



Case Report

Effectiveness of Dry Needling to the Sternocleidomastoid Muscle, Manual Therapy, and Exercise to Reduce Pain and Improve Function in Subjects with Chronic Cervicogenic Headaches: A Retrospective Case Series

Rob Sillevis^{1*} and Karen Wyss²

¹Department of Rehabilitation Sciences, Florida Gulf Coast University, Florida, USA

²Integrated Therapy Practice, PC Merrillville, Indiana, USA

***Corresponding author:** Rob Sillevis, Department of Rehabilitation Sciences, Florida Gulf Coast University, 10501 FGCU Boulevard south Marieb 428, Fort Myers, Florida 33965, USA

Citation: Sillevis R and Wyss K. Effectiveness of Dry Needling to the Sternocleidomastoid Muscle, Manual Therapy, and Exercise to Reduce Pain and Improve Function in Subjects with Chronic Cervicogenic Headaches: A Retrospective Case Series. Ann Case Report 14: 423. DOI: 10.29011/2574-7754.100423

Received Date: 05 June, 2020; **Accepted Date:** 17 June, 2020; **Published Date:** 24 June, 2020

Abstract

Background: Muscle impairment has been related to the development of cervicogenic headaches (CGH). It has been demonstrated that trigger points of the sternocleidomastoid muscle (SCM) can produce CGH. Dry needling can reduce muscle dysfunction and therefore the purpose was to demonstrate the effect of dry needling the sternocleidomastoid muscle (SCM) in subjects with CGH.

Case Report: The subjects in this case series were referred by a neurologist for physical therapy and diagnosed with cervicogenic headaches. Subject one was a 52 y/o male, subject 2 was a 22 y/o male and subject 3 was a 39 t/o female. All three subjects presented with signs of neck involvement and unilaterally of the head pain. All subjects received dry needling of trigger points in the SCM using Seirin J, no 2 needles 0.12 mm thick and 15mm long in combination with soft tissue techniques to the cervical region, joint manipulation and the use of augmented exercise. Baseline measures were taken and repeated at 3 and 6 weeks.

Conclusion: This case series describes the benefits of dry needling in combination with manual therapy and exercise in three subjects over the course of 10 treatments. After treatment intervention all three subjects reported that the dry needling intervention was beneficial. Active range of motion and passive range of motion improved as did the self-perceived disability on the Headache disability index and Neck Disability Index. Dry needling was tolerated well by the subjects, they reported it contributed to improvements in pain and function, without significant adverse effects.

Keywords: Dry needling, Cervicogenic headache, Sternocleidomastoid

Background

Neck disorders are common and create a large burden on society. It taxes the healthcare system more than 50 billion dollar each year [1]. Additionally, neck related disorders can lead to a reduced or inability to work, and possibly reduced work-related productivity. Subjects with dysfunctions originating in the cervical spine can present with large variety of symptomatic regions including: the neck, the occipital and facial areas, the shoulder and arm, and the scapulothoracic region. Any structure in the neck including: the intervertebral disc, ligaments, muscles, facet joints,

dura, and nerve roots can contribute to the pain [2]. Cervicogenic headache (CGH) is an example of a condition that is caused by dysfunction in the cervical spine. About 15-20% of all headaches are CGH's and the prevalence in the general population is around 4%. These headaches typically originate in the cervical spine and spread to the frontal- temporal and orbital regions of the face and possibly the trapezius, shoulders and scapular regions [3-5]. Although the exact mechanism causing CGH is not clear it appears that the upper cervical spine plays a key role in the pathogenesis [6-9]. A possible rationale for the development of CGH is the direct relationship between the trigeminal nerve and the spinal nerves C1-C3 at the trigeminocervical nucleus [10]. Here the nerves of the upper cervical spine and the trigeminocervical nucleus connect

and nociceptive spinal signals can converge from the spine to trigeminal nerve. This could result in a perception of radiating pain via the ophthalmic branch of the trigeminal nerve.

The upper cervical region is controlled by the suboccipital muscles and the larger cervical muscle groups. Dysfunction in the muscle control could lead to movement disorder of the upper cervical region and thus contribute to the development of CGH. It has been previously demonstrated that abnormal cervical functioning will change the proprioceptive awareness coming from mechanoreceptive neurons in this region [11]. There is an exceptionally high density of these in the suboccipital muscles located in the posterior upper cervical spine [11]. With cervical dysfunction, proprioception may be impeded as a result of pain, swelling, trauma, and/or muscular fatigue. In addition to this relationship between muscle and proprioception Scali et al. [12] and Pontel et al. [13] demonstrated that fascial tissues originating from the Rectus Capitis Posterior Minor, Rectus Capitis Posterior Major, and the Obliquus Capitis Inferior can be identified in the space between the C1 and C2 vertebrae; these structures have been referred to as the “myodural bridges”. Between the arches of C1 and C2, the myodural bridges merge with the meningovertbral ligaments and cross the epidural space, inserting into the posterior aspect of the dura mater. It was previously proposed that these myodural bridges were to protect the cervical dura during motion and prevent compression of the cord [12]. The significance of this finding is that there is a direct anatomical connection between the muscle, cervical fasciae and the central nervous system. This could possibly explain the phenomenon of neurotension often identified by clinicians when treating patients with headaches and cervical related dysfunctions [14-16].

The upright position in human’s results in loading of the cervical spine due to the weight of the head. This can leave the neck susceptible to progressive, degenerative changes over time. This will result in forward placement of the head in the sagittal plane leading to increased mechanical joint compression, increased cervical curve, and a posterior rotation of the head relative to the neck. This will result in progressive muscle adaptation. This has been identified as possible contributing factor for the development of CGH [17,18]. The ventral ramus of the cervical spine innervates the prevertebral muscles along with C2 and C3 [19]. The median atlantoaxial joint and its ligaments, the posterior cranial fossa and dura mater, the trapezius, and sternocleidomastoid (SCM) are supplied by C1-C3 nerves [19].

Muscles will adapt to both the position they are placed in and the functions they have to perform. Patients with CGH often present with forward head posture that leads to an upper cross muscle syndrome (UCMS) [20]. This muscle syndrome is characterized by the simultaneous development of both weak and short muscles. Weakness and endurance deficits in the deep neck flexor muscles have been identified in those with CGH. This may

contribute to muscular imbalance and susceptibility to injury in the cervical region. Within this UCMS the sternocleidomastoid muscle will present bilaterally in hypertone state and shortened position [17]. Prolonged muscle tone will lead to muscle dysfunctions such as trigger points. Trigger points are identified as a taut band within a muscle and have a characteristic nodular texture upon palpation. When palpated trigger points will elicit pain that can be felt locally or can cause radiating pain. Trigger points have been identified in those with CGH in the upper trapezius, SCM, erector spinae, and suboccipital muscles [21]. It has been demonstrated that trigger points of the SCM can produce a unilateral referred pain over the forehead and around the ipsilateral eye and ear as seen in CGH [22].

