Potentiation of physiotherapy by low-level laser or kinesio taping for treatment of cervicogenic headache: a randomized controlled study

Hazem Mohamed Saleh[a], Marina Onsy Fahim Edward[c], Ahmed Al Farouk Abdel Fattah[b], Mohamed Farouk Ali[d]

[a]Otorhinolaryngology Unit, National Institute of Laser Enhanced Sciences, Cairo University, [b]Department of Otorhinolaryngology, Faculty of Medicine, Cairo University, [c]Center for Physiotherapy, Helmeya Military Hospital, Cairo, [d]Department of Physical Therapy in Orthopedics, Faculty of Physical Therapy, 6th of October University, 6th of October City, Egypt

Correspondence to Hazem Mohamed Saleh, MD, 10, El Messaha Square, Apt. 1401, 12311 Giza, Egypt
Tel: +20 237 482 838; fax: +20 237 482 838; e-mail: hazemsalehniles@yahoo.com

Received 28 June 2016
Accepted 14 July 2016

The Egyptian Journal of Otolaryngology
2016, 32:248–254

Background
Cervicogenic headache (CGH) is a referred pain originating from the neck and perceived in the head and/or face. Its morbidity and cost of treatment hugely affect the society. Classical management is by physiotherapy (PT) and analgesics.
Patients and methods
A total of 45 patients with CGH were treated either by PT alone or by PT and low-level laser or by PT and kinesio taping (KT).
Results
Three outcome measures were obtained: the pain pressure threshold, the neck disability index, and the forward head posture improved significantly in all groups. Compared with PT alone, adding KT gave better results in all three parameters. Adding low-level laser gave better scores in both pain pressure threshold and neck disability index. Adding KT to PT gave better results in all parameters than adding low-level laser.
Conclusion
In the short term, KT improves the outcome of PT for CGH to a greater extent compared with the low-level laser therapy.

Keywords:
cervicogenic headache, forward head posture, kinesio taping, laser, neck disability index, pain pressure threshold, physiotherapy

Egypt J Otolaryngol 32:248–254

1012-5574

Background

The prevalence of headache in adult population is 46%. It is the most common pain condition causing loss of productive time in workforce. The average loss is 3.5 h/week [1]. In the EU, the total annual cost of headache among adults aged from 18 to 65 years is €173 billion [2].

The International Headache Society (IHS) identified 14 different types of headache [3]. Headache can be primary, resulting from vascular or muscular origins, or secondary, resulting from another source such as inflammation or head and neck injury. Cervicogenic headache (CGH) is considered a secondary headache. It is defined as pain referred from one source in the neck and perceived in one or more regions of the head and/or face [4,5].

CGH accounts for 15–20% of all chronic and recurrent headaches. It affects 2.2–2.5% of the adult population, with a four to one female to male ratio [6]. Its prevalence varies from 0.7 to 13.8% [7].

CGH is thought to be arising from cervical structures innervated by the upper three cervical spinal nerves. Any structure innervated by the C1–C3 spinal nerves can be the source of CGH [8]. Dysfunctions occur mostly at the C2–C3 zygapophysial joints, but CGH can also arise from dysfunction at the C2–C3 disc, at the C3–C4 disc, at the facet joints, at the atlantoaxial (C1–C2), or the atlanto-occipital (C0–C1) joints [6]. Cervical myofacial trigger points are also considered potential pain generators for CGH. However, these tender points often overlie the facet joints and may be indistinguishable from the latter as generators of pain [8]. It has been also shown that stimulation of the greater occipital nerve (a branch of the cervical plexus constituted by the dorsal roots of C1, C2, and C3) causes an increased neuronal activity in both the cervical and trigeminal neuronal systems [9,10], making its stimulation a possible cause of CGH. Because of the heterogeneity of presentation and the numerous pain generators that can cause CGH, it is often difficult to identify its exact source [8].

 DOI: 10.4103/1012-5574.192549

The trigeminocervical nucleus descends in the spinal cord to the level of C3/C4 and is in anatomical and functional continuity with the dorsal gray columns of these spinal segments. Pain generated in any location within the trigeminocervical territory is referred to the frontal region via the trigeminocervical nucleus [11,12].

