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Intra- Rater Reliability of Cranio Cervical Flextion Test in the Subject with Cervical Spondylosis

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Abstract
Cranio-cervical flexion test (CCFT) was one among the method for evaluating the Deep Neck Flexor activity and is reliable in asymptomatic individuals. Studies demonstrated that patient with chronic neck pain had poor ability to perform the CCFT when compared with asymptomatic subjects. The objective of the study was to test the intra-rater reliability of the cranio-cervical flexion test in subject with cervical spondylosis. Thirty subjects diagnosed with cervical spondylosis were recruited for the study. All the patient need to performed standardized CCFT protocol. Five progressive stages were achieved with 10 seconds hold at each stage followed by 30 seconds rest and score was note. After the 24 hours again test was performed and the score was done and tests score has been analyzed. The Intra rater reliability coefficient was 0.504 (95% Confidence interval, 0.73) which was statistically significant (p-value <0.002). Results showed that there is moderate intra-rater reliability in subject with cervical spondylosis. Cranio-cervical flexion test can be used as a measurement tool to rule out the Deep neck flexor activity in cervical spondylosis.

Keywords: Cranio Cervical Flexion Test (CCFT), cervical spondylosis, Deep neck flexor (DNFs)

1. Introduction

Cervical spondylosis is a generalized disease process affecting all levels of the cervical spine. Cervical spondylosis encompasses a sequence of degenerative changes in the inter-vertebral discs, osteophytosis of the vertebral bodies, hypertrophy of the facets and laminal arches, and ligamentous and segmental instability [1].

Cervical spondylosis is a commonly occurring problem, which interferes with daily activities of many people. The prevalence of cervical spondylosis in general population is 49%. [2] Cervical spine pains affects nearly 50% of the population at some time in their lives [3]. It affect both the sexes. It usually starts earlier in female than in male[2]. The process of degeneration differs from person to person and is precipitated by injury, body posture, occupation stain, body type or life style[4]. It is often associated with a variety of complications, such as headache and loss of range of motion in the cervical spine [5].

Instability is one element of cervical pain. Situations involving trauma, genetic predisposition, disc degeneration, and surgery may compromise the stabilizing mechanisms of the cervical spine [6]. In addition, cervical impairment (defined as any cervical pain, loss of range of motion, or decreased strength [defined as the force-generating capacity of a muscle] or endurance of the neck musculature, including, but not limited to, the sternocleidomastoid, trapezius, and deep neck flexor (DNF) muscles might be a causative or contributory factor in the pathogenesis of head and