Dry needling is modality used within the management of musculoskeletal dysfunctions. It has been used to treat local tissues such as trigger points and tendinitis and it has been used to have central effects by needling paravertebally. Dry needling typically is not used as a stand-alone therapeutic intervention but can be used to augment manual therapy interventions by directly influencing the musculoskeletal system [23,24]. Dry needling is a technique using a thin needle to penetrate the skin and subsequent layers. The intend is to mechanically disrupt tissue, however without the use of any pharmacological agents [23]. There is growing evidence that dry needling is beneficial although the exact mechanism by which this occurs remains elusive. Dry needling will cause both local and central mechanisms to restore homeostasis and repair at the site of the tissue disruption [25-27]. It has been reported that dry needling results in a reduction in local and central pain, improves mobility, vascular responses, and decreased active trigger point activity [24,28-34]. Additionally, there might be activation of the descending control mechanisms in the central nervous system [27,32]. Despite emerging evidence supporting the use of dry needling it is not clear what the optimal location for needling is when managing patients with CGH. A combination of localized needling with Para spinal needling to enhance the central effect of needling has been shown to be beneficial [35].

Given the lack of research supporting the use of dry needling within the multi-modal treatment approach for patients with CGH, there is a need for the documentation and presentation of clinically effective interventions that can reduce CGH, improve pain, improve ROM and thereby improving general function. Therefore, the purpose of retrospective case series was to investigate the benefit for dry needling coupled with a standard manual therapy approach for subjects with CGH.

Case Report

The subjects in this case series were referred by a neurologist for physical therapy and diagnosed with cervicogenic headaches. All three subjects presented with symptoms and signs of neck involvement (characteristics 1) and unilaterally of the head pain,

without side shift (characteristic 3). These characteristics are part of the classification criteria for CGH determined by the International Headache Society [36]. The reliability using criteria 1 and 3 to diagnose CGH was previously demonstrated [36].

Subject 1 was a 52-year-old male who developed CGH symptoms after an accident several years ago he reported a recent aggravation of his condition making him seek medical care. He reported contralateral stiffness in the neck and pain with cervical rotation. He reported that his pain radiated down both arms L>R mainly in the biceps areas. He reported that his headache would start in the sub occipital space and end on the frontal area. He reported that his headache intensity depended on his stress level. Based on a Numeric Pain Scale Pain (NPS) he reported his pain fluctuating between 0/10 to 9/10. He reported his pain on a visual analog scale (VAS) to at the time of the evaluation. The VAS for patients with acute and chronic pain is a reliable and valid tool to measure pain [37]. He reported his pain at 47mm (out of 100mm). He also completed the Neck Disability Index (NDI) and the Headache Disability Inventory (HDI) as self-reported measures. The NDI a self-reported measure based on 10 items. It measures patient reported disability levels [38-42]. Lower scores on the NDI indicate lower disability levels [43]. At the time of examination his score was 28/ 100, which indicates a “lower” level of neck related disability. It has been demonstrated that the NDI has good content and construct validity in patients with neck pain [38,44]. The HDI measures the self-reported direct impact of headaches on daily living. It is a 25-item questionnaire in which higher scores indicate higher impact. The HDI contains two separate subscales. There is a functional subscale consisting of 12 items and an emotional subscale with 13 items. There is a maximum total score of 100. At the time of his examination his score was 24/100, which indicates a “moderate” level of disability. The HDI has good construct validity and test-retest reliability [45]. His review of system was negative and did not identify any red and yellow flags.

Subject 2 was a 22-year old male with chronic headaches and his medical management up till this point consisted of medication management. He reported that a recent brain MRI scan was unremarkable. His headaches were primarily located on the right temporal and frontal region of the head. He did indicate that it appeared that his headache intensity was influenced by noise and light. He reported that his pain would radiate into the right shoulder region. The headache would typically appear as the day went on and increased in intensity toward the evening. At the time of the evaluation he reported his pain at 65mm on the VAS. His NDI score was 30/100, which indicated a “lower” level of neck related disability. He did score 52/100 on the HDI, which indicated a “severe” level of disability as a result of his headaches. His review of system was negative and did not identify any red and yellow flags.

Subject 3 was a 39-year old female referred for chronic headaches. She also reported neck and lower back pain. She reported that the headaches were present daily and would start in the base of the skull and cause pain in the back of the head. She reported that tightness was present in in the neck and her in combination with her headache she would develop pain in the lower jaw on the left. At the time of the evaluation she reported her pain at 40mm on the VAS. Her NDI score was 26/100, which indicated a “lower” level of neck related disability. She scored 44/100 on the HDI, which indicated a “moderate” level of disability as a result of his headaches. Her review of system was positive for a bilateral mastectomy. She reported that her oncologist cleared her for care and felt that her headache syndrome was not related to her previous breast cancer issues. She was previously treated for anemia, osteoarthritis, and Asthma. She indicated that she has been dealing with depression and her neurologist is helping with the medical management of this.

Clinical Impression 1

Given the fact that all three subjects have had chronic issues and presentation was consistent with the classification criteria set by the International Headache Society the diagnosis of CGH seemed appropriate [36]. Differential diagnosis consisted of cervical pathology including facet arthropathy, radiculopathy, cervical ligamentous instability, and muscle imbalance. Due to the fact that all three subjects underwent a detailed neurological assessment including MRI imaging of the cervical spine by the referring neurologist the major cervical pathology was ruled out. All three subjects, based on their review of systems, were considered appropriate to receive dry needling of the sternocleidomastoid muscle within the management of their CGH. Further examination of each subject was appropriate. The examination included the determination of functional limitations, range of motion deficits, muscle dysfunction, identification of trigger points, and a screen to rule out serious neurovascular pathology in cervical region that might require a referral to another medical specialist.

Examination

On examination all three subjects ambulated normally. They were seated during the intake interview and initial observation revealed a typical forward head position in all three subjects. Forward head posture will lead to posterior rotation of the head on the neck and will lead to muscle adaptation. This could include muscle weakness of the deep neck flexors and tightness of the suboccipital muscles, sternocleidomastoid, trapezius and pectoralis muscles. This pattern of adaptation has previously been described as the upper cross muscle syndrome (UCMS) [20].

Active range of motion (ROM) of the cervical region and bilateral shoulders was assessed in sitting using both a goniometer and inclinometer. Assessment of AROM of the cervical spine has

been shown to be beneficial when examining patients with CGH [46]. Cervical ROM was measured for neck flexion, backward bending of the neck, and side bending using a single inclinometer. The inclinometer was placed on the superior surface of the subjects' heads facing perpendicular to the direction of movement when assessing flexion, extension, and lateral flexion. Cervical rotation was assessed using a goniometer. The intra and inter-rater reproducibility of cervical motion testing has been shown as good [46]. The results of the motion assessment can be found in table 1. Subject 1 displayed decreased forward flexion of the cervical spine and bilateral rotation was limited. Based on the contribution of the suboccipital region to the development of CGH atlanto-axial (AA) mobility was assessed in supine using the cervical flexion-rotation test (FRT). This test is carried out by placing the neck in maximum flexion resulting in maximum facet movement between segments below the AA segment. In this position the head will be rotated in each direction. Range will be measured with the goniometer and the quality of endfeel will be identified [47]. In patients with CGH the FRT has a high sensitivity (90-91%), a high specificity (88-90%), and overall good diagnostic accuracy (91%) [48-50]. Subject 1 had decreased AA mobility in right rotation more than left. Shoulder motion for bilateral flexion and abduction seemed within normal limits and did not provoke any symptoms. Subject 2 displayed normal forward and backward bending of the cervical spine. Cervical left rotation was more limited than right rotation. The FRT did not reveal any difference between sides. In subject 3 arm bilateral arm flexion and abduction was normal. Subject 3 displayed decreased forward bending of the neck. Rotation was bilaterally equal at 54 degrees, but this is below normal expected rotation [46]. Bilateral side bending of the neck appeared normal and the FRT reveals that bilateral AA rotation was limited left more than right. Just as in the other two subjects shoulder motions were normal bilaterally in subject 3. The validity and reliability of spinal segmental motion assessment ranges from poor to good [51-55]. Facet mobility of C2 through C7 was assessed using a down slide test in all subjects [56]. Subject 1 revealed C4-5 and C5-C6 hypomobility. Subject 2 displayed stiffness at C5-C6 right and subject 3 had limited C5-C6 and C6-7.