CGH is often unilateral, but it can be bilateral. It affects mostly the occipital region, the frontal region, or the retro-orbital region. It is commonly associated with suboccipital neck pain and can be combined with ipsilateral arm discomfort [13]. Possible associated symptoms include dizziness, nausea, lightheadedness, inability to concentrate, and visual disturbance [6]. Clinically, the presence of upper cervical joint restrictions and tenderness detected by manual examination and accompanied by impairment of the deep cervical flexors and/or scapular postural muscles indicate that the headache is cervical in origin [6]. Other physical impairment accompanying CGH include postural abnormalities, muscle tightness, and neural tissue mechanical sensitivity [14].

A variety of invasive and noninvasive therapeutic modalities are used in the treatment of CGH [15]. The invasive modalities include injections, dry needling, and surgery. Radiofrequency has been used for the ablation of pain generators at the dorsal root medial branches. Such procedures require imaging guidance (real-time fluoroscopy and use of contrast media) [5]. Besides their associated risks, most of these treatments lack the evidence-based proof of effectiveness [4,5]. The noninvasive treatment techniques include transcutaneous electrical nerve stimulation and physiotherapy (PT) (massage, exercise, manipulation, traction, or mobilization) [6,16]. PT is the primary and classical therapy of CGH [17]. The physiotherapeutic modalities vary according to the experience of the therapist [4,18,19].

Low-level laser therapy (LLLT) is commonly used to treat different types of neck pain. Unlike high-power lasers with thermal effects used during surgical procedures and for thermolysis, low-power lasers have little or no thermal effects but have a simulative effect on target tissues and are used to treat an array of musculoskeletal conditions. They decrease pain and inflammation, stimulate collagen metabolism and wound healing, and promote fracture healing [20].

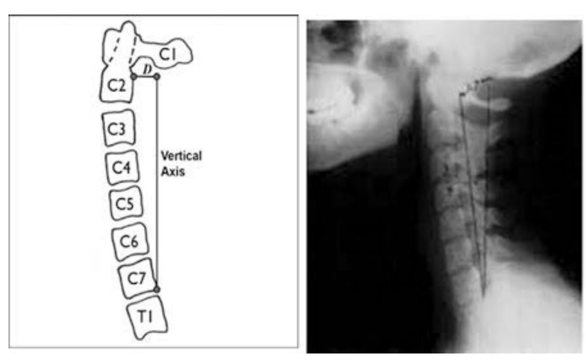
Kinesio taping (KT) is a relatively new type of taping. It was originally created by a Japanese chiropractor Kenzo Kase in 1980 and gained popularity in various clinical settings. The tape, approximately of the same epidermis thickness, is made of an elastic polymer strand wrapped by 100% cotton fibers. It allows fast evaporation of body moisture and drying [21]. KT provides a positional stimulus through the skin, aligns fascial tissues, and creates more space by lifting fascia and soft tissue above the area of pain/inflammation. It provides sensory stimulation to assist or limit motion. It assists in the removal of edema by directing exudates toward lymph ducts [22].

In this prospective randomized controlled study, we compared the clinical outcomes of treating CGH by classical PT alone with those after the addition of LLLT or KT – one at a time – to PT.

Patients and methods

From March 2014 to August 2015, 83 patients, presenting to the Physical Therapy Center at Helmeya Military Hospital, Cairo, Egypt, were diagnosed as having CGH according to the revised diagnostic criteria of the International Cervicogenic Headache Study Group [23] and the diagnostic criteria of CGH issued in the International Headache Society's International Classification of Headache Disorders [3]. Patients with a history of head and neck surgery, erosive bone diseases, rheumatoid arthritis or other inflammatory joint disease, bone infection, and local benign or malignant tumors were excluded. For the remaining patients, a lateral radiograph on the cervical spine from C2 to C7 was done. A vertical line was drawn from the posterior inferior corner of C7, and the perpendicular distance from this line to the posterior superior portion of the vertebral body of C2 was measured to determine the forward head displacement in relation to the thorax (Fig. 1).

