio® Tex tape [18] were applied: a vertical Y-shaped strip was applied first, from the upper thoracic upwards, with 2 tails on the cervical extensor muscles. The second strip was applied transversely over the C5-C7 vertebra, from middle to sides with approximately 50% stretch [18].

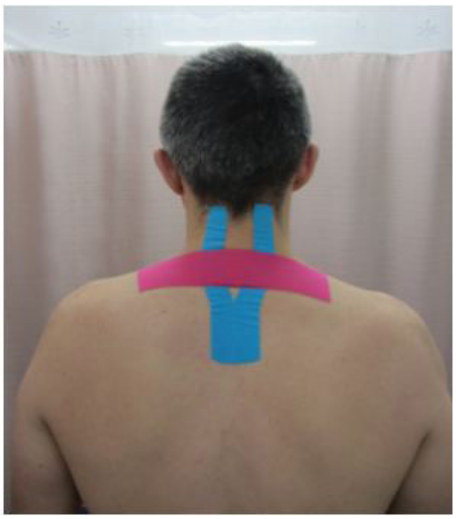

Figure 1: The taping application on the cervical spine.

Study Procedure

Eligible participants provided informed consent. The investigator was a qualified and experienced physiotherapist, certified as a Kinesio® taping practitioner. Each patient was assessed at baseline before taping, 20 minutes post-taping, and seven days post-taping. Following the subjective evaluation, an introductory Virtual Reality (VR) session was provided to minimize learning and training in the VR neck kinematics assessment. The VR neck assessment was conducted in an upright sitting position, with the trunk strapped to the back of a rigid chair to eliminate thoracic motion. VR evaluation took up to 15 minutes, with 3 breaks every 2 minutes. Additional rests were provided if needed. Following the VR assessment, tape was applied.

The second examination was performed 20 minutes post-taping. Patients were instructed to maintain the elastic tape for up to 5 days and to remove the tape if symptoms were aggravated or if any topical irritation appeared. Lastly, the third examination was performed one-week post-taping, without taping. No other physiotherapy procedures were provided during the study period.

Outcomes Measures

Self-reported Outcome Measures

1. Disability associated with neck pain was measured by the Neck Disability Index (NDI) [19]. The NDI has been shown to have good validity and reliability [20-22]. A Minimal Clinically Important Change (MCIC) of 7% was suggested for NDI [23].
2. Neck pain intensity was measured by a 100 mm Visual Analogue Scale (VAS). The MCIC of 21mm-25mm has been suggested [23,24].
3. TAMPA Scale of Kinesiophobia (TSK), is a 17-item questionnaire to assess fear of movement and re-injury [25]. The TSK has demonstrated as valid and reliable in neck pain [26,27]. Higher scores (0-68) correspond to higher kinesiophobia, and scores greater than 37 indicate a high degree of kinesiophobia [28]. The Minimal Detectable Change (MDC) of the TSK was 5.6 [29].

Physical Outcome Measures

Cervical motion kinematics were collected using a neck VR system previously developed and studied [12,(Sarig Bahat, Sprecher et al. 2016)]. Hardware included the Oculus Rift DK1 head-mounted display with three-dimensional built-in tracking (https://www.oculus.com/en-us/rift/). Tracking data were analyzed by the developed software in real-time. VR software was developed using the Unity-pro software, version 3.5 (Unity Technologies, San Francisco), and included three modules, including (ROM), velocity and accuracy modules. These modules enable elicitation of cervical motion by the patient's response to the provided visual stimuli. A full kinematic report for each patient was generated after completion of the modules. During the VR session, the virtual pilot flying the red airplane is controlled by the patient's head motion and interacts with targets appearing from four directions (to elicit flexion, extension, right rotation, left rotation) (Figure 1). The VR modules are illustrated in Figure 1,2, described in detail below. Further details regarding the VR assessment are described in previous publications [31,32]. For all kinematic measures, motion initiation was determined as 5% of peak velocity [33]. Data was low-pass filtered (frequency 6 Hz, order 4) and sampling rate was 60Hz. The cervical kinematic variables were calculated for each trial in each of the four directions assessed (F, E, RR, LR).