Subject	Neck forward flexion	Neck backward bending	Neck rotation right	Neck rotation left	Neck side bend right	Neck side bend left	Cervical neck flexion rotation test right	Cervical neck flexion rotation test left	Shoulder abduction bilateral
1									
Initial visit	55	45	55	50	35	40	30	38	>160
Week 3	55	48	54	54	40	45	42	45	>160
Week 6	53	40	62	62	40	45	44	50	>160
2									
Initial visit	70	50	62	56	30	30	45	45	>160
Week 3	60	55	66	64	45	45	40	45	>160
Week 6	60	60	65	65	45	45	41	52	>160
3									
Initial visit	58	50	53	53	48	53	35	32	>160
Week 3	58	50	55	55	43	40	35	38	>160
Week 6	60	70	70	67	50	62	45	45	>160

Table 1: Active range of motion assessment neck and shoulder at initial visit, week 3 and week.

Neurological assessment

The subjects were screened for the presence of cervical radiculopathy using the clinical prediction rule. It has been demonstrated that if there is cervical rotation to the side of symptoms in combination with a positive upper limb tension test (ULTT), positive distraction test, and a positive Spurling A test that there is an increased likelihood that the subject would have cervical radiculopathy [57]. Our subjects did not test positive for the ULTT and the Spurling A test therefore the likelihood that there was an underlying condition of cervical radiculopathy was minimal. Normal upper extremity deep tendon reflexes and normal myotomal strength in the upper quadrant was present in each subject. The seated Sharp-Purser and supine alar ligament tests were negative. Based on this it was assumed that the upper cervical ligamentous system was intact [58].

Palpation and Muscle assessment

The cervical region was palpated, and the upper quadrant muscles were assessed for both muscle length and strength. Subject 1 displayed weakness of the short neck flexors, graded 4/5 [59]. Muscle endurance of the deep neck flexors was assessed as described by Jarman et al [60]. This endurance test has moderate to good interrater reliability. Normal individuals should be able to hold this position for 30 seconds. Subject 1 was only able to hold the test position for 23 second. Strength of her middle and lower trapezius was grade 4/5. Subject 1 displayed muscle tightness of the bilateral cervical Para spinals, the suboccipital muscles, bilateral upper trapezius and levator scapula, bilateral sternocleidomastoid muscles (SCM) and pectoralis muscles. Palpation of Subjects 2 identified a tender point at the right greater occipital nerve, and the right C5-6 pillar was sensitized. He displayed muscle weakness of the deep neck flexors graded 4-5 with a muscle endurance test of 18 seconds. He had weakness of the thoracic spine extensors graded 4/5, neck side bend right 4/5 and side bend left 4-5. His rhomboids and middle trapezius were graded 4/5. He displays muscle tightness of the suboccipital muscles, bilateral upper trapezius and levator scapula, bilateral sternocleidomastoid muscles (SCM) and pectoralis muscles. Palpation of the cervical region in Subjects 3 revealed a hypersensitivity of the C3-C4 segment. She displayed muscle weakness of the deep neck flexors graded 3-5 with a muscle endurance test of 0 seconds. She was not able to control the testing position at all. She displayed weakness of the thoracic spine extensors graded 4-5, neck side bend bilaterally 4-5. Her rhomboids and middle trapezius were graded 4-5. She displays muscle tightness of the suboccipital muscles, bilateral upper trapezius and levator scapula (right more than left, bilateral SCM (left>right) and pectoralis muscles (left>right). All three subjects presented consistent with the upper crossed muscle syndrome [20].

Clinical Impression 2

The clinical impression in these cases was based on the physical therapy examination and evaluation procedures for individuals with cervical related CGH. Considering the fact that all three subjects had increased tone and sensitivity upon palpation of the suboccipital muscles, decreased intervertebral facet mobility, muscle weakness of the deep neck flexors, muscle tightness fitting the upper crossed muscle syndrome this supported the original diagnosis of CGH. This led to the hypothesis that these patients could benefit from manual therapy including joint manipulation, dry needling, and muscle stretching and strengthening. Successful outcomes were considered as improved AROM measures such as the neck flexion rotation tests, improved NDI and HDI scores NPRS and VAS scores, increased strength and endurance of the deep neck flexors, and normalization of functional activities without symptoms.

Intervention

One physical therapist (KW) completed all examination and treatment intervention in this case series. KW has over 30 years of experience in manual therapy and is fellowship trained. Additionally, she has 12 years of experience using dry needling. Subjects 1 and 3 received 10 treatments and subject 2 received 8 treatments. Each subject was informed of the possible risks and complications of both the manual therapy techniques and dry needling. Verbal consent was obtained to continue with care. No contraindications were identified in any of the subjects that would prevent the use of DN.

A summary of the techniques used in this case series is presented in Table 2. The manual therapy methods for addressing joint mobility were determined by the treating therapist and based on the clinical examination of each respective patient. We recognize that there is no current practice guideline available identifying those subject that could benefit from cervical manipulation techniques. Cervical manipulation of various grades has been shown to be beneficial to improve ROM, decrease muscle tone, and decrease pain [61]. The treating clinician used her clinical reasoning decision making skills to determine the direction and magnitude of the joint manipulation in each patient case, and whether to use thrust or non-thrust manipulation techniques. Test-retest cervical rotation was used to measure the success of the intervention. Current evidence indicates that subjects with neck pain benefit from upper thoracic thrust manipulation and therefore the subjects underwent a non-specific supine thrust manipulation to the upper cervical spine. This concurs with the 2017 clinical practice guidelines indicating the possible benefit for patients with chronic cervicogenic headaches [62]. Joint manipulation as an intervention was ceased when normal joint mobility was achieved. To address the issue of muscle tonicity the subjects received deep friction of the suboccipital muscles followed by the suboccipital release technique (SRT). Rodriguez-Huguet et al [63] demonstrated that the SRT has a positive short-term effect on pain and pain pressure threshold in subjects with neck pain. It has been demonstrated that SRT can result in an immediate change in muscle tone [64,65]. The suboccipital release technique has been shown to be beneficial with tissue lengthening resulting in overall decreased muscle tone. The subjects underwent stretching of those muscles that were identified by the treating therapist as shortened. These included suboccipital muscles, upper trapezius, SCM, and the levator scapula muscles. Subjects were instructed to perform stretching exercises in such a way that a static stretch was maintained for 30 seconds and repeated 3 times. Stretching has been shown to be beneficial within the management of neck pain [66]. Treatment progression for each patient was based on frequent reassessment of the tissues to determine the effect of treatment interventions.