Figure 1



Anterior head displacement measured as horizontal distance (D) between posterior–superior body of C2 vertebra and vertical line drawn superiorly from posterior–inferior body of C7 vertebra. T1=first thoracic vertebra, C1–C7=first to seventh cervical vertebra.

Patients with forward head displacement of more than 15 mm received an explanation of the study and were offered the option to be included in it. Finally, 45 patients (24 female, 21 male, age range: 30–40 years, mean=34 years and 7 months) gave informed consents to be included. The study design was approved by the local ethical committee at Helmeya Military Hospital, Cairo. The 45 patients were randomly assigned to one of the following three groups:

Group A (control group) consisted of 15 patients (six male and nine female, mean age: 34 years and 11 months). This group was treated by PT alone for 6 weeks, three sessions per week. The exercise program consisted of stretching exercises for the sternocleidomastoids (SCM), the scalenes and upper fibers of trapezius, followed by strengthening isometric exercises for the neck flexors (SCM, rectus capitis anterior, and longus capitis), extensors (recti capitis posterior, semispinalis capitis, splenius capitis, longissimus capitis, and upper trapezius), lateral flexors (SCM, longissimus capitis, splenius capitis, and cervicis and iliocostalis cervicis), and neck rotators (splenius cervicis, multifidus, semispinalis capitis, cervicis, and rotatores). The program ended by postural correction exercises according to Pearson and Walmsley [24]. The postural correction exercises consisted of cervical retraction exercises, upper cervical nodding exercises, and scapular retraction exercises. All exercises were performed by the same certified physiotherapist.

Group B (first experimental group) consisted of 15 patients (seven male and eight female, mean age: 34 years and 5 months). They were treated by the same PT program as in group A in addition to LLLT (PT+LLLT) in three sessions per week for 6 weeks. Laser therapy was performed with an infrared diode laser (model BRT/1, wave length=830 nm, energy intensity=9 J; Biorem, Agropoli (SA), Italy) applied in a continuous-wave mode for a total of 15 min at the beginning of each PT session. The output power was 4 mW, the power density was 10 mW/cm^2, the spot size was 0.4 cm, and the treatment time was 120 s. The distance between the laser and the patient was 75 cm (Fig. 2). The whole area from the occiput to C7 was exposed by the automatically moving laser head.

Group C (second experimental group) consisted of 15 patients (eight male and seven female, mean age: 34 years and 4 months). They were treated by the same PT program as in group A with the application of a KT (Kinesio K-Active; Nitto Denko Corp., Tokyo, Japan) (PT+KT). The tape was kept in place and changed weekly. It was applied on deep cervical extensors by measuring the distance between the occipital union and T4/T5 cervical vertebrae; two pieces of the tape were cut in a Y-shape equal to this distance. The base was fixed at T4/T5, and the two strips of the tape were run along the spine, one on the right side and the other on the left side. Patients were then asked to flex the cervical vertebrae (maximum flexion) while making a heterolateral rotation of the head, and the tape was stretched and the anchor fixed below the occipital union. We then put pressure by the knuckles on the tape to stimulate its adhesive effect. For the upper fibers of trapezius, we measured the distance between the acromion processes and the occipital union. We cut two pieces of tape equal to this distance. We started by fixing the base of the tape on the origin of upper fibers of trapezius. Then, the patients were asked to laterally flex the neck (maximum side bending), and we fixed the anchor at the insertion in the acromion process. We then put pressure by the knuckles on the tape to stimulate its adhesive effect (Fig. 3).

Figure 2

Laser application to the cervical region.

