Assessment of Cervical Proprioception in Patients with Cervicogenic Headache: A Cross-sectional Study

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ABSTRACT

Background: Cervicogenic Headache is typically chronic , presented as unilateral cephalgia, and is believed to be acquired by musculoskeletal dysfunction of the neck. Cervical proprioception has a significant job in keeping up ordinary spinal development , stability and maintaining the balance of the body as a whole. **Objective** :The point of this examination was to research the impact of cervicogenic headache on cervical active repositioning accuracy and cervical range of motion. **Materials and Methods:** Fourty subjects of both genders (28 females and 12 males) were selected and allocated into 2 groups ,Cervicogenic Headache (CGH) group comprising of 15 females and 5 males and control group (13 females and 7 males). Their age range was (20-40).Cervical proprioception and range of motion were evaluated by CROM device. Cervical proprioception was surveyed utilizing a head repositioning task: subjects were asked to relocate their heads as accurately as possible to a previously remembered head position following an active movement (flexion, extension and left and right rotations). **Results:** There was a significant effect of Cervicogenic Headache on cervical reposition error in all tested cervical movements and there was statistical significant decrease in ROM values of all tested cervical movements(flexion, extention and right &left rotation).**Conclusion:** There was a connection between CGH and the increase in cervical reposition error and limited ROM contrasted with healthy subjects. These effects ought to be considered in the rehabilitation program of patients with CGH.

Key words: Cervicogenic Headache; cervical proprioception; cervical reposition error; cervical range of motion ; neck musculoskeletal dysfunction .

INTRODUCTION

Cervicogenic headache(CGH) is a sub-group of Secondary headaches may be associated with increasing age1.It may be arising from musculoskeletal dysfunction of the cervical spine, especially the upper three cervical portions or coming about because of a serious underlying disease for example, a brain tumor, aneurysm, infection, substance misuse or withdrawal, or inflammatory disease but may present as referred pain from other regional structures, for example, the teeth, nose, ears, or neck.[2]

The International Classification of Headache Disorders (lCHD); a second edition (lCH D-ll) classified over 300 different types of headaches within two categories: primary headaches and secondary headaches. Primary headaches are the most common headache types and have no other underlying cause. They include: tension-type headache (TTH), cluster headache and additional trigeminal autonomic cephalalgias, and other primary headaches. Secondary headaches are classified according to their causes and are classified in 10 separate categories.[3]

Secondary headaches with a neuromusculoskeletal etiology that are, therefore, potentially amenable to interventions within the physical therapy scope of practice include cervicogenic headache, occipital neuralgia, and headache associated with temporomandibular disorder.[4]

Headache is a common condition influencing 47% of the global population with cervicogenic headache (CGH) representing 15–20% of all chronic and recurrent headaches. CGH influence 2.2–2.5% of the adult population and appear to influence women four times more than men .5 Classification of CGH relies upon a range of subjective features together with proof of impairment of cervical function on physical assessment . This impairment incorporates atlanto-axial motion segment (C1/2 level) dysfunction..6

Cervicogenic headache pain(CGH) has been generally identified with joint, disk, and ligament pain from the upper cervical spine; in any case, clinicians should consider that the upper cervical spine also gets afferent inputs from muscles. The role of referred pain to the head evoked by muscle tissues has received particular interest in the last years .[7]

Dysfunction of the neck and shoulder girdle muscles can be one of the primary etiological factor responsible for CGH. [8]

The International Headache Society (IHS) described the pain as being unilateral or bilateral, influencing the head or face yet has most regularly symptomatic the occipital region, frontal area , or retro –orbital locale. Also it is characterized by one-sided headache with signs and symptoms of neck association, such as, pain by movement, by external pressure over the upper cervical, and/or sustained awkward headpositions.[9]

The lower cervical spine may play an indirect role in pain creation if dysfunctional, however there is no proof of a direct referral pattern. Through controlled nerve obsttucting of different structures in the cervical spine, it gives the idea that the zygoapophyseal joints,particularly those of C2/C3, are the most common sources of CGH pain. This finding is much increasingly basic in patients with a background marked by whiplash. [10]