Subject 1 visits	STM/Stretching	Manipulation	Augmented exercises	Dry Needling SCM
Visit 1	Suboccipital Release, Upper trapezius, Levator scapula, Stretching SCM	OA distraction, C1-2, C4-5, C5-6 Manipulation Grade III Mid TSA thrust	-Supine chin tuck: 20 reps -Supine pectoralis stretch 3x30sec -Postural education, seated -Seated TSA ex over roll 10 reps, frequently -Self-mobilization low CSA, 5 reps bilateral, pain free	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 2	Suboccipital release, Upper Trapezius, STM Cervical and thoracic paraspinals	OA distraction, C1-2, C4-5, C5-6 Manipulation Grade III Mid TSA thrust	DNF strengthening: supine x20 Scap retraction/Rhomboid 3x20 Green theraband; Stretching pecs, upper trapezius, SCM and levators	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 3	Suboccipital release, Upper Trapezius, STM Cervical and thoracic paraspinals	OA distraction, C1-2, C4-5, C5-6 Manipulation Grade III Mid TSA thrust	DNF strengthening: supine x20 Scap retraction/Rhomboid 3x20 Green theraband; Stretching pecs, upper trapezius, SCM and levators	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 4	Suboccipital release, Upper Trapezius, STM Cervical and thoracic paraspinals	OA distraction, C1-2, C5-6, C6-7 Manipulation Grade III Mid TSA thrust	Prone over ball: neck ext 2sets 10 reps holding 5sec ea. Green theraband:Scap retraction/Rhomboid 3x20; Stretching pecs, upper trapezius, SCM and levators	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 5	Suboccipital release, Upper Trapezius, STM Cervical and thoracic paraspinals	AA rot Grade III; C5-6, C6-7 Manipulation Grade III PA T4-7 Gr III	Prone over ball: neck ext 3sets 10 reps holding 5sec ea. Blue theraband: Scap retraction/Rhomboid 3x15; Stretching pecs, upper trapezius, SCM and levators. Pulleys: middle and lower trapezius 5# 3x15	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 6	Suboccipital release, Levator scapula insertion, STM Cervical and thoracic paraspinals	AA rot Grade III; C5-6, C6-7 Manipulation Grade III PA T4-7 Gr III	Quadruped: neck ext 3sets 10 reps holding 5sec ea. Blue theraband: Scap retraction/Rhomboid 3x15; Stretching pecs, upper trapezius, SCM and levators. Pulleys: middle and lower trapezius 5# 3x20	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 7	Suboccipital release, Levator scapula insertion, STM Cervical and thoracic paraspinals	AA rot Grade III; C5-6, C6-7 Manipulation Grade III PA T4-7 Gr III	Blue theraband: Scap retraction/Rhomboid 3x15; Stretching pecs, upper trapezius, SCM and levators. Pulleys: middle and lower trapezius 5# 3x20	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 8	Suboccipital release, Levator scapula insertion, STM Cervical and thoracic paraspinals	AA rot Grade III; C5-6, C6-7 Manipulation Grade III Mid TSA thrust	Blue theraband: Scap retraction/Rhomboid 3x15; Stretching pecs, Pulleys: middle and lower trapezius 10# 3x20	2 needle insertion: Mastoid insertion and ½ and 1” distal

Citation: Sillevs R and Wyss K. Effectiveness of Dry Needling to the Sternocleidomastoid Muscle, Manual Therapy, and Exercise to Reduce Pain and Improve Function in Subjects with Chronic Cervicogenic Headaches: A Retrospective Case Series. Ann Case Report 14: 423. DOI: 10.29011/2574-7754.100423

Visit 9	Suboccipital release, Levator scapula insertion and upper trapezius, STM Cervical and thoracic paraspinals	AA rot Grade III; C6-7 Manipulation Grade III Mid TSA thrust	Blue theraband: Scap retraction/ Rhomboid 3x17; Stretching pecs, Pulleys: middle and lower trapezius 10# 3x20 DNF supine, head unsupported	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 10	Suboccipital release, Levator scapula insertion and upper trapezius, STM Cervical and thoracic paraspinals	AA rot Grade III; C6-7 Manipulation Grade III Mid TSA thrust	Blue theraband: Scap retraction/ Rhomboid 3x20; Stretching pecs, Pulleys: middle and lower trapezius 10# 3x20 Wall plank	2 needle insertion: Mastoid insertion and ½ and 1” distal
Subject 2 visits	STM/Stretching	Manipulation	Augmented exercises	Dry Needling SCM
Visit 1	-Suboccipital Release, Upper Trapezius. -Stretching R Upper Trapezius and SCM. -R scapular release -CSA paraspinal STM	OA distraction, Manipulation Grade III: C5-6,	-Supine chin tuck 20 reps -Supine pectoralis stretch -Seated TSA ex over roll, 10x -Red TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral 3x15	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 2	-Suboccipital Release, Upper Trapezius. -Stretching R Upper Trapezius and SCM. -R scapular release	OA distraction, Manipulation Grade III: C5-6, 1 st rib spring L	-SCM and Upper Trapezius stretch -Supine pectoralis stretch -Seated TSA ex over roll with DNF control, 10x -Red TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral 3x15	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 3	-Suboccipital Release, Upper Trapezius. -Stretching R Upper Trapezius and SCM.	OA distraction, Manipulation Grade III: C5-6, PA manipulations mid TSA Scapular inferior and lateral glide	-SCM and Upper Trapezius stretch -Supine pectoralis stretch -Seated TSA ex over roll with DNF control, 10x -Red TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral 3x17	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 4	-Suboccipital Release, Upper Trapezius and Levator release. -Stretching R Upper Trapezius, Levator and SCM.	OA distraction, Manipulation Grade III: C5-6, PA manipulations mid TSA Scapular inferior and lateral glide	-SCM and Upper Trapezius stretch -Doorway pectoralis stretch -Supine TSA ex over roll with DNF control, 10x -Red TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral 3x20	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 5	-Suboccipital Release, Upper Trapezius and Levator release. -Stretching R Upper Trapezius, Levator and SCM.	OA distraction, Manipulation Grade III: C5-6, PA manipulations mid TSA Scapular inferior and lateral glide	-SCM, levator, and Upper Trapezius stretch -Doorway pectoralis stretch -Supine TSA ex over roll with DNF control, 10x -Green TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral, scapular depression 3x12	2 needle insertion: Mastoid insertion and ½ and 1” distal