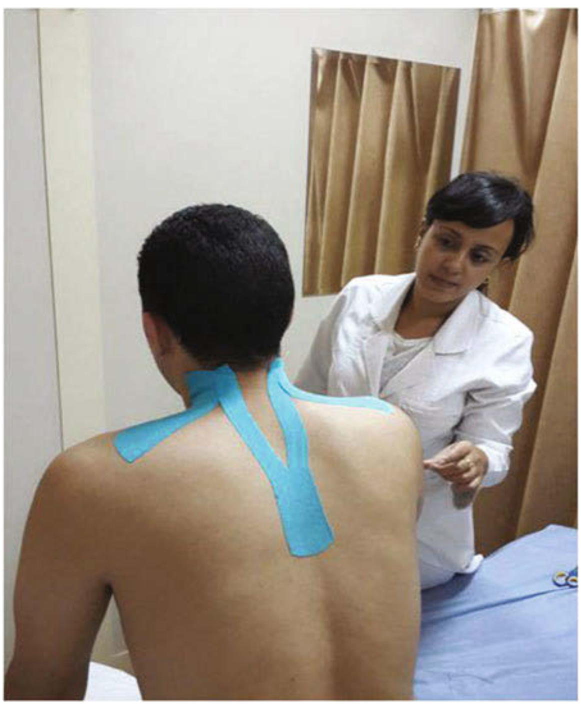
Outcome measures

An electronic algometer (Force one gauge model FDI; Wagner Instruments, Greenwich, Connecticut, USA) was used to measure the tenderness at the myofascial trigger points in order to determine the pain pressure threshold. The myofascial trigger points were identified as they overlaid the facet joints. The baseline value was determined at the initial visit, and the post-treatment value was taken at the end of the last visit.

The neck disability index is a self-report questionnaire with 10 items, each rated from 0 (no disability) to 5 (complete disability). In its Arabic edition, the neck disability index is a valid and reliable patient-rated instrument for assessing self-rated disability due to neck pain of mechanical origin [25]. The neck disability index was taken for all patients. The numeric responses for each item were summed for a total score ranging between 0 and 50. The baseline value was determined at the initial visit, and the post-treatment value was taken at the end of the last visit.

The forward head posture was assessed by a lateral radiograph done within 2 days after the last treatment session. This was compared with the initial radiograph done before inclusion in the study.

Figure 3



Kinesio taping application to the cervical muscles.

Statistical analysis

Descriptive statistics and paired *t*-test were used to compare the pretreatment and post-treatment results of the three parameters of each of the three groups. Analysis of variance (ANOVA) post-hoc test was used to compare the post-treatment results of the three parameters in the three groups. Statistically significant differences were determined with a confidence interval of 95% ($P<0.05$). Data were analyzed by SPSS program version 22 (SPSS Inc., Chicago, Illinois, USA).

Results

All the included patients continued the study until its end. The three groups were homogeneous with no statistically significant differences in age, weight, and height, where the F and P values were 0.19, 0.82; 0.08, 0.91; and 0.48, 0.61, respectively.

Outcome measures

Pain pressure threshold

There was a significant difference between the pretreatment and post-treatment values of the pain pressure threshold in all three groups, as seen by the paired *t*-test (Table 1).

ANOVA revealed that there was no significant difference in the pretreatment values of the pain pressure threshold between the three groups, as F value was 0.48 and P value was 0.61. However, there was a significant difference in the post-treatments values, as F value was 72.68 and P value was 0.0001. Comparison of the post-treatment values

Table 1 Mean and±SD, *t*-value and *P* value of pain pressure threshold before and after treatment of groups A, B, and C

	Group A		Group B		Group C	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean±SD	2.48±0.16	3.22±0.19	2.46±0.2	3.82±0.2	2.42±0.15	4.1±0.21
Mean difference	0.74		1.36		1.68	
Percentage of improvement (%)	29.83		55.28		69.42	
t-Value	11.16		20.0		24.61	
P value	0.0001		0.0001		0.0001	
Significance	S+		S+		S+	

P, probability; S+, significant.

of the three groups by the post-hoc test showed that there was a significant difference in the post-treatment values of the pain pressure threshold between groups A (PT) and B (PT+LLLT) with a mean difference value of 0.6 and *P* value of 0.0001. There was a significant difference in the post-treatment values of the pain pressure threshold between groups A (PT) and C (PT+KT), where the mean difference value was 0.88 and *P* value was 0.0001. Finally, there was a significant difference in the post-treatment values of the pain pressure threshold between groups B (PT+LLLT) and C (PT+KT), where the mean difference value was 0.27 and *P* value was 0.001.

Neck disability index

There was a significant difference between the pretreatment and post-treatment values of the neck disability index in all the three groups, as seen by the paired *t*-test (Table 2).