1. Peak velocity (Vpeak, °/sec) was calculated as the peak angular velocity of three maximal results achieved from each direction. This measure has previously demonstrated good repeatability, and its Minimal Detectable Change (MDC) was found to be 35°/sec [34].
2. Mean velocity (Vmean, °/sec) was calculated as the mean angular velocity of three maximal results achieved from each direction. This measure has previously demonstrated good repeatability, and its MDC was found to be 14.31°/sec [34].
3. Accuracy error (º) was collected during the smooth head pursuit task in the accuracy module. It consisted of the accumulated difference between virtual target and participant's head position in the plane of motion. Therefore, accuracy error was calculated in the sagittal plane for Flexion and Extension, and in the horizontal plane for Rotation. MDC has yet to be described.
4. Cervical ROM results were calculated as the maximal ROM achieved in each direction. This methodology has previously demonstrated good repeatability and sensitivity [33,35]. A change of ROM greater than 6.5 degrees in any direction is considered to reflect a true change [36].

Statistical Analysis

A paired-sample t-test was used to evaluate the pre-post changes at the two-time points. Significance level was set at 5%. Cohen's d was calculated to determine the effect size for each outcome measure. Data was analyzed using the SPSS software, version 17.

Results

Twenty-seven subjects were recruited to the study during 2014. Twenty-four of them completed the study procedure. Figure 1 presents the flow of participation throughout the study, including exclusions, dropouts and reasons. There were 3 (11%) dropouts leading up to the one week follow up assessment, and one case (0.04%) of side effects, in which the VR assessment was not completed.

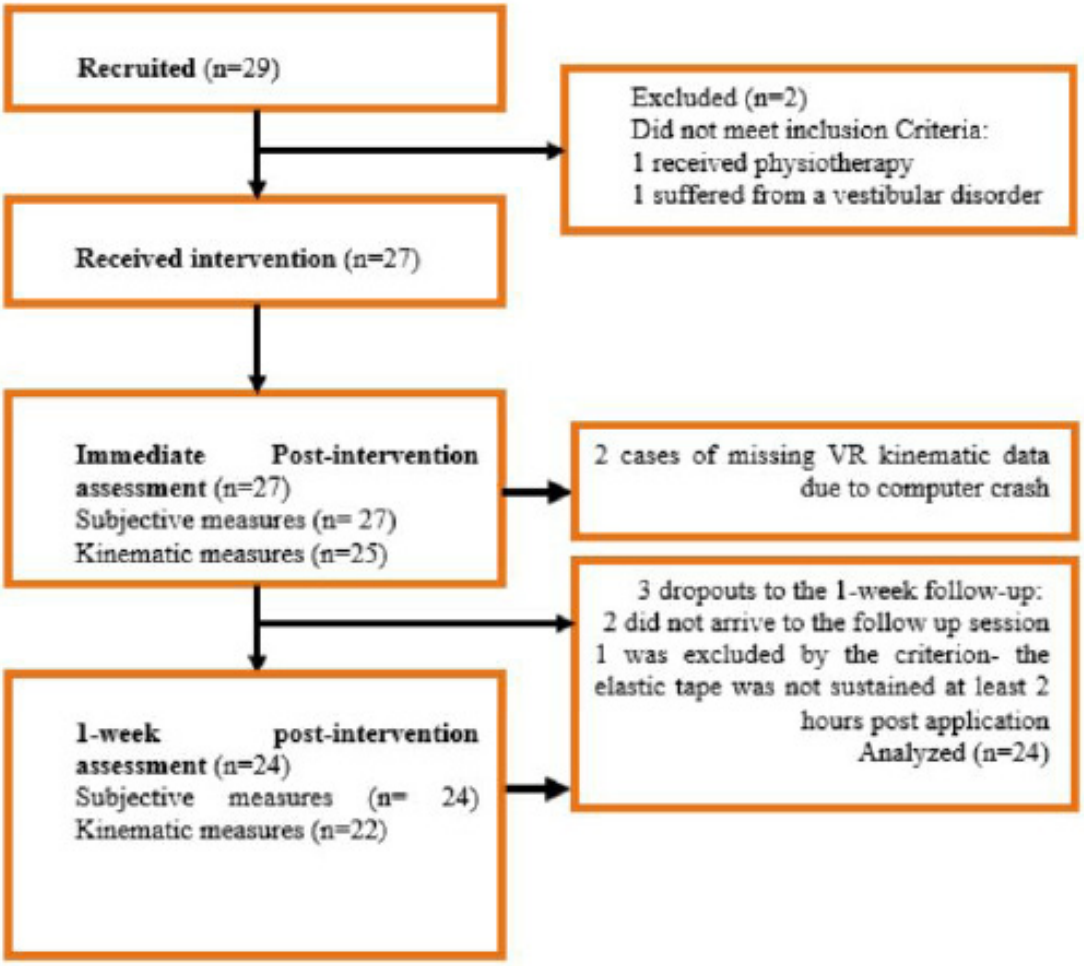

Figure 2: Flow chart of study participation and drop-outs, including reasons and missing data.