Visit 6	-Suboccipital Release, -Stretching R Upper Trapezius, Levator and SCM.	OA distraction, Manipulation Grade III: C5-6, PA manipulations mid TSA	-SCM, levator, and Upper Trapezius stretch -Doorway pectoralis stretch -Supine TSA ex over roll with DNF control, 10x with 5s.hold -Green TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral, scapular depression 3x15 -wall plank with scapular retraction and CSA control 5x10sec hold	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 7	Suboccipital Release, -Stretching R Upper Trapezius, Levator and SCM. -CSA PS STM	OA distraction, Manipulation Grade III: C5-6, C6-7 PA manipulations mid TSA	-SCM, levator, and Upper Trapezius stretch -Doorway pectoralis stretch -Supine TSA ex over roll with DNF control, 10x with 5s.hold -Green TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral, scapular depression 3x20 -wall plank with scapular retraction and CSA control 5x15sec hold	2 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 8	Suboccipital Release, -Stretching R Upper Trapezius, Levator and SCM. -CSA PS STM	OA distraction, Manipulation Grade III: C5-6, C6-7 PA manipulations mid TSA	-Doorway pectoralis stretch -Supine TSA ex over roll with DNF control, 10x with 5s.hold -Green TB: Shoulder flexion unilat, Hor Abd alt, ER bilateral, scapular depression 3x20 -Prone: UT, MT, LT 3# 3x20	2 needle insertion: Mastoid insertion and ½ and 1” distal
Subject 3 visits	STM/Stretching	Manipulation	Augmented exercises	Dry Needling SCM
Visit 1	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid	-Suboccipital distraction -OA/AA Gr II	-Upper Cervical Flexion stretch -UT stretch Red TB: alt hor abd-alt FF-alt ER/ retraction 3x10	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 2	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II	-Upper Cervical Flexion stretch -UT stretch Red TB: alt hor abd-alt FF-alt ER/ retraction 3x10reps	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 3	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -Scapular glides	-Upper Cervical Flexion stretch -UT stretch, levator stretch Red TB: alt hor abd-alt FF-alt ER/ retraction 3x15reps	3 needle insertion: Mastoid insertion and ½ and 1” distal

Visit 4	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -Scapular glides	-Upper Cervical Flexion stretch -UT stretch, levator stretch Green TB: alt hor abd-alt FF-alt ER/ retraction 3x10 Pulleys: Ext 90-0 deg and Add 90-0 deg: 10# 3x10reps Postural instructions	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 5	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -Scapular glides	-Upper Cervical Flexion stretch -UT stretch, levator stretch Green TB: alt hor abd-alt FF-alt ER/ retraction 3x12 Pulleys: Ext 90-0 deg and Add 90-0 deg: 10# 3x15reps Postural instructions	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 6	Suboccipital release, STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -Scapular glides	-Upper Cervical Flexion stretch -UT stretch, levator stretch Green TB: alt hor abd-alt FF-alt ER/ retraction 3x12 Pulleys: Ext 90-0 deg and Add 90-0 deg: 10# 3x15reps Postural instructions	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 7	STM UT and bilateral CSA paraspinals STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -C5-6, C6-7 Gr II -Scapular glides	-Upper Cervical Flexion stretch -UT stretch, levator stretch Green TB: alt hor abd-alt FF-alt ER/ retraction 3x15 Pulleys: Ext 90-0 deg and Add 90-0 deg: 10# 3x20reps Postural instructions	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 8	STM UT and bilateral CSA paraspinals, medial border scapulae STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -C5-6, C6-7 Gr II -Scapular glides	DNF 10x10sec supine Stretch SCM, Pecs Prone: 2# Middle, Lower and Upper trap: 3x10 reps	3 needle insertion: Mastoid insertion and ½ and 1” distal
Visit 9	STM UT and bilateral CSA paraspinals, medial border scapulae STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -C5-6, C6-7 Gr II -Scapular glides	DNF 10x10sec supine Stretch SCM, Pecs Prone: 2# Middle, Lower and Upper trap: 3x10 reps Lumbar stabilization combined with cervical stabilization in standing	2 needle insertion: Mastoid insertion and 1” distal
Visit 10	STM UT and bilateral CSA paraspinals, medial border scapulae STM L SCM/ mastoid, masseter, scalenii	-Suboccipital distraction -OA/AA Gr II -C5-6, C6-7 Gr II -Scapular glides	DNF 10x15sec supine Stretch SCM, Pecs Prone: 3# Middle, Lower and Upper trap: 3x10 reps Lumbar stabilization combined with cervical stabilization in standing	2 needle insertion: Mastoid insertion and 1” distal

Table 2: Treatment intervention per visit.

Trigger points have been identified in those with CGH in the upper trapezius, SCM, erector spinae, and suboccipital muscles [21,67]. Trigger points of the SCM can produce a unilateral referred pain over the forehead and around the ipsilateral eye and ear as seen in CGH [22]. Dry needling is a physical therapy intervention in which a thin needle is directly placed into a trigger point to elicit a twitch response. It has been shown that this has positive effects including; reductions in local and central pain, biomechanical changes, vascular effects, and local twitch responses changing active trigger point activity [24,28-31]. Centrally, this could be explained by the fact that needling activates the descending control mechanisms [27,32]. This concurs with the fact that dry needling results in an immediate increase in pain threshold, increased joint mobility, and a reduction of muscle tone [24]. The clinician used the same dry needling protocol for each subject. Subjects were placed in the supine position with a roll under the knees to decrease neural tension and a low pillow under the head. Trigger points were identified through direct muscle palpation. After this the trigger points were located by palpation. Seirin J, no 2 needles 0.12 mm thick and 15mm long were inserted into the trigger points. A clean needling technique was used by the physical therapist. Before needle insertion the skin was cleaned using an 70% isopropyl alcohol swipe. The needles were inserted with the dominant hand of the clinician (Figure 1). The needles were left in situ this for 10 min. After this the needles were removed. It has been demonstrated recently that leaving the needles in situ for longer time is beneficial [23] (Figures 2 and 3).



Figure 1: Inserting needle in SCM-figure shows the needle being inserted.

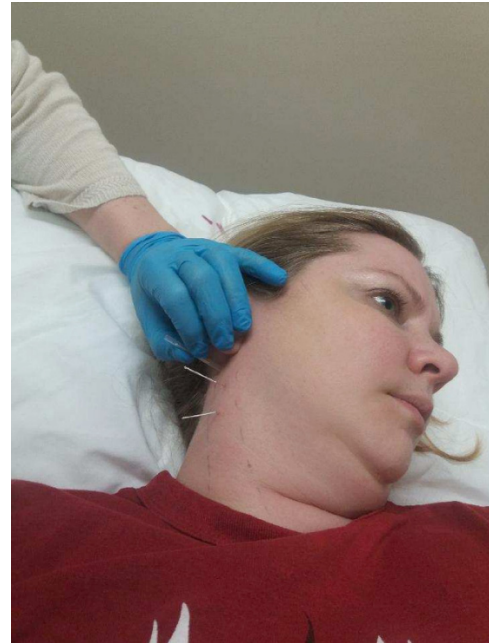


Figure 2: Needle placement in trigger point-figure shows the needles placed in trigger points and left *in situ*.



Figure 3: Needles in SCM- Figure shows close up on three needles in situ in the SCM with local sympathetic response.

Based on the clinical interventions all subjects underwent an augmented exercise to carry over the treatment effect (Table 2). The exercises generally focused on elongation of the suboccipital, upper trapezius, pectoralis, and SCM muscles. Strengthening of the deep neck flexors, thoracic extension and shoulder retractors. A home exercise program was established for each subject consisted of the augmented exercises performed in the clinic (Table 2). In general, the subjects were instructed to complete their home exercise programs 3x a day. Subjects were discharged from physical therapy when a plateau in improvement and reduction in headaches was achieved. They were advised to continue with their home exercise programs.