ANOVA revealed that there was no significant difference in the pretreatment values of the pain pressure threshold between the three groups, as *F* value was 0.48 and *P* value was 0.61. However, there was a significant difference in the post-treatment values, as *F* value was 72.68 and *P* value was 0.0001. Comparison of the post-treatment values of the three groups by the post-hoc test showed that there was a significant difference in the post-treatment values of the neck disability index between groups A (PT) and B (PT+LLLT), where the mean difference value was 5.0 and *P* value was 0.0001. There was a significant difference in the post-treatment values of the neck disability index between groups A (PT) and C (PT+KT), where the mean difference value was 8.46 and *P* value was 0.0001. Finally, there was a significant difference in the post-treatment values of the neck disability index between groups B (PT+LLLT) and C (PT+KT), where the mean difference value was 3.46 and *P* value was 0.005.

Forward head posture values

There was a significant difference between the pretreatment and post-treatment values of the forward head posture in all three groups, as seen by the paired *t*-test (Table 3).

ANOVA revealed that there was no significant difference in the pretreatment values of the neck disability index between the three groups, as *F* value was 0.09 and *P* value was 0.91. However, there was a significant difference in the post-treatment values, as *F* value was 26.37 and *P* value was 0.0001. Comparison of the post-treatment values of the three groups by the

Table 2 Mean and±SD, *t*-value and *P* value of the pretreatment and post-treatment values of the neck disability index of groups A, B, and C

	Group A		Group B		Group C	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean±SD	27.8±3.74	20.13±3.48	28.46±4.5	15.13±3.18	28.06±4.47	11.66±2.94
Mean difference	7.66		13.33		16.4	
Percentage of improvement (%)	27.55		46.83		58.44	
t-Value	13.74		8.84		14.01	
P value	0.0001		0.0001		0.0001	
Significance	S+		S+		S+	

P, probability; S+, significant.

Table 3 Mean and±SD, *t*-value and *P* value of the pretreatment and post-treatment values of the forward head posture of groups A, B, and C

	Group A		Group B		Group C	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean±SD	1.82±0.14	1.78±0.12	1.85±0.13	1.76±0.12	1.84±0.12	1.56±0.07
Mean difference	0.04		0.09		0.28	
Percentage of improvement (%)	2.19		4.86		15.21	
t-Value	2.44		6.5		13.31	
P value	0.02		0.0001		0.0001	
Significance	S+		S+		S+	

P, probability; S+, significant.

post-hoc test showed that there was no significant difference in the post-treatment values of the forward head posture between groups A (PT) and B (PT+LLLT), as the mean difference value was 0.01 and *P* value was 0.73. There was a significant difference in the post-treatment values of the forward head posture between groups A (PT) and C (PT+KT) as the mean difference value was 0.22 and *P* value was 0.0001, and finally there was a significant difference in the post-treatment values of the forward head posture between groups B (PT+LLLT) and C (PT+KT) as the mean difference value was 0.2 and *P* value was 0.0001.

Discussion

This study highlights the significant improvement that occurred in the pain pressure threshold, the neck disability index, and the forward head posture after adding the KT to the traditional physical therapy for the treatment of CGH. Adding the LLLT to the PT led to improvement, but in the pain pressure threshold and the neck disability index only.

All the three studied groups showed marked reduction in three measured outcome parameters (the pain pressure threshold, the neck disability index, and the forward head posture) when compared with their pretreatment values. The improvement was more apparent in experimental groups PT+LLLT and PT +KT when compared with the control group (PT). There was a significant difference in the outcome parameters between the PT+LLLT group and the PT group and another significant difference between the PT+KT group and the PT+LLLT group.

The female preponderance, known for this condition [13], was not apparent in our study, because we recruited our patients from a military hospital, where the majority of patients were middle-aged men.

We relied upon forward head posture of greater than 15 mm as an inclusion criterion because persons with more severe postural abnormalities experience a higher incidence of pain (headache) compared with those with less severe abnormalities [26]. The forward head posture is the result, rather than the cause, of headache. It was stated that the pain associated with forward head position is most probably originating from the cervical facet joints. Because facet joints planes are obliquely oriented, the forward head position increases the compressive force between the facet articular cartilage of the inferior articular process and the adjacent facet of the superior articular process [27].