Characteristics of Patients

Following screening, the study sample consisted of 14 females and 13 males with chronic idiopathic neck pain. Table 1 presents the study's population characteristics.

Characteristic		
Age (years) Mean, SD	45.2	16.6
Gender (Female, Male)	14	13
Neck pain duration (months) Mean, SD	51.9	64
Neck pain region (Unilateral, Bilateral/Central)	8	19
Neck pain intensity (VAS 100mm) Mean, SD	44.7	11
Neck pain disability (NDI, %)	22.4	11.3
SD- Standard Deviation, VAS- Visual Analogue Scale, NDI- Neck Disability Index		

Table 1: Population characteristics.

There was balanced distribution in gender, and the majority of participants reported very chronic bilateral or central neck pain. Reported neck pain was of mild to moderate intensity and associated disability. In regard to the taping intervention, there was only one case where taping did not sustain 2 hours, and on average, the taping sustained on the patients for 3.48±1.53 days, ranging between 2 hours to 7 days.

Pre-Post Intervention Results

Pre- to post-intervention results are presented in Tables 2 and 3, including Cohen's d effect size values (Table 2) and confidence intervals (Table 3).

Measure		Pre-intervention N=27	Post-intervention N=24		One-week post-intervention N=24	
		Mean±SD	Mean±SD	Cohen's d	Mean±SD	Cohen's d
Subjective						
Pain intensity (VAS, 0-100 mm)		44.7±11.01	22.92±9.99**	2.15	27.5±2 0.56**	1
Neck Disability Index (%)		22.41±11.25	NA	NA	16.83±10.89**	0
TSK (0-68)		33.22±7.04	NA	NA	29.92±7.76*	0
VR kinematics		N=27	N=25		N=22	
ROM (°)	F	43.26±11.09	49.94±12.09**	0.57	51.04±13.34 *	1
	E	50.61±16.01	55.64±14.1*	0.32	56.51±13.36*	0
	RR	59.53±19.11	64.72±17.76	NS	73.26±15.68*	1
	LR	55.79±18.26	61.15±18.27*	0.29	61.86±13.57	NS
Peak Velocity (°/s)	F	136.52±76.87	138.63±64.32	NS	154.02±68.32	NS
	E	131.12±85.65	139.81±95.93	NS	181.98±111.12**	1
	RR	217.07±170.14	240.72±189.94	NS	263.1±176.61	NS
	LR	224.50±164.33	235.96±171.11	NS	228.60±126.81	NS
Mean Velocity (°/s)	F	55.82±29.46	66.39±32.24*	0.34	67.65±21.74*	0
	E	61.06±34.18	69.55±43.9	NS	78.43±42.39*	0
	RR	100.71±80.74	119.65±112.17	NS	110.11±46.47	NS
	LR	95.28±61.98	101.86±61.57	NS	108.68±47.77	NS
Accuracy (°)	F	67.85±22.92	65.93±17.07	NS	59.21±15.20	NS
	E	64.01±21.67	49.57±15.37**	0.77	47.46±16.36**	1
	RR	74.10±26.11	62.19±25.64*	0.46	52.69±15.34*	1
	LR	73.75±29.22	56.19±19.40*	0.71	50.78±17.41*	1
VR-Virtual Reality; VAS-Visual Analogue Scale for Pain Intensity; TSK-TAMPA Scale of Kinesiophobia; ROM-Range of Motion; F- Flexion; E- Extension; RR-Right Rotation; LR- Left Rotation; SD-Standard Deviation; Cohen's d provides a value for size effect, *P<0.05, **P<0.001 indicating significant difference, bolded cell indicates significant difference in change of variables tested; NA-not available; NS-not significant; Accuracy: the difference between target and player's position throughout the VR session represents the accuracy error in the sagittal plane (y axis) for flexion and extension, and in the horizontal plane (x axis) for rotation.						

Table 2: Results for subjective and kinematic outcome measures in pre-, immediate, post- and one-week post-intervention.