Outcomes

The changes in outcome measures for each subject are outlined in table 3. The benefit of dry needling of the SCM was measured by pain reduction, reduction in self-perceived disability level, through self-report on overall improvement, and subject feedback on the needling. At baseline, at three weeks, and at 6 weeks’ pain and disability were assessed by using the VAS, NDI, and the HDI. Each subject improved on these measures. Over the course of treatment Subject 1 reported a decrease in pain on the VAS by 34 mm, subject 2 reported a decrease of 15mm, and subject 3 a reduction of 30mm. These reported changes are above the meaningful clinical important difference (MCID) for the VAS which is a change of 10 mm or greater [37,68,69]. Over the course of treatment Subject 1 reported a decrease in headache related disability on the HDI by 6 points, subject 2 reported a decrease of 26 points, and subject 3 a reduction of 8 points. Subject 1 reported a decrease in neck pain related disability on the NDI by 24 points, subject 2 reported a decrease of 10 points, and subject 3 a reduction of 8 points. A change score on the NDI of more than 5 points has been found clinically important. All three subjects met the MCID for both the NDI and the HDI. All 3 subjects reported feeling better, have less headaches, and reported that treatment intervention was beneficial.

3			
Initial visit	26	44	40
Week 3	26	42	52
Week 6	18	32	10

Table 3: Outcome measures NDI, HDI, VAS at initial visit, week 2,3.

The changes in range of motion of the neck are outlined in table 1. The challenge interpreting range of motion and motion change is that it cannot be determined where the motion takes place and or if there are restricted segments or a change segmental motion. The only segment specific test used in this study was the neck flexion rotation test. This tests specifically measures movement in the atlantoaxial (AA) joint. Evaluating changes in AA mobility over the course of treatment could be indicative of changes in headache intensity/ experience. Subject 1 improved in right rotation by 46% and left rotation by 32%. Subject 2 improved did not improve in right rotation (which was considered normal at initial assessment) but improved in left rotation by 18%. Subject improved in right rotation by 35% and in left rotation by 22%.

Discussion

The clinical results in all three subjects suggest direct benefit from the interventions. The self-reported outcome measures show that all three subjects improved in pain and disability. The subjects reported that there was a decreased headache intensity and that the headache interfered less with their daily functioning. It has been demonstrated that subject with CGH benefit from manual therapy. There is little conclusive evidence that dry needling of the SCM has additional benefits. The subjects in this case series reported that the dry needling was perceived as beneficial. The SCM has been identified as a potential source of headaches. Based on fact that the SCM is located on the front of the neck it is often overlooked within the management of subjects with CGH. Additionally, patients with CGH typically report pain being located in the posterior neck region, especially in the sub occipital area. Active trigger points in the SCM can refer pain to the head and face region [22]. This makes the SCM a relevant muscle within the management approach of subjects with CGH. It appears that CGH is the direct result of dysfunction in the upper cervical spine [19]. All subjects reported the presence of chronic headaches. This could indicate that all subjects had a state of both peripheral and central sensitizations. Dry needling of trigger points with a thin needle results in intra-muscular stimulation due to direct mechanical disruption of tissue fibers [23]. It has been proposed that this tissues disruption will lead to a cascade of events in order to restore local homeostasis [25]. This could result in a reduction of nociceptive information reaching the spinal cord. When there

Subject	NDI	HDI	VAS
1			
Initial visit	28	24	47
Week 3	24	24	50
Week 6	4	16	13
2			
Initial visit	30	52	65
Week 3	18	30	50
Week 6	20	26	40

is a reduction or elimination of nociceptive activity reaching the spinal cord the level of sensitization can reduce. It seems plausible that this occurred in our subjects as they reported a reduction of pain and headache symptoms. Although the true mechanism by which dry needling effects the human body remains elusive it has been demonstrated that dry needling away from the local pain source can result in an overall decrease in pain [26,70,71]. This is supported by the fact that all three subjects reported that dry needling of the SCM was beneficial. Although we limited needling in our subjects to the SCM there have been reports that needling of other muscles when managing subjects with neck pain [72]. Future studies should further explore this.

During each treatment session the test-retest principle was used. After each intervention the subject was less reactive and reported improvement. The treatment sequence that was used could have impacted the outcomes. The treating clinician opted to treat the soft tissues first with myofascial techniques followed by the joint manipulation approaches. Joint manipulation of various grades was used in all three subjects and this was based on the identification of joint hypomobility. If no hypomobility was present, no manipulation was used. This is consistent with current clinical practice guidelines [62]. After joint techniques the subjects underwent the augmented exercise program, followed by the dry needling. This treatment sequence was preferred by the clinician to make sure that there enough time to leave the needles in situ and prevent and possible tissue irritation/ complication by exercising structures that were just needled. Future research should evaluate and determine the impact of treatment sequence on patient perceived outcomes.

This case series reports the positive benefits of the combination of traditional manual therapy and augmented exercise with dry needling of the sternocleidomastoid muscle in subjects with CGH. The sample size was small which limits the conclusions that can be drawn and no causality between intervention and outcome can be established with certainty. All three subjects in this study were typical subjects seen with cervicogenic headache in everyday practice. Considering the fact that the subjects received an augmented exercise program that was also performed as a HEP it is possible that this contributed to the positive outcomes in this case series. Future research is necessary to identify the direct benefit using dry needling of the SCM within the management of CGH.

Conclusion

This retrospective case series describes the benefit of combining the use of traditional manual therapy intervention, an augmented exercise program, and dry needling of the sternocleidomastoid muscle in subjects with cervicogenic headaches. This benefit was reflected in a positive change in

the VAS, HDI, and NDI in all subjects. All subjects displayed improved range of motion of the neck and the upper cervical spine. Dry needling was tolerated well by the subjects, they reported it contributed significantly to improvements in pain and function, without significant adverse effects. The addition of dry needling to treatment when managing subjects with CGH appears beneficial. Future higher-level research is needed to fully explore this relationship.

References

1. Law EF, Palermo TM, Zhou C, Groenewald CB (2019) Economic Impact of Headache and Psychiatric Comorbidities on Healthcare Expenditures Among Children in the United States: A Retrospective Cross-Sectional Study. *Headache* 59: 1504-15.
2. Katsuura Y, Bruce J, Taylor S, Gullota L, Kim HJ (2020) Overlapping, Masquerading, and Causative Cervical Spine and Shoulder Pathology: A Systematic Review. *Global Spine J* 10: 195-208.
3. J Olesen, T J Steiner (2004) The International Classification of Headache Disorders: 2nd edition. *Cephalalgia* 24: 9-160.
4. Nilsson N (1995) The prevalence of cervicogenic headache in a random population sample of 20-59 year olds *Spine* 20: 1884-8.
5. Sjaastad O, Bakketeig L (2008) Tension-type headache: Comparison with migraine without aura and cervicogenic headache. The Vaga study of headache epidemiology. *Functional Neurology* 23: 71-6.
6. Sjaastad O, Bakketeig L (2008) Prevalence of cervicogenic headache: VAGA study of headache epidemiology. *Acta Neurol Scand* 117: 173-80.
7. Haldeman S, Dagenais S (2001) Cervicogenic headaches: a critical review. *The Spine Journal* 1: 31-46.
8. April C, Axinn M, Bogduk N (2002) Occipital headaches stemming from the lateral atlanto-axial (C1-2) joint. *Cephalalgia* 22: 15-22.
9. Moore CS, Sibbritt DW, Adams J (2017) A critical review of manual therapy use for headache disorders: prevalence, profiles, motivations, communication and self-reported effectiveness. *BMC Neurol* 17: 61.
10. Mingels S, Dankaerts W, Granitzer M (2019) Is There Support for the Paradigm 'Spinal Posture as a Trigger for Episodic Headache'? A Comprehensive Review. *Curr Pain Headache Rep* 23: 17.
11. Roijezon U, Clark NC, Treleaven J (2015) Proprioception in musculoskeletal rehabilitation. Part 1: Basic science and principles of assessment and clinical interventions. *Man Ther* 20: 368-77.
12. Scali F, Marsili ES, Pontell ME (2011) Anatomical connection between the rectus capitis posterior major and the dura mater. *Spine (Phila Pa 1976)* 36: E1612-4.
13. Pontell ME, Scali F, Marshall E, Enix D (2013) The obliquus capitis inferior myodural bridge. *Clin Anat* 26: 450-4.
14. Szikszay TM, Luedtke K, Harry von P (2018) Increased mechanosensitivity of the greater occipital nerve in subjects with side-dominant head and neck pain - a diagnostic case-control study. *J Man Manip Ther* 26: 237-48.
15. Caamano-Barrios LH, Galan-Del-Rio F, Fernandez-de-Las-Penas C, Cleland JA, Plaza-Manzano G, et al. (2019) Evaluation of neurodynamic responses in women with frequent episodic tension type head-