The improvement in the pain pressure threshold in the PT+LLLT group may be due to the rapid analgesic effect of the LLLT. This is consistent with the proposed mechanism of action of LLLT, which made it a commonly used treatment for somatic dysfunctions resulting in cervical motion restriction [28]. Simons *et al.* [29] tested the immediate effect of LLLT on patients with CGH and proved that there is an improvement, although little, in pain and functional outcomes.

In a randomized clinical trial by Bronfort *et al.* [17], substantial improvement in the neck disability index was observed with the use of LLLT compared with the manual (physical) therapy; however, the difference was not statistically significant. In contrast to these findings, our study demonstrated that the addition of LLLT had significantly improved the neck disability index score relative to the group that had received the traditional physical therapy alone. This discrepancy may be due to different laser parameters.

As the results of neck disability index depend on the amount of neck pain during rest, the amount of neck pain during activity of daily living, the pain intensity, and the muscle strength, the improvement in neck disability index with the use of KT is suggested to be due to a combined effect of reduction in pain and improvement in neck muscle strength [21].

Draper *et al.* [30] explained that the rationale behind the superiority of KT over LLLT is the reduced reflex activity associated with the former technique. As compared with LLLT, KT modifies stretch perception and nociceptive nerve endings in the joint and muscle and play an important role via neurotransmitter modulation or gate control. Repetitive light muscle contractions caused by the KT increase venous, lymphatic drainage and relieve paraspinal congestion [30]. This agreed with our results that showed that the KT group had more improvement in the pain threshold and the forward head posture and showed consequently significantly higher improvement in the neck disability index.

However, studies showed that KT combined with postural correction exercises had short-term effect in improving pain, active cervical range of motion, and functional ability than postural correction exercises alone in treating chronic mechanical neck pain [21]. We could not assess the time scale of the effect of KT application on CGH, because our results were collected immediately after the 6-week treatment period. Further investigation with longer follow-up period is needed.

Conclusion

In the immediate and short term, KT improves three of the outcomes of PT for CGH, namely the pain pressure threshold, the neck disability index, and the forward head posture. This improvement is more than that observed when the LLLT is added to PT.

Acknowledgements

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Reid SA, Rivett DA, Katekar MG, Callister R. Efficacy of manual therapy treatments for people with cervicogenic dizziness and pain: protocol of a randomised controlled trial. BMC Musculoskelet Disord 2012; 13:201.

2 Linde M, Gustavsson A, Stovner LJ, Steiner TJ, Barré J, Katsarava Z, *et al.* The cost of headache disorders in Europe: the Eurolight project. Eur J Neurol 2012; 19:703–711.

3 Gladstone JP, Dodick DW. Revised 2004 International Classification of Headache Disorders: new headache types. Can J Neurol Sci 2004; 31:304–314.

4 Inan N, Ates Y. Cervicogenic headache: pathophysiology, diagnostic criteria and treatment. Agri 2005; 17:23–30.

5 Nagar VR, Birthi P, Grider JS, Asopa A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headache. Pain Physician 2015; 18:109–130.

6 Racicki S, Gerwin S, Diclaudio S, Reinmann S, Donaldson M. Conservative physical therapy management for the treatment of cervicogenic headache: a systematic review. J Man Manip Ther 2013; 21:113–124.

7 Martelletti P, van Suijlekom H. Cervicogenic headache: practical approaches to therapy. CNS Drugs 2004; 18:793–805.

8 Wang E, Wang D. Treatment of cervicogenic headache with cervical epidural steroid injection. Curr Pain Headache Rep 2014; 18:442.

9 Bartsch T, Goadsby PJ. Stimulation of the greater occipital nerve induces increased central excitability of dural afferent input. Brain 2002; 125:1496–1509.

10 Goadsby PJ, Knight YE, Hoskin KL. Stimulation of the greater occipital nerve increases metabolic activity in the trigeminal nucleus caudalis and cervical dorsal horn of the cat. Pain 1997; 73:23–28.

11 Linton SJ. A review of psychological risk factors in back and neck pain. Spine (Phila Pa 1976) 2000; 25:1148–1156.

12 Thompson DP, Oldham JA, Urmston M, Woby SR. Cognitive determinants of pain and disability in patients with chronic whiplash-associated disorder: a cross-sectional observational study. Physiotherapy 2010; 96:151–159.