Among the subjective measures, immediate post-intervention change was collected only for VAS, as it was not relevant to re-measure NDI and TSK 20 minutes after the first evaluation. Pain intensity decreased from 44.7±11.01 to 22.92±9.99, showing an excellent size effect (Cohen's d 2.15). At one-week post-intervention, significant improvements occurred for all three subjective outcome measures, with VAS demonstrating the highest size effect (Cohen's d 1.04), and only a small effect size showing for NDI and TSK. For the objective outcome measures, there were overall significant improvements in ROM and accuracy, immediately and at one-week post intervention. Strongest changes were demonstrated in ROM and accuracy of rotational motion, with Cohen's d of 0.73-0.93 indicating a high size effect. Immediate improvements were also found for mean velocity for flexion (Cohen's d 0.34), and accuracy for extension and right and left rotation (Cohen's d between 0.46 and 0.77). At one-week post-intervention, significant changes were found for peak velocity in extension (Cohen's d 0.51), mean velocity for flexion and extension (Cohen's d between 0.45 and 0.46), and accuracy for extension and right and left rotation (Cohen's d between 0.85 and 0.93).

		Post-intervention			One-week Post-intervention		
Measure		Mean	95% CI		Mean difference	95% CI	
		difference	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Subjective							
Pain intensity (VAS, 0-100 mm)		21.29**	17.2	25.38	16.71**	10.38	23.03
Neck Disability Index (%)		NA	NA	NA	4.71**	2.67	6.75
TSK (0-68)		NA	NA	NA	1.62*	0.11	3.14
VR kinematics							
ROM (°)	F	-6.68**	-10.01	-3.35	-7.09	-11.13	-3.04
	E	-5.02*	-8.67	-1.38	-5.97*	-10.26	-1.67
	RR	-5.2	-10.5	0.1	-12.66*	19.6	-5.74
	LR	-5.36*	-9.22	-1.5	-5.8	-12.35	0.75
Peak Velocity (°/s)	F	-2.11	-23.93	19.72	-14.22	-53.27	24.83
	E	-8.69	-30.64	13.27	-50.63**	-84.35	-16.91
	RR	-23.65	-57.11	9.8	-44.75	-92.14	2.64
	LR	-11.45	-47.28	24.37	-16.87	-63.08	29.32
Mean Velocity (°/s)	F	-10.57*	-18.53	-2.61	-11.64*	-23.22	-0.06
	E	-8.5	-21.94	4.94	-17.46*	-30.53	-4.4
	RR	-18.94	-37.9	0.01	-7.09	-38.19	24.02
	LR	-6.58	-20.92	7.75	-12.32	-28.5	3.86
Accuracy (°)	F	1.92	-7.5	11.34	9.53	-0.24	19.3
	E	14.53**	7.37	21.7	16.50**	4.93	28.06
	RR	11.92*	1.1	22.74	20.53*	9.06	31.99
	LR	17.56*	8.09	27.03	21.32*	10.32	32.31

VR-Virtual Reality; VAS-Visual Analogue Scale for pain intensity; TSK-TAMPA Scale of Kinesiophobia; ROM-Range Of Motion; F- Flexion; E- Extension; RR- Right Rotation; LR- Left Rotation; SD-Standard Deviation; *P<0.05, **P<0.001 indicating significant difference, bolded cell indicates significant difference in change of variables tested; NA-Not Available; NS-Not Significant; Accuracy: the difference between target and player's position throughout the VR session represents the accuracy error in the sagittal plane (y axis) for flexion and extension, and in the horizontal plane (x axis) for rotation.

Table 3: Mean pre- to post-intervention difference results for subjective and kinematic outcome measures immediately post-intervention and one-week post-intervention.

Post-taping changes in cervical range of motion

All ROM measures increased post-taping except for right rotation at immediate post-intervention, and left rotation at one-week follow-up. The Cohen's d measure indicated a medium effect size for flexion and right rotation measurements and a small effect size for extension and left rotation measurements.

Cervical Motion Velocity

The mean velocity scores in flexion increased at both time points ($p<0.05$) and for extension at one-week post-intervention ($p<0.05$). The Cohen's d measure indicated a small effect size. There was no improvement in rotation movements. Peak velocity increased significantly from before the application to one-week post-intervention only for extension ($p<0.001$). The Cohen's d measure indicated a medium effect size. No change was detected for flexion and rotation movements.

Cervical Motion Accuracy

Cervical motion accuracy improved ($p<0.05$) at both time points in all directions except flexion and right rotation at one-week post-intervention. The significant improvements demonstrated immediately post taping were of a medium to large effect size (Cohen's d 0.46-0.77), and the improvements demonstrated a week later, a large effect size (Cohen's d 0.85-0.93). Short-term strongest self-reported improvements post-taping were demonstrated in pain VAS. Objectively, ROM and accuracy demonstrated overall improvements in all directions. However, velocity showed only a partial and mild improvement, as expected.