- ache. *Musculoskelet Sci Pract* 44: 102063.
16. von Piekartz HJ, Schouten S, Aufdemkampe G (2007) Neurodynamic responses in children with migraine or cervicogenic headache versus a control group. A comparative study. *Man Ther* 12: 153-60.
 17. Moore MK (2004) Upper crossed syndrome and its relationship to cervicogenic headache. *J Manipulative Physiol Ther* 27: 414-20.
 18. Biondi DM (2005) Noninvasive treatments for headache. *Expert Rev Neurother* 5: 355-62.
 19. Bogduk N, Govind J (2009) Cervicogenic headache: an assessment of the evidence on clinical diagnosis, invasive tests, and treatment. *Lancet Neurol* 8: 959-68.
 20. Fernandez-de-Las-Penas C, Ge HY, Arendt-Nielsen L, Cuadrado ML, Pareja JA (2007) Referred pain from trapezius muscle trigger points shares similar characteristics with chronic tension type headache. *Eur J Pain* 11: 475-82.
 21. Olivier B, Pramod A, Maleka D (2018) Trigger Point Sensitivity Is a Differentiating Factor between Cervicogenic and Non-Cervicogenic Headaches: A Cross-Sectional, Descriptive Study. *Physiother Can* 70: 323-9.
 22. Missaghi B (2004) Sternocleidomastoid syndrome: a case study. *J Can Chiropr Assoc* 48: 201-5.
 23. Sillevs R, Van Duijn J, Shamus E, Hard M (2019) Time effect for in-situ dry needling on the autonomic nervous system, a pilot study. *Physiother Theory Pract* 1-9.
 24. Liu L, Huang QM, Liu QG, Thitham N, Li LH, Ma YT, et al. (2018) Evidence for Dry Needling in the Management of Myofascial Trigger Points Associated with Low Back Pain: A Systematic Review and Meta-Analysis. *Arch Phys Med Rehabil* 99: 144-52 e2.
 25. Ma Y-T, Ma M, Cho ZH (2005) Biomedical Acupuncture for Pain Management; an integrative approach. Missouri: Elsevier Churchill Livingstone.
 26. Furlan A, van Tulder M, Cherkin D, Tsukayama H, Lao L, Koes B, et al. (2005) Acupuncture and Dry-Needling for Low Back Pain: An Updated Systematic Review Within the Framework of the Cochrane Collaboration. *Spine* 30: 994-63.
 27. Huguenin L, Brukner P, McCrory P, Smith P, Wajswelner H, Bennell K (2005) Effects of dry needling of gluteal muscles on straight leg raise: a randomized, placebo controlled, double blind trial. *Br J Sports Med* 39: 84-90.
 28. Tough EA, White AR, Cummings TM, Richards SH, Campbell JL (2009) Acupuncture and dry needling in the management of myofascial trigger point pain: a systematic review and meta-analysis of randomised controlled trials. *Eur J Pain* 13: 3-10.
 29. Kamali F, Sinaei E, Morovati M (2018) Comparison of Upper Trapezius and Infraspinatus Myofascial Trigger Point Therapy by Dry Needling in Overhead Athletes with Unilateral Shoulder Impingement Syndrome. *J Sport Rehabil* 1-24.
 30. Perreault T, Dunning J, Butts R (2017) The local twitch response during trigger point dry needling: Is it necessary for successful outcomes? *J Bodyw Mov Ther* 21: 940-7.
 31. Nunez-Cortes R, Cruz-Montecinos C, Vasquez-Rosel A, Paredes-Molina O, Cuesta-Vargas A (2017) Dry Needling Combined with Physical Therapy in Patients With Chronic Postsurgical Pain Following Total Knee Arthroplasty: A Case Series. *J Orthop Sports Phys Ther* 47: 209-16.
 32. Irrnich D, Behrens N, Gleditsch J, Stor W, Schreiber M, Schops P, et al. (2002) Immediate effects of dry needling and acupuncture at distant points in chronic neck pain: results of a randomized, double-blind, sham-controlled crossover trial. *Pain* 99: 83-9.
 33. Gattie ER, Cleland JA, Snodgrass SJ (2017) Dry Needling for Patients with Neck Pain: Protocol of a Randomized Clinical Trial. *JMIR Res Protoc* 6: e227.
 34. Gerber LH, Sikdar S, Aredo JV, Armstrong K, Rosenberger WF, Shao H, et al. (2017) Beneficial Effects of Dry Needling for Treatment of Chronic Myofascial Pain Persist for 6 Weeks After Treatment Completion. *PM R* 9: 105-12.
 35. Ga H, Choi J, Park C, Yoon H (2007) Dry Needling of Trigger Points with and Without Paraspinal Needling in Myofascial Pain Syndromes in Elderly Patients. *J Alt Complem Med* 13: 617-24.
 36. Headache Classification Subcommittee of the International Headache S. *The International Classification of Headache Disorders: 2nd edition.* *Cephalalgia* 24: 9-160.
 37. Gallagher E, Liebman M, Bijur P (2001) Propective Validation of Clinically Important Changes in Pain Severity Measured on a Visual Analogue Scale. *Annals of Emergency Medicine* 38: 633-8.
 38. Vernon H, Mior S (1991) The Neck Disability Index: a study of reliability and validity. *Journal of Manipulative and Physiological Therapeutics* 14: 409-15.
 39. Childs J, Cleland J, Elliot J, Teyhen D, Wainner R, Whiteman J, et al. (2008) Neck Pain: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *Journal of Orthopaedic & Sports Physical Therapy* 38: A1-A34.
 40. Cleland JA, Childs JD, McRae M, Palmer JA, Stowell T (2005) Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. *Man Ther* 10: 127-35.
 41. Tseng Y, Wang W, Chen W, Hou T, Chen T, Lieu F (2006) Predictors for immediate responders to cervical manipulation in patients with neck pain. *Manual Therapy* 11: 306-15.
 42. Riddle D, Stratford P (1998) Use of generic versus region-specific functional status measures on patients with cervical spine disorders. *Physical Therapy* 78: 951-63.
 43. Cleland J, Fritz J, Whitman J, Palmer J (2006) The Reliability and Construct Validity of the Neck Disability Index and Patient Specific Functional Scale in Patients with Cervical Radiculopathy. *Spine* 31: 598-602.
 44. Hoving J, O'Leary E, Niere K, Green S, Buchbinder R (2003) Validity of the neck disability index, Northwick Park neck pain questionnaire, and problem elicitation technique for measuring disability associated with whiplas-associated disorders. *Pain* 102: 273-81.
 45. Jacobson GP, Ramadan NM, Norris L, Newman CW (1995) Headache disability inventory (HDI): short-term test-retest reliability and spouse perceptions. *Headache* 35: 534-9.
 46. Farooq MN, Mohseni Bandpei MA, Ali M, Khan GA (2016) Reliability of the universal goniometer for assessing active cervical range of motion in asymptomatic healthy persons. *Pak J Med Sci* 32: 457-61.
 47. Piva SR, Erhard RE, Childs JD, Browder DA (2006) Inter-tester reli-