13 Jensen R, Stovner LJ. Epidemiology and comorbidity of headache. Lancet Neurol 2008; 7:354–361.

14 Dunning JR, Cleland JA, Waldrop MA, Amot CF, Young IA, Turner M, Sigurdsson G. Upper cervical and upper thoracic thrust manipulation versus nonthrust mobilization in patients with mechanical neck pain: a multicenter randomized clinical trial. J Orthop Sports Phys Ther 2012; 42:5–18.

15 Schoensee SK, Jensen G, Nicholson G, Gossman M, Katholi C. The effect of mobilization on cervical headaches. J Orthop Sports Phys Ther 1995; 21:184–196.

16 Schellhas KP, Garvey TA, Johnson BA, Rothbart PJ, Pollei SR. Cervical diskography: analysis of provoked responses at C2–C3, C3–C4, and C4–C5. Am J Neuroradiol 2000; 21:269–275.

17 Bronfort G, Evans R, Nelson B, Aker PD, Goldsmith CH, Vernon H. A randomized clinical trial of exercise and spinal manipulation for patients with chronic neck pain. Spine (Phila Pa 1976) 2001; 26:788–797. discussion 798-789.

18 Reid SA, Callister R, Katekar MG, Rivett DA. Effects of cervical spine manual therapy on range of motion, head repositioning, and balance in participants with cervicogenic dizziness: a randomized controlled trial. Arch Phys Med Rehabil 2014; 95:1603–1612.

19 Aaseth K, Grande RB, Benth JS, Lundqvist C, Russell MB. 3-Year follow-up of secondary chronic headaches: the Akershus study of chronic headache. Eur J Pain 2011; 15:186–192.

20 Hurwitz EL, Carragee EJ, van der Velde G, Carroll LJ, Nordin M, Guzman J, *et al.* Treatment of neck pain: noninvasive interventions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. J Manipulative Physiol Ther 2009; 32:S141–S175.

21 Gonzalez-Iglesias J, Fernandez-de-Las-Penas C, Cleland JA, 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; 39:515–521.

22 Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. J Orthop Sports Phys Ther 2008; 38:389–395.

23 Sjaastad O, Fredriksen TA, Pfaffenrath V. Cervicogenic headache: diagnostic criteria. The Cervicogenic Headache International Study Group. Headache 1998; 38:442–445.

24 Pearson ND, Walmsley RP. Trial into the effects of repeated neck retractions in normal subjects. Spine (Phila Pa 1976) 1995; 20:1245–1250; discussion 1251

25 Shaheen AA, Omar MT, Vernon H. Cross-cultural adaptation, reliability, and validity of the Arabic version of neck disability index in patients with neck pain. Spine (Phila Pa 1976) 2013; 38:E609–E615.

26 Griegel-Morris P, Larson K, Mueller-Klaus K, Oatis CA. Incidence of common postural abnormalities in the cervical, shoulder, and thoracic regions and their association with pain in two age groups of healthy subjects. Phys Ther 1992; 72:425–431.

27 Sun A, Yeo HG, Kim TU, Hyun JK, Kim JY. Radiologic assessment of forward head posture and its relation to myofascial pain syndrome. Ann Rehabil Med 2014; 38:821–826.

28 La Touche R, Fernandez-de-Las-Penas C, Fernandez-Carnero J, Diaz-Parreno S, Paris-Alemany A, Arendt-Nielsen L. Bilateral mechanical-pain sensitivity over the trigeminal region in patients with chronic mechanical neck pain. J Pain 2010; 11:256–263.

29 Simons DG, Hong CZ, Simons LS. Endplate potentials are common to midfiber myofacial trigger points. Am J Phys Med Rehabil 2002; 81:212–222.

30 Draper CE, Besier TF, Santos JM, Jennings F, Fredericson M, Gold GE, *et al.* Using real-time MRI to quantify altered joint kinematics in subjects with patellofemoral pain and to evaluate the effects of a patellar brace or sleeve on joint motion. J Orthop Res 2009; 27:571–577.