Discussion

The results of this pilot study should be interpreted with caution as there was no comparison to control, and placebo effect cannot be ruled out. However, the changes observed clinically are described in this paper in relation to Cohen's d results, and Minimally Clinically Important Difference (MCID) to provide reference to the changes in lack of control. Results showed statistically significant improvements in pain intensity, ROM and motion accuracy immediately and one-week after taping. The significant reduction in pain intensity (VAS) was greater than MCIC, which supports its clinical relevance, however the significant NDI and TSK reductions were smaller than MDC/MCIC and therefore cannot support clinical effectiveness [23,37]. The lack of a greater change in NDI and TSK may be a result of a floor effect, as NDI and TSK baseline values were low.

Amongst the objective measure, ROM increase was statistically significant in all directions excluding RR immediately post, and LR 1-week post-taping, and consisted of approximately 10%-20% increase in ROM. This increase in ROM was greater than the MDC reported previously by Audette et al (MDC=3.6-6.5º), and by Fletcher et al. (MDC=5.4-9.6º) [38,39]. This reference provides the ROM change some support for its relevance in lack of control. Mean velocity improved significantly only in flexion and extension a week after taping, but the change was smaller than the MDC found previously (mean velocity MDC flexion=19.73, extension= 22.98 degrees) [34]. The significant improvement in cervical motion accuracy was of a large effect size (Cohen's d=0.85-0.93) one-week later, suggesting fine motor control may benefit from taping, however we could not identify MDC findings for this measure, and further research is needed to explore its clinical value. The short-term significant improvements following taping on pain levels, disability, and ROM noted in this study seem more pronounced than previously reported in other taping studies [40-42]. Gonzalez-Iglesias et al had a design advantage over current study including a sham control group as compared to taping in 41 patients with neck pain [41]. They found a 10% reduction in pain intensity, and approximately 10-15% ROM increase, which is somewhat smaller than correct study, and was significantly greater in their intervention group compared to the control [41].

Two non-controlled studies [40,42] conducted a similar to current pre- to post study. Karatas et al. investigated taping in 32 surgeons with surgery-related neck and back pain, and demonstrated a significant positive effect of taping on pain, disability and ROM [40]. Lastly, Saavedra-Hernandez et al. compared neck taping to manipulation and found both had similar effects [42]. In spite of our findings being consistent to previous ones, further randomized controlled trials are needed to provide an evidence based recommendation regarding the effectiveness of cervical taping in the short and intermediate term.

Beyond existing evidence, this study explored the effect of taping on velocity and accuracy of cervical motion, which have not been investigated previously. Kinematic impairments have been consistently shown to be associated to neck pain [10,12,31,43,44], and can affect dynamic neck function used when driving, where quick head motion occurs in response to surrounding stimuli [31,45]. Taping was not found to change velocity in a proportion that exceeds MDC, excluding the increase in RR peak velocity that did (MDC=44.75) [12]. Given that the current study examined a population with mild to moderate pain intensity and disability, further research should investigate the effect of cervical taping in more severely affected patients with neck pain.

Clinically, taping is often applied in combination with other therapeutic modalities, such as manual therapy and exercise [13]. Additionally, positive response often leads to repeated taping, or self-taping. The variability in number of repetitions and choice of therapeutic combinations, challenges the RCT design as being the ultimate model for studying the effectiveness of techniques such as taping. Horn and Gassaway [46] propose the practice-based evidence study design as an alternative for evaluating the therapy's

effectiveness. This includes constructed collection of the practice as is, but requires very large samples to overcome the multifactorial analysis [46]. This would be possible with a multi-center of international collaborations and may enable us to evaluate the effectiveness of taping that is so commonly used, in addition to RCTs. The main limitations identified in this study were the small sample size and lack of a control group. The sample size was legitimate in a pilot trial, and was addressed statistically, by calculating Cohen's d to reflect effect size. The lack of control means a placebo effect cannot be ruled out.

Conclusion

The results of this pilot study seem to indicate that cervical taping may be effective and clinically meaningful in the short-term in improving neck pain, ROM, and accuracy of cervical motion in patients with chronic neck pain. Further research is needed with randomized controlled trials and larger samples of various levels of severity, and possibly repeated applications of taping to provide clinical recommendation regarding this commonly used technique. Conducting focus groups in the future to further examine patients' satisfaction following taping may strengthen the study results and therefore is recommended.

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