- ability of passive intervertebral and active movements of the cervical spine. *Man Ther* 11: 321-30.
48. Hall TM, Robinson KW, Fujinawa O, Akasaka K, Pyne EA (2008) Inter-tester reliability and diagnostic validity of the cervical flexion-rotation test. *J Manipulative Physiol Ther* 31: 293-300.
49. Ogince M, Hall T, Robinson K, Blackmore AM (2007) The diagnostic validity of the cervical flexion-rotation test in C1/2-related cervicogenic headache. *Man Ther* 12: 256-62.
50. Swanson BT, Craven AB, Jordan J, Martin R (2019) Comparison of range of motion during the cervical flexion rotation versus the side-bending rotation test in individuals with and without hyperlaxity. *J Man Manip Ther* 27: 24-32.
51. Seffinger M, Najm W, Mishra S, Adams A, Dickerson V, Murphy L, et al. (2004) Reliability of Spinal Palpation for Diagnosis of Back and Neck Pain: A Systematic Review of the Literature. *Spine* 29: E413-E25.
52. Humphreys B, Delahaye M, Peterson C (2004) An investigation into the validity of cervical spine motion palpation using subjects with congenital block vertebrae as a 'gold standard' *BMC Musculoskeletal Disorders* 5: 19.
53. Degenhardt B, Snider K, Snider E, Johnson J (2005) Interobserver Reliability of Osteopathic Palpatory Diagnostic Tests of the Lumbar Spine: Improvements from Consensus Training. *JAOA* 105: 465-73.
54. Christensen H, Vach W, Vach K, Manniche C, Haghfelt T, Hartvigsen L, et al. (2002) Palpation of the Upper Thoracic Spine: An Observer Reliability Study. *Journal of Manipulative and Physiological Therapeutics* 25: 285-92.
55. van Trijffel E, Lindeboom R, Bossuyt PM, Schmitt MA, Lucas C, Koes BW, et al. (2014) Indicating spinal joint mobilisations or manipulations in patients with neck or low-back pain: protocol of an inter-examiner reliability study among manual therapists. *Chiropr Man Therap* 22: 22.
56. Paris S, editor S1 course notes 2000; Chicago: Institute of Physical Therapy.
57. Wainner RS, Fritz JM, Irrgang JJ, Boninger ML, Delitto A, Allison S (2003) Reliability and diagnostic accuracy of the clinical examination and patient self-report measures for cervical radiculopathy. *Spine (Phila Pa 1976)* 28: 52-62.
58. Mintken PE, Metrick L, Flynn TW (2008) Upper cervical ligament testing in a patient with os odontoideum presenting with headaches. *J Orthop Sports Phys Ther* 38: 465-75.
59. Edmondston SJ, Wallumrod ME, Macleod F, Kvamme LS, Joebges S, Brabham GC (2008) Reliability of isometric muscle endurance tests in subjects with postural neck pain. *J Manipulative Physiol Ther* 31: 348-54.
60. Jarman NF, Brooks T, James CR, Hooper T, Wilhelm M, Brismee JM, et al. (2017) Deep Neck Flexor Endurance in the Adolescent and Young Adult: Normative Data and Associated Attributes. *PM R* 9: 969-75.
61. Gross A, Miller J, D'Sylva J, Burnie SJ, Goldsmith CH, Graham N, et al. (2010) Manipulation or mobilisation for neck pain: a Cochrane Review. *Man Ther* 15: 315-33.
62. Blanpied PR, Gross AR, Elliott JM, Devaney LL, Clewley D, Walton DM, et al. (2017) Neck Pain: Revision 2017. *J Orthop Sports Phys Ther* 47: A1-A83.
63. Rodriguez-Huguet M, Gil-Salu JL, Rodriguez-Huguet P, Cabrera-Afonso JR, Lomas-Vega R (2018) Effects of Myofascial Release on Pressure Pain Thresholds in Patients with Neck Pain: A Single-Blind Randomized Controlled Trial. *Am J Phys Med Rehabil* 97: 16-22.
64. Kim SJ, Lee JH (2018) Effects of sternocleidomastoid muscle and suboccipital muscle soft tissue release on muscle hardness and pressure pain of the sternocleidomastoid muscle and upper trapezius muscle in smartphone users with latent trigger points. *Medicine* 97: e12133.
65. Kim BB, Lee JH, Jeong HJ, Cynn HS. (2016) Effects of suboccipital release with craniocervical flexion exercise on craniocervical alignment and extrinsic cervical muscle activity in subjects with forward head posture. *J Electromyogr Kinesiol* 30: 31-7.
66. Miller J, Gross A, D'Sylva J, Burnie SJ, Goldsmith CH, Graham N, et al. (2010) Manual therapy and exercise for neck pain: A systematic review. *Man Ther* 15: 334-54.
67. Togha M, Bahrpeyma F, Jafari M, Nasiri A (2019) A sonographic comparison of the effect of dry needling and ischemic compression on the active trigger point of the sternocleidomastoid muscle associated with cervicogenic headache: A randomized trial. *J Back Musculoskeletal Rehabil*.
68. Kelly A (1998) Does the clinically significant difference in visual analog scale pain scores vary with gender, age, or cause of Pain? *Academic Emergency Medicine* 5: 1086-90.
69. Cleland J, Childs J, Whitman J (2008) Psychometric Properties of the Neck Disability Index and Numeric Pain Rating Scale in Patients with Mechanical Neck Pain. *Arch Phys Med Rehabil* 89: 69-74.
70. Venancio R, Alencar FA, Zamperini C (2008) Different Substances and Dr-Needling Injections in Patients with Myofascial Pain and Headaches. *The Journal of Craniomandibular Parctice* 26: 96-103.
71. Anandkumar SMS PBCOCCD, Manivasagam MBDCFDC (2017) Effect of fascia dry needling on non-specific thoracic pain - A proposed dry needling grading system. *Physiother Theory Pract* 33: 420-8.
72. Hsieh Y, Kao M, Kuan T, Chen S, Chen J, Hong C (2007) Dry Needling to a Key Myofascial Trigger Point May Reduce the Irritability of Satellite MTrPs. *Am J Phys Med Rehabil* 86: 398-403.