Proprioception refers to neural cumulative input to the central nervous System (CNS) proceeding from specific nerve endings called mechanoreceptors11. It is the feeling of realizing where one's body is in space and is traditionally compromised of both static (i.e. joint position sense) and dynamic (i.e. kinesthetic movement sense) components .[12]

Proprioception permits the body to keep stability and orientation during both static and dynamic activities 13. It is a sensory system that regulates muscles action and contributes to muscle reflexes for dynamic joint stability . [14]

Afferent proprioceptive data is important for sensorimotor control of posture and movement [15] and changed proprioceptive function is related with joint illness16 and other musculoskeletal conditions [17].Cervical proprioception is significant for ideal neck performance. Cervical muscles have various associations with vestibular, visual and higher centres and collaborations with these can deliver powerful proprioceptive information[18].

Neck related symptoms are characteristics of cervicogenic headache. Past examinations have displayed that cervical musculoskeletal impairment is an ordinary element of cervicogenic headache.[19,20]

Additionally, a pattern of cervical musculoskeletal impairment inclusive of upper cervical joint dysfunction joined with restricted cervical movement and impairment in muscle function can recognize cervicogenic headache from other forms of headache .[20]

Cervicogenic headache starts in the upper cervical spine, the upper cervical spine has greater amount of proprioceptive receptors than the caudal zone of the spine [21,22.]

People with neck pain are known to have greater errors in positioning the head in neutral following voluntary movement.[23,17] Alterations in proprioception are thought to reflect abnormal spindle afferent discharge either due to activation of chemo- or nociceptive sensory afferents24,25. direct trauma to cervical structures or increased sympathetic drive resulting in a conflict of inputs from visual, vestibular, and somatosensory sources.

Thus. it may be expected that people with cervicogenic headache (CGH) also display deficits in proprioception.[26.]

Willem De Hertogh et al. have explored cervical kinaesthesia in patients with cervicogenic headache (CGH) and asymptomatic controls, No critical contrasts were found between the two groups.The authors, however, studied a very smale sample(10 CEH patients and 23 asymptomatic controls) and Subjects, were asked to relocate their heads to the NHP.[27]

Chen et al . . have examined cervical kinaesthesia in patients with unilateral cervicogenic headache (CEH) and asymptomatic controls , significant differences were found between the two groups.The authors, however, studied a very smale sample(13 CEH patients and 14 asymptomatic controls) and the authors used cervical rotation only as ameasurement of cervical kinaesthesia.[28]

Uptill now there were few studies investigate the central effects of the cervicogenic headache syndrome itself on cervical proprioception.

Previous physical therapy treatments were used When managing patients with headaches associated with neck pain include: low-load endurance craniocervical and cervicoscapular exercises, multimodal care (spinal mobilization, craniocervical exercise and postural correction) and manipulation to the cervical and thoracic spine. 29 but these treatments not included proprioceptive training exersises as a main part of rehabilitation intervention.

Therefore, this study may provide the physical therapists with the base line in rehabilitation intervention of cervical disorders - by including the proprioceptive training exersises as a main part of rehabilitation intervention of cervicogenic headache patients- through investigating the effect of CGH on cervical proprioception.

MATERIALS AND METHODS

This study was conducted at the Faculty of Physical Therapy, Cairo University and the out patient clinic of kasr Elainy to investigate the effect of cervicogenic headache on cervical proprioception and ROM .

Design of the study:The study design was an observational cross-sectional one.

Participants: The study was conducted in the period from April 2019 till January 2020 on twenty patients (15 females and 5 males) with cervicogenic headache and chronic neck pain, and Twenty normal subjects(13 females and 7 males) their age range (20-40)and with body mass index less than 30 kg/m2.

The patients were diagnosed, and referred from a neurologist. Patients were recruited from the out patient clinic of kasr Elainy and external clinic of faculty of physical therapy cairo university .The diagnosis was confirmed by International Headache Society classification (HIS) classification of CGH and Cranio cervical flexion rotation test. The patients participated in this study after signing an istitutionally approved informed consent form prior participating in the study and the experimental research was approved by the ethics committee of the Faculty of Physical Therapy, Cairo University with approval number (P.T.REC/012/002380).

All participants with cervicogenic headache were diagnosed by an experienced neurologist according to the current diagnostic criteria for cervicogenic headache **(Headache Classification Committee of the International Headache, 2013)**30

International Headache Society classification of CGH

1. Pain, referred from a source in the neck and perceived in one or more regions of the head and/or face, fulfilling criteria 3 and 4

2. Clinical, laboratory, and/or imaging evidence of a disorder or lesion within the cervical spine or soft tissues of the neck known to be or generally accepted as a valid cause of headaches

3. Evidence that the pain can be attributed to the neck disorder or lesion based on at least one of the following: a. Demonstration of clinical signs that implicate a source of pain in the neck b. Abolition of the headache following diagnostic blockade of a cervical structure or its nerve supply using placebo or other adequate controls

4. . Pain resolves within 3 months after successful treatment of the causative disorder or lesion

Inclusive criteria : Patients were included in the study if they have one-sided pain beginning in the neck and transmitting to the frontotemporal region, pain irritated by neck movement, limited cervical range of motion, joint tenderness in at least one of the joints of the upper cervical spine (C1-C3), neck pain and headache history of at least 3 months and frequency of headache at least twice per month and Poor sitting stance or forward head as one common reason for this kind of headache.

Exclusive criteria : past history of injury and medical procedure of head and neck , musculoskeletal problems/disorders (e.g. cervical radiculopathy, myopathy, advanced osteoporosis, head/neck trauma), neurological problems/diseases (e.g. Parkinson's disease, stroke)**,**Tumours , cracks , infections and rheumatoid arthritis of upper cervical spine, or progressed cervical spine degenerative ailment .

Measurement procedures:

Neck disability index (NDI):It is a survey with 10 things including pain, personal care, lifting, reading, headaches, concentration, work, driving, sleeping and recreation The NDI can be scored as a raw score or multiplied and communicated as a percent. Each area is scored on a 0 to 5 rating scale, in which zero means 'No pain' and 5 means 'Worst believable pain'. All the points can be added to a total score. The test can be interpretated as a crude score, with a greatest score of 50, or as a rate . 0 points or 0% means : no activity limitations , 50 points or 100% means complete activity limitation. A higher score demonstrates more patient-rated disability.

CROM device:It is a kind of goniometer designed especially to measure ROM for the cervical spine.

The CROM device has been assessed regularly, with number of studies evaluating its reliability on healthy volunteers or symptomatic sufferers .31,32,33

The CROM has three inclinometers, one to measure in every plane, and is strapped to the head. One gravity dial meter measures flexion and extension, another gravity dial meter measures lateral flexion and a compass meter measures rotation with its accuracy reinforced with the aid of two magnets positioned over the subject's shoulders.

Manual testing including Cranio-cervical Flexion-Rotation Test was used to assess dysfunction at the C1-C2 motion segment.

Procedures :The ages of subjects will be recorded and their heights and weights will be measured. Subjects will be given instructions to circle one of the six choices which describes the severity of each item (0–5)) that most closely suited their condition at the present time, at that point marks were counted and partitioned by 50 or 45 chance that one segment was missing with total score ranging from 0 (no pain ordisability) to 50 (severe pain and disability).34

Assessment of cervical ROM using Cervical range of motion device

Each subject sit down in a straight back, wood-outline seat with upright posture, low and mid back areas contacting the backrest, feet level on the floor, and upper extremities placed at the sides with the shoulders relaxed. Every subject then

Performed 2 repetitions of each motion through a comfortable yet complete AROM to guarantee subject familiarity.

The analyzer, without the guide of the CROM, verbally and manually prompted the subject so that, to the best visual estimate of the tester, the subject’s nose, chin, and visual gaze were pointing straight ahead (neutral rotation); and the subject’s ear lobe and the base of the eares were horizontally level (neutral flexion-extension).

Two sets of 4 estimations were performed. For each set, the four cervical motions were estimated once, with no rest time between each cervical motion. A 30-second rest happened between sets 1 and 2,pending which the CROM was removed from the subject and then reapplied.

For every cervical movement, the standard protocol for situation of the subject’s head and neck in the anatomically neutral position was first performed for flexion, and extension the relevant inclinometer was read (starting position), and the value reported to the recorder. At the end of every movement ,the inclinometer was read again (ending position), and the value again reported to the recorder. The recorder calculated the amount of movement (ending position minus starting position) and silently recorded the value. For rotation, the dial of the magnetic inclinometer was manually set to zero prior to the movement, and the end position value directly reflected the amount of motion.

Assessment of cervical proprioception using Cervical range of motion device

Head reposition accuracy tests: neutral head position (NHP) and target head position (THP) tests: The test methods were equivalent to those described by **Lee** et al**., 2006**35. The NHP test used to measure the subject's capacity to actively reposition their head to their self-selected neutral position. The THP test used to measure the individual's ability to actively reposition the head to a previously described target position.

After explaining the testing procedure, the CROM device was fixed on the head of the tested subject. The members were told to sit down upright with their feet level on the floor, their back against the seat backrest and facing straight ahead, this position was set up as their self-selected "NHP".

CROM unit was set over the head and joined posteriorly through the Velcro strap

The magnetic part of the unit was then put squarely above the shoulders

The CROM device was calibrated to an NHP.

In test (THP) test, the subject's head was slowly moved to the predetermined target position, 50% of maximum range of motion. The speed of passive neck motion was very slow as higher speeds related with critical changes in vestibular function according to age 36**.** The head was kept up in the target position for 3 seconds, and the subject was asked to remember that location because he or she would be asked to reproduce this location with eyes blindfolded.

Thereafter, the member came back to neutral position and afterward was given the verbal guidance of repeating the target position as precisely as the person could . When the subjects had arrived at the reference position, the subject's relocation accuracy was estimateded in degrees with CROM device.

The THP repositioning tests were acted in the four directions (flexion, extension, right rotation, left rotation). Three trials were undertaken in each direction of movement and the mean of these trials (mean error) was used for analysis. No feedback about repositioning performance was given during the testing. The entire technique took roughly 15 min for each subject.

Data analysis:.Descriptive statistics and t-test were conducted for comparison of mean age, weight, height and BMI between both groups. Chi-squared ($\chi 2$) test was conducted for comparison of the distribution of sex between both groups .Unpaired t test was conducted for comparison of active repositioning errors and cervical ROM between both groups. Pearson correlation coefficient was conducted to investigate the correlation between active repositioning errors and cervical ROM.

The level of significance for all statistical tests was set at $p < 0.05$.All statistical tests were performed through the statistical package for social studies (SPSS) version 25 for windows. (IBM SPSS, Chicago, IL, USA).

RESULTS

Comparing the general characteristics of the subjects of both groups revealed that there was no significance difference between both groups in the mean age, weight, height, or BMI ($p > 0.05$).(Table 1).There was no significant difference between both groups in sex distribution ($p = 0.49$).

Table 1. Descriptive statistics and t test for the mean age, weight, height, BMI, and sex of the study and control groups.

	Study group	Control group	MD	t- value	p-value	χ^2
	$\bar{X}$ ± SD	$\bar{X}$ ± SD				
Age (years)	28.55 ± 6.72	27.85 ± 4.18	0.7	0.39	0.69	
Weight (kg)	69.95 ± 4.21	68.7 ± 5.3	1.25	0.82	0.41	
Height (cm)	168.2 ± 5.65	167.65 ± 6.84	0.55	0.27	0.78	
BMI (kg/m²)	24.77 ± 1.83	24.47 ± 1.78	0.3	0.51	0.61	
Females	15 (75%)	13 (65%)			0.49	0.47
Males	5 (25%)	7 (35%)				

ð X: Mean, SD: Standard deviation, MD: Mean difference, t-value: Unpaired t-value, p-value: Probability value, χ2: Chi-squared value

Comparison of ROM between the study and control groups:

Flexion ROM

The mean ± SD flexion ROM of the study group was 63 ± 7.32 degrees and that of the control group was 77 ± 6.56 degrees. The mean difference between both groups was -14 degrees. There was a significant decrease in the flexion ROM of the study group compared with that of the control group ($p = 0.0001$). (Table 2).

Extension ROM

The mean ± SD extension ROM of the study group was 54.5 ± 6.04 degrees and that of the control group was 66 ± 5.02 degrees. The mean difference between both groups was -11.5 degrees. There was a significant decrease in the extension ROM of the study group compared with that of the control group (p = 0.0001). (Table 2).

Comparison of right and left rotation ROM between the study and control groups:

Right rotation ROM

The mean ± SD right rotation ROM of the study group was 62 ± 6.15 degrees and that of the control group was 75 ± 6.06 degrees. The mean difference between both groups was -13 degrees. There was a significant decrease in the right rotation ROM of the study group compared with that of the control group (p = 0.0001). (Table 2).

Left rotation ROM

The mean ± SD left rotation ROM of the study group was 60 ± 7.25 degrees and that of the control group was 74 ± 5.98 degrees. The mean difference between both groups was -14 degrees. There was a significant decrease in the left rotation ROM of the study group compared with that of the control group (p = 0.0001). (Table 2).

Table 2. Comparison of flexion, extension, Right rotation and Left rotation ROM between the study and control groups**.**

ROM (degrees)	Study group	Control group	MD	t-value	p-value
	$\bar{X}$ ± SD	$\bar{X}$ ± SD			
Flexion	63 ± 7.32	77 ± 6.56	-14	-6.36	0.0001*
Extension	54.5 ± 6.04	66 ± 5.02	-11.5	-6.54	0.0001*
Right rotation	62 ± 6.15	75 ± 6.06	-13	-6.72	0.0001*
Left rotation	60 ± 7.25	74 ± 5.98	-14	-6.65	0.0001*

ð: Mean, SD: Standard deviation, MD: Mean difference, p-value: Probability value, *Significant

Comparison of active repositioning errors between the study and cont rol groups:

Active repositioning errors in flexio n

The mean ± SD active repositio ning errors in flexion of the study gro up was 4.26 ± 0.67 degrees and that o f the control group was 1.9 ± 0.6 degr ees. The mean difference between bot h groups was 2.36 degrees. There was a significant increase in the active rep ositioning errors in flexion of the stud y group compared with that of the con trol group (p = 0.0001). (Table 3).

Active repositioning errors in exten sion

The mean ± SD active repositio ning errors in extension of the study g roup was 5.24 ± 1.06 degrees and that of the control group was 2.27 ± 0.93 d egrees. The mean difference between both groups was 2.97 degrees. There was a significant increase in the active repositioning errors in extension of th e study group compared with that of t he control group (p = 0.0001). (Table 3).

Active repositioning errors in right rotation

The mean ± SD active repositio ning errors in right rotation of the stud y group was 6.09 ± 1.01 degrees and t hat of the control group was 2.1 ± 0.8 2 degrees. The mean difference betwe en both groups was 4 degrees. There was a significant increase in the active repositioning errors in right rotation o f the study group compared with that of the control group (p = 0.0001). (Ta ble 3).

Active repositioning errors in left ro tation

The mean ± SD active repositio ning errors in left rotation of the study group was 6.5 ± 0.87 degrees and that of the control group was 2.31 ± 0.76 d egrees. The mean difference between both groups was 4.2 degrees. There w as a significant increase in the active r epositioning errors in left rotation of t he study group compared with that of the control group (p = 0.0001). (Table 3).

Table 3. Comparison of active repositioning errors between the study and control groups.

Active repositioning errors (degrees)	Study group	Control group	MD	t- value	p-value
	$\bar{X} \pm$ SD	$\bar{X} \pm$ SD			
Flexion	4.26 ± 0.67	1.9 ± 0.6	2.36	11.61	0.0001 *
Extension	5.24 ± 1.06	2.27 ± 0.93	2.97	9.37	0.0001 *
Right rotation	6.09 ± 1.01	2.1 ± 0.82	4	13.65	0.0001 *
Left rotation	6.5 ± 0.87	2.31 ± 0.76	4.2	16.07	0.0001 *

ð: Mean, SD: Standard deviation, MD: Mean difference, p-value: Probability value, *Significant

DISCUSSION

The aim of the present study was to investigate the effect of cervicogenic headache on cervical proprioception and ROM . patients with CGH confirmed by international headache society (HIS)diagnostic criteria ,NDI, and cranio-cervical flexion rotation test .CROM device will be used to test repositioning accuracy of the cervical spine and ROM for all subjects in the two groups.

The study findings revealed that there was a significant effect of cervicogenic headache on cervical reposition error in the four cervical movements; flexion, extension and right &left rotation and there was statistical significant decrease in ROM values of flexion, extension and right &left rotation in the CGH group compared with the control group.

Firstly; cervical reposition error

This finding might be due to somatosensory impairment which is likely brought about by dysfunction in the upper cervical structures, which are known to have high proportion of proprioceptors giving data that is essential to postural control 37. And cervical repositioning accuracy is a part of postural control. also Proprioception is a component of the somatosensory system [38.]

An increase in cervical repositioning error could be attributed to neck pain which is a feature of cervicogenic headache 19, and it is suggested that People with neck pain are known to have greater errors in positioning the head in neutral following voluntary movement 17,23 . changes in proprioception are thought to reflect abnormal spindle afferent discharge either because of activation of chemo- or nociceptive Sensory afferents [24,25.]

Thus. it may be expected that people with cervicogenic headache (CGH) also display deficits in proprioception[.26.]

Moreover, it is known that integration of sensory input from visual , vestibular, somatosensory, and cervical receptors is significant for keeping up postural stability 39 , And neck pain and hypersensitivity are features of cervicogenic headache 19. in patients with neck pain, proof recommends that altered cervical afferent input because of changed or upset sensitivity of cervical mechanoreceptor and muscle spindle activity can influence postural stability and pose challenges to the postural control system [37,40.]

likewise altered cervical afferent input and a mismatch between convergence of sensory inputs from altered cervical proprioceptors and normal sensory input from other subsystems (ie , visual and vestibular systems) can lead to altered postural stability [41.]

Moreover, the increase in cervical repositioning error in the CGH group might be ascribed to impairment in muscle function as it is suggested that cervicogenic headache sufferers show deficits in the strength of their cervical flexor and extensor muscles 42,19and Electromyographic (EMG) studies have demonstrated an altered motor strategy when patients with cervicogenic headache perform the clinical test of craniocervical flexion 19,20. And Cervical muscles have numerous connections with vestibular, visual and higher centres and interactions with these can create effective proprioceptive input [18]

So, impairment in muscle function in cervicogenic headache sufferers may affect cervical proprioception.

The current study is in agreement with the findings of Chen et al, 201828 who reported that there was asymmetrical cervical proprioception in patients with unilateral cervicogenic headache when comparing the head repositioning accuracy between the painful and the non- painful sides and with the asymptomatic participants.

Nonetheless, the present work is in conflict with that of Willem De Hertogh et al.200727who presumed that cervical proprioception is not hindered in non-traumatic CEH and the utilization of kinaesthetic evaluation and treatment in this patient group seems to be limited.

Secondly;ROM

There was decrease in ROM in the study group than control group as Rectus capitis posterior(RCP) muscles work, without pathology, to contribute essentially to maintenance of a normal, neutral head posture as well as keeping up stability of the head during the performance of daily activities that need extension, rotation, and side bending of the head. 43

The results of the present study agree with **Knackstedt etal.,2010**, 44who have revealed significant decreases in active ROM in those with CGH as The cervical ROM tested was significantly reduced in 16 persons, while four persons had a normal ROM.

The results of the current study reject with **Hall and Robinson,2004 ,**6who have discovered no huge contrasts in AROM when appeared differently in relation to asymptomatic subjects. These findings also indicate that subclassifying CGHs into traumatic versus atraumatic origin might be significant, since headache and neck ROM are inversely related in patients who have sustained a whiplash injury. 45

The difference in extension AROM between CGH patients and normal subjects was less than flexion and rotation AROM this may be due to forward head posture was more typical in CGH patients than different patients, which was additionally connected with weakness and diminished endurance of the deep neck flexors and tightness of suboccipital muscles and upper trapezius which assumed to make flexion more limited compared to extension 46. Also suboccipital muscles can be classified functionally as extensor muscles. Bilateral contraction of Rectus capitis posterior minor (RCPm) muscles is purported to lead to extension of the headsegment.47

The principle limitation of this study was that the nature of past treatment for CGH patients was not recorded.

CONCLUSION

The CGH may be related with cervical proprioception deficiency and limited cervical ROM. According to the present study finding, neck proprioception and flexibility exersises ought to be considered in rehabilitation program of CGH. Further examinations ought to be directed in various age groups and take the age as afactor.

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