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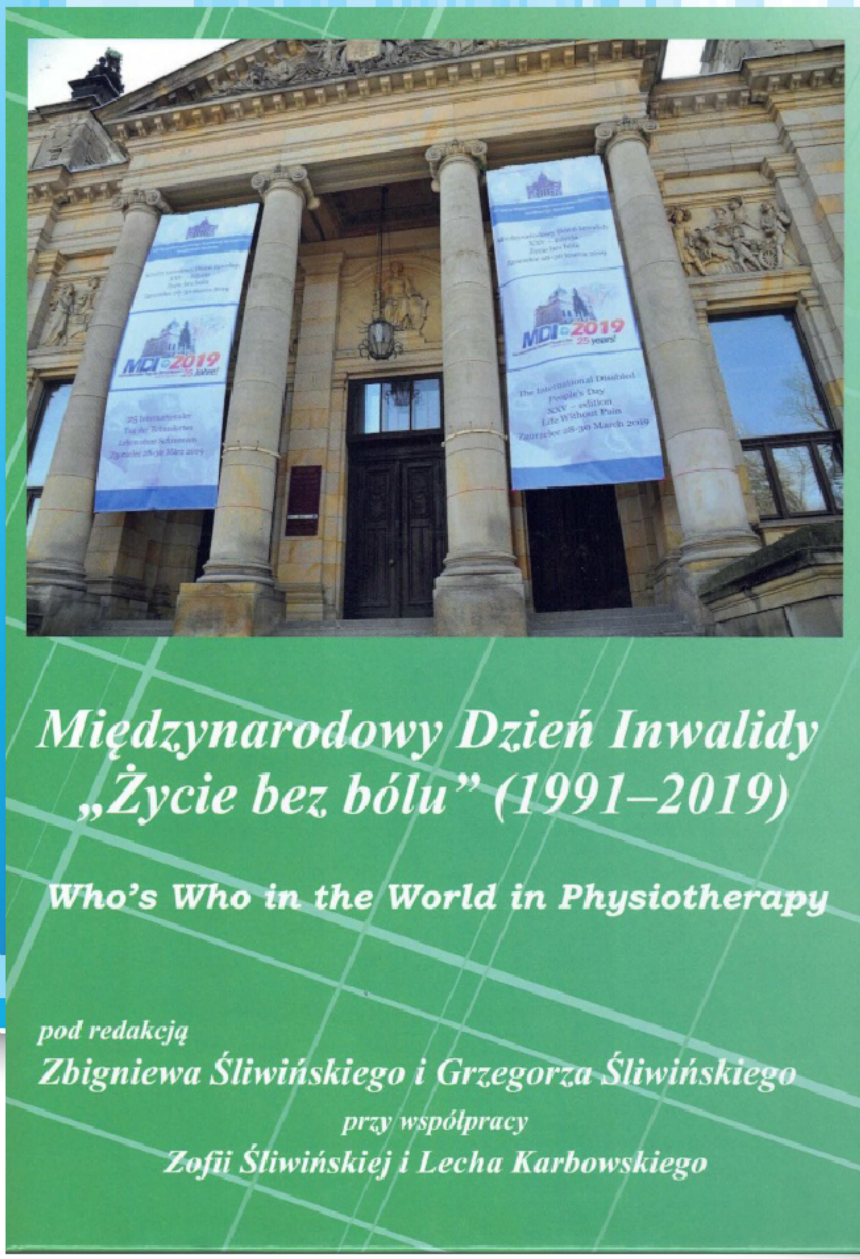

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Does cervical proprioception affect hand dexterity of physiotherapists with and without mechanical neck pain?

Czy propriocepcja szyjna wpływa na sprawność ręki u fizjoterapeutów cierpiących z powodu mechanicznego bólu szyi?

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Abstract

Purposes. This study was conducted to compare between cervical proprioception and hand dexterity in physiotherapists with and without mechanical neck pain, and to determine the relationship between cervical proprioception and hand dexterity in physiotherapists. Materials and methods. Sixty physiotherapists (30 with chronic mechanical neck pain (G1), mild to moderate neck pain lasted more than 6 months and 30 healthy control (GII)). Both sexes were enrolled with; age ranged from 25 to 35 years, normal body mass index (BMI) and at least one year of practice of manual work. All participants undergone evaluation of cervical joint position error (JPE) using cervical range of motion device (CROM) through head-to-neutral repositioning (NHR) and head-to-target repositioning (THR) tests in flexion direction in addition to evaluation of hand dexterity using Purdue pegboard test. Results. There was statistically significant difference in median values of JPE and hand dexterity between both groups. There was statistically significant indirect medium to strong correlation between JPE in flexion (NHR and THR) and hand dexterity (in dominant and assembly tests). Conclusions. Physiotherapists with neck pain have impairment in cervical proprioception which in turn negatively affects hand dexterity. Hand dexterity is important functional property for physiotherapist to apply different manual techniques. So, impairment of hand dexterity may interfere with the efficiency of manual application.

Key words:

cervical proprioception, joint position error, hand dexterity, chronic neck pain

Streszczenie

Cel. Badanie to przeprowadzono w celu porównania propriocepcji szyjnej ze sprawnością ręki u fizjoterapeutów z mechanicznym bólem szyi i bez niego oraz w celu określenia związku między propriocepcją szyjną a sprawnością ręki u fizjoterapeutów. Materiały i metody. 60 fizjoterapeutów; 30 z przewlekłym mechanicznym bólem szyi (G1) od łagodnego do umiarkowanego bólu szyi trwającego dłużej niż 6 miesięcy i 30 zdrowych fizjoterapeutów przypisanych do grupy kontrolnej (GII)). Osoby obu płci brały udział w badaniu; wiek wahał się od 25 do 35 lat, uczestnicy mieli normalny wskaźnik masy ciała (BMI) i co najmniej rok pracy fizycznej za sobą. Ocena błędu pozycji stawu szyjnego (JPE) za pomocą przyrządu do pomiaru zakresu ruchu kręgosłupa szyjnego (CROM) poprzez testy head-to-neutral repositioning (NHR) i head-to-target repositioning (THR) w zgięciu, zginaniu w prawo i w lewo oraz obrotach prawo- i lewostronnych. Do oceny sprawności rąk wykorzystano test zręcznościowy Purdue Pegboard. Wyniki. Istniała istotna pośrednia korelacja (średnia do silnej) między zręcznością ręki (w testach kończyny dominującej i obu kończyn) a JPE w zgięciu (NHR i THR). Wnioski. Upośledzenie propriocepcji szyjnej u pacjentów z bólem szyi negatywnie wpływa na sprawność ręki.

Słowa kluczowe

propriocepcja szyjna, błąd pozycji stawu, sprawność ręki, przewlekły ból szyi

Introduction

Neck pain is an “ache or discomfort in the anatomical area between the occiput and the third thoracic vertebra” (T3). Pain may extend laterally between the medial margins of scapulae [1]. Neck Pain is a common work-related musculoskeletal disorder (WRMSD) seen in many healthcare professions such as dentists, physiotherapists, etc. [2]. The lifetime prevalence of neck pain has been reported to be 26% to 71% with 12-month prevalence [3]. About 50–85% of individuals with neck pain suffer from persistent or recurrent impairing pain [4]. It reduces the individuals' ability to participate in work which in turn negatively affects their quality of life. Also, it has major economic consequences through increasing the cost of health care and work absenteeism [5].

Proprioception refers to “information sent by afferent receptors from peripheral muscles, capsules, ligaments, and joints to the central nervous system. This information contributes to efficient neuromuscular control of movement and joint stability” [6]. During limb movement, the kinesthetic and visual inputs are constantly matched against the brains internal map of the body to predict the future limb position. In the absence of visual feedback, the sensory signals from muscle stretch, contraction, and tension are sent to the central nervous system (CNS) to generate awareness of limb proprioception (position) [7]. Central nervous system interprets the upper limb joint position sense by using position of the head and neck [8].

Dexterity is an essential functional property of the hand. It refers to the ability to grasp and manipulate small objects with a coordinated hand and finger movements [9]. To produce this small, precise movement, adequate musculoskeletal and neurological functions are typically required [10]. The criteria used to assess this skill are speed and precision [11].

Physiotherapists, specifically manual therapists, are involved in activities like gripping, handling, transferring and shifting patients and must have excellent hand function to give effective treatment [12]. The main concern in most of previous studies was to determine the relation between neck pain and handgrip strength [1, 12]. Although, it has a little relation to the patient actual hand function. Proper hand function doesn’t depend upon absolute strength rather than it requires quick coordinated muscle activity (dexterity). There is no study concerned with hand dexterity in physiotherapists with neck pain and its relation to abnormal cervical proprioceptive error that is usually found in neck pain patients [13]. So, the aims of this study were to compare between cervical proprioception and hand dexterity in physiotherapists with and without mechanical neck pain, and to determine the relationship between cervical proprioception and hand dexterity in physiotherapists.

Materials and methods

Study design

This study was a cross-sectional, observational correlation study. The study was approved by the ethical committee of the faculty of physical therapy, Cairo University, Egypt (P.T.REC/012/002861).

Participants

Sixty physiotherapists (PTs) from both sexes enrolled in this study. Participants were assigned into two groups (study and control group). Study group (GI) included thirty physiotherapists with chronic mechanical neck pain. Control group (GII) included thirty age and sex matched healthy physiotherapists without mechanical neck pain. Participants in group I were diagnosed as mechanical neck pain based on a careful clinical evaluation by the neurologist and this diagnosis was confirmed radiologically by MRI of the cervical spine. The participants were recruited from the Faculty of Physical Therapy, Cairo University, and private clinics.

Inclusion criteria

Sixty physiotherapists (thirty with mechanical neck pain and thirty without mechanical neck pain). Both sexes participated in the study. Age ranged from 25 to 35 years. For group I, patients who had chronic mechanical neck pain lasted more than 6 months. Mild (5-44 mm) to moderate (45–74) neck pain as indicated by visual analogue scale (VAS) [14]. Participants had at least one year of practice of manual work, right hand dominance, and with normal body mass index (BMI) (18.5– 24.99 kg/m^2) [15].

Exclusion criteria

Patients with any cervical pathology rather than mechanical neck pain, previous cervical or shoulder surgery or trauma, diabetic patients with shoulder problems, history of any neurologic disease that may affect the hand functions, carpal tunnel syndrome, De Quervain's disease, deformities in elbow or hand and patients suffering from psychological or cognitive disturbances.

Instruments

Cervical proprioception was assessed by measuring cervical joint position error (JPE). Cervical JPE was measured by using the cervical range of motion device (CROM). The CROM is used to measure cervical range of motion (ROM) in all direction. It is simple to use as it requires minimal palpation to locate landmarks. It is a cost-effective tool when compared to other motion analysis systems. It has high concurrent validity and test-retest reliability [16].

Hand dexterity was assessed using the Purdue pegboard test (PPT) (Lafayette, IN 47903 USA, Model 32020A). It was identified as one of the top three assessments of hand dexterity for health care professionals [17]. This is a test used to assess how the subjects can use their hands quickly and accurately. It has high validity and excellent test-retest reliability with few confounding variables, such as age, gender, and handedness [18].

Assessment procedure

All participants signed a written consent form after receiving full information on the purpose of the study, procedure, possible benefits, privacy, and use of data. All participants were submitted to the following battery of evaluation:

Evaluation of neck pain intensity

Visual Analogue Scale (VAS) was used to determine the severity of neck pain. It is a 10-cm straight line with two ends, one end corresponding to no pain and the other end corresponding to the worst imaginable pain. The subject was asked to mark a point on the line that had corresponded to pain level, he or she experienced [19]. The VAS is a very reliable pain severity measure and is used as the standard against other rating methods and it is the simplest to use [20]. Participants in study group should had mild to moderate neck pain to be included in the study.

Evaluation of cervical JPE using cervical range of motion (CROM)

Subjects were asked to sit upright in a chair with back support. They were asked to assume and maintain this position throughout the test, head looking straight forward (neutral head position), hips and knees 90 degrees of flexion and feet fixed the ground. Subject was blindfolded by a travel eye mask. Velcro straps were used to secure CROM unit on the head, Then the CROM was calibrated to zero (neutral). Participants underwent two tests to assess cervical JPE in flexion direction. The first test was the head-to-neutral repositioning (NHR) test. It assesses the ability to reposition the head to self-selected neutral position. The subjects were instructed to fully flex their heads and back to what to be the starting head position (neutral) [21]. When the subjects reach this reference position the subject's reposition accuracy was measured. The second test was the head-to-target repositioning (THR) test. This test assesses the ability to reposition the head to previously determined angle. First, patient cervical flexion range of motion was measured to determine the target head position (50% of maximum range of motion). Second, the head was held and moved slowly to the predetermined target head position. The subjects were asked to actively reproduce this position. In both tests, the subject's reposition accuracy was measured in degrees using the lateral gravity dial inclinometer of the CROM. Each test was carried out three times. The average of the three trials was taken for analysis. The absolute value of the difference between the target angle and subject's repositions angle was calculated to determine cervical JPE [22].

Assessment of hand dexterity using the Purdue pegboard test

The subject was comfortably seated on a chair. The Purdue was placed on a table directly in front with the row of the concave cups at the top of the board. There were 25 pins in the far-right and far-left cups with a total of 50 pins. The two middle cups contained washers and collars. Subjects were asked to do the following tests:

- The first test, dominant test, the subject was asked to take one pin from the right-handed cup with his/her right hand then to insert it in the top hole in the right column. The total number of pins inserted in 30 seconds was calculated.
- Assembly test: the subject was asked to take one pin from the right-handed cup with his/her right hand. While inserting it in the top hole in the right column, the subject was asked to take a washer with his/her left hand. As soon as the pin had been inserted, the subject was asked to place the washer over it. While the washer was being placed over the pin, the subject was asked to take a collar with his/her right hand. While the collar was being placed over the pin, the subject was asked to take another washer and place it over the collar.

Before the beginning of the assembly test, the subject was asked to make four or five complete assemblies to ensure that the subject completely understood the alternating procedure. The number of assembled components was calculated. Each completed assembly was interpreted as 4 points [18].

Data analysis and statistical design

Data were expressed as mean ± SD of subjects' characteristics. Shapiro-Wilk and Kolmogorov-Smirnov tests for normality showed that all measured variables were not normally distributed. So, unpaired t-test was used to compare between subjects' characteristics of the two groups. Median and interquartile range were used for presentation of pain, cervical proprioception and dexterity. Spearman correlation coefficient(rs) was used find out the correlation between cervical JPE and hand dexterity in physiotherapists with and without mechanical neck pain. Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. The p-value less than or equal to 0.05 was considered significant.

Results

Subjects characteristics

The mean age, sex and BMI of group I and II are presented in table 1. There were no significant differences between the two groups in their mean age, sex and BMI ($p > 0.05$).

Table 1. Patients demographic data in both groups

Variables	Group I n = 30	Group II n = 30	P-value
Age [years]	27.53 ± 3.6	27.36 ± 2.25	0.832[a]
Sex [M:F]	14:16	9:21	0.071[b]
BMI [kg/m^2]	23.8 ± 1.4	23.66 ± 1.37	0.711[a]

Data are represented as (Mean ± SD); a, Unpaired t-test; b, Chi squared test; BMI, Body Mass Index; Level of significance at P ≤ 0.05.

Difference between the measured variables of the two groups
Statistical analysis using the results of Mann-Whitney test in the table 2. revealed that there was significant difference in median values of all measured variables between both groups. Group I showed significant higher median values of joint position error in flexion direction NHR and THR proprioception tests compared to group II. There was a significant lower median values of hand dexterity in dominant and assembly tests of group I compared with that of group II.

Table 2. Comparison between all measured variables of both groups

Variables		Group I Median (IQ)	Group II Median (IQ)	P-value
VAS (n)		4 (2.25)	0 (0)	0.001*
Hand dexterity using the Purdue pegboard test	Dominant (n)	13 (4)	16 (3)	0.001*
	Assembly (n)	22 (7)	36 (4)	0.001*
NHR	Flexion (°)	5 (3)	0 (3.25)	0.001*
THR	Flexion (°)	4 (4.5)	2 (2)	0.001*

*VAS: Visual analogue scale; NHR: Head-to-neutral repositioning test; THR: Head-to-target repositioning test; IQ: Interquartile range; *: Significant*

Correlation between cervical proprioception and hand dexterity
Statistical analysis in table (3) showed results of Spearman correlation co-efficient test.
- There was significant medium indirect correlation between the median values of joint position error in flexion direction in NHR and THR proprioception tests and the median values of hand dexterity in the dominant test.
- There was significant strong indirect correlation between the median values of joint position error in flexion direction in NHR proprioception test and assembly test of dexterity.
- There was significant medium indirect correlation between the median values of joint position error in flexion direction in THR proprioception test and the median values of hand dexterity in the assembly test.

Table 3. Correlation between cervical JPE (flexion) and hand dexterity

		NHR Flexion	THR Flexion
Dominant	R	−0.548	−0.504
	P-value	0.001*	0.001*
Assembly	R	−0.610	−0.469
	P-value	0.001*	0.001*

*NHR: Head-to-neutral repositioning test THR: Head-to-target repositioning test r: Spearman correlation coefficient P value: Probability value *: Significant*

Discussion

Manual dexterity means the ability to perform fine coordinated movement of the hand and fingers with high integrated precision and speed [9]. Proper dexterous movement require proper motor control and sensory motor integration of the upper limb [10].
The purposes of this study were to compare between cervical proprioception and hand dexterity in physiotherapists with and without mechanical neck pain, and to determine the relationship between cervical proprioception and hand dexterity in physiotherapists.
Sixty physiotherapists (PTs) from both sexes participated in this study. Participants were assigned into two groups (study group and control group). The study group (GI) included thirty physiotherapists with chronic mechanical neck pain. The control group (GII) included thirty matched healthy physiotherapists without mechanical neck pain.
The participants' age in the present study ranged from 25–35 years as it has been found that the "incidence of WRMSDs is the highest within the first 5 years of practice and most common in junior PTs and newly qualified graduates. Prevalence is lower in older PTs, as they gained experience and using administrative positions that are less physically demanding" [23]. Also, to avoid age-related degenerative changes that may affect

cervical region and therefore affecting the hand functions rather than cervical proprioception. These changes interfere with the ability of the nervous system to activate hand muscles through increasing tissue pressure and compromising myoneural conduction velocity and tissue blood flow and oxygenation [12].

Participants' body mass index (BMI) was in the normal average to exclude the effect of BMI on hand motor functions. The relationship between BMI and handgrip strength is debatable. Some researchers found a positive relationship while others reported partial positive or non- significant relationship [24].

The results of this study showed that there was a significant difference between the median values of all measured variables in both groups. The study group showed a statistically significant higher median values of cervical joint position error (JPE) in comparison to the control group. These results come in agreement with a systematic review conducted by de Vries et al [13] on Joint position sense error in patients with neck pain who concluded significantly increased JPSE in the neck pain group (traumatic and non-traumatic) in comparison to the healthy control group.

Also, De Zoete et al [25], revealed a greater reposition error in idiopathic neck pain in comparison to healthy controls in joint position sense (JPS) testing, indicating that this test may be clinically useful in assessing sensorimotor control. In contradistinction, Grip et al [26], and Uthaikhup et al [27], did not report any significant differences in JPSE between participants with non-traumatic neck pain and healthy controls. The difference among studies might be attributed to different ages, sample size, duration of neck pain, and using a different measuring device. As they measured cervical joint position error using the 3 Space "Fastrak™" but in this study cervical joint position error was measured using CROM device. The "Fastrak™" is an “electromagnetic measuring instrument that tracks the positions of sensors relative to a source in three dimensions” [13].

High proprioceptive error in the study group may be attributed to, physiotherapists are usually working in astatic awkward or cramped positions for long periods. A prolonged low level of muscle contraction impairs oxygen transportation that might be associated with neck muscle pain and fatigue [28]. Persistent postural malalignment places strain on neck muscles especially deep neck flexors leading to fatigue of these muscles [29]. The spindles of the cervical muscles, not the joint capsules, are the primary proprioceptors of the neck [30]. So, fatigue of these muscles leading to altered afferent cervical input and increase cervical joint position error. Proprioception is essential for maintaining joint stability under dynamic conditions. So, proprioception impairment might be a predisposing factor in the development of clinical pain [31].

This explanation partially agrees with Yong et al. [30] who conducted a study to investigate the relation between head posture and proprioceptive function in the cervical region. For head posture, the craniovertebral angle (CVA) was measured and the JPS was calculated for cervical proprioception. A significant negative correlation was observed between the CVA and position sense error in flexion and extension. That means the forward head posture is associated with greater repositioning error than a more upright posture.

This explanation contradicts with Eva-Maj et al. [32] who induced acute neck pain by hypertonic saline injection in the splenius capitis muscle on one side and found cervical proprioceptive disturbance following the injection. That means neck pain itself has a clear role in proprioception and neck sensorimotor control. The main role of pain is to prevent further tissue damage. So, pain leads to decrease in muscle activity and afferent proprioceptive transfer [33].

Although patients with chronic neck pain have impairment in proprioception, previous studies have not consistently shown any relation between pain intensity and proprioceptive performance. The subjective intensity of neck pain may not be easily quantified especially if it occurs only intermittently or is subclinical [21].

The results of the current study showed that there was a significant difference between the median values of hand dexterity tests between both groups. The study group showed a statistically significant lower median value of hand dexterity. The major finding of the current study was a significant indirect medium to strong correlation between cervical JPE in flexion (HNR and HTR) and hand dexterity. These results come in partial agreement with a study conducted to determine the Relationship between neck Pain and hand dexterity among violinists in Kota Kinabalu, Sabah, Malaysia. The study revealed greater impairment in tapping speed of the right middle ring finger (as an indicator of hand dexterity) in violinists with neck pain compared to violinists without neck pain [9]. Unfortunately, there was no other previous studies to compare the results with.

The findings of the current study may be attributed to altered afferent cervical input in the neck pain group. As most physiotherapists are usually working with abnormal head flexed posture during handling their patients and assume this position for a prolonged time. This habitual posture leading to increase loading on cervical muscles, fatigue especially in deep neck flexors and extensors, so alters cervical afferent input [34]. Also, this flexed head posture increases gravitational demands on the neck muscles as it is reported to be 3–5 times higher neutral posture [35].

This explanation was supported by Shaghayegh-Fard et al. [36] and Yong et al. [29] who studied the correlation between head posture and proprioceptive function of the cervical region and found that forward head posture (pain-free) is significantly positively correlated with cervical joint position error.

Alteration of cervical afferent input impairs sensory-motor integration of upper limb and therefore affecting hand motor functions such as dexterity. As the CNS interprets upper limb JPS based on the position of the head and neck [8]. So, altered neck sensory input impairs the awareness of upper limb joint position, which is critical for smooth and purposeful upper limb movement [7]. That was evident in impairment of upper limb proprioception (especially wrist proprioception) in patients with chronic mechanical neck pain [37]. Joint proprioception is essential in appropriate movement performance, in such a way that may affect hand functions such as hand dexterity.

Le et al [9] attributed the results to neck pain as altered input from neck muscles secondary to pain and fatigue which may affect sensory input to the central nervous system. Consequently, impairing upper limb proprioception and limit the performance of precision tasks. But as mentioned above previous studies have not consistently shown an association between pain intensity and proprioceptive performance.
Our results also agreed with a study applied by Zamorano et al. [38] that found that tactile sensitivity is significantly altered in violinists with neck pain. It was found that, in occupational professions that require excellent hand skills, there is an increase in the cortical receptive field of those parts most frequently used, a process called adaptive cortical reorganization (cortical plasticity) and also, there is a decrease in the threshold of mechanical receptors in hand. In neck pain, there is maladaptive cortical reorganization as there is an alteration of the spatial organization (representation size of the hand becomes smaller) and magnitude of response elicited by cutaneous stimulation decrease. So maladaptive cortical reorganization in response to neck pain leads to alteration in sensory-motor integration of the upper limb, the way sensory input is transmitted and processed by CNS. But this previous study attributed those changes to neck pain. Although, those previous changes such as alteration in sensory-motor integration of upper limb were observed also in subjects with forwarding head posture (pain-free). There was an alteration in cortical activity in forward head posture and that was attributed to alteration of cervical afferent input [39].
Also, the results of the current study agreed to a study that found that adjusting dysfunctional spinal segments by manipulation alters early sensorimotor integration (SMI) of input from the upper limb (as evidenced with a decrease in N30 somatosensory evoked potential complex amplitudes). Change in SMI that occurred after spinal manipulation predominantly was in the prefrontal cortex that has a vital role in SMI [40]. As spinal manipulation normalizes afferent input from the affected segment so improves proprioceptive input and improves sensory-motor integration of the upper limb and may lead to improvement of motor functions of the hand.
There current study was limited to the following; There were no previous studies of the scope of the current study to which the current findings could be compared. Also, Personal differences between subjects in lifestyle, clinical practice setting, numbers of patients whom the physiotherapists dealing with may affect the results.
So, it is recommended to study the relationship between cervical proprioception and hand dexterity in patients with forward head (pain free) to end with a confirm relationship between cervical proprioception and hand dexterity.\

Conclusions

Physiotherapists usually assume faulty head posture during application of various interventions to patients. Thus, leads to alteration in cervical afferent input that affects sensory motor integration of upper limb therefore affecting hand functions such as hand dexterity. Hand dexterity is important functional property for physiotherapist to apply different manual techniques. So, impairment of hand dexterity may interfere with the efficiency of manual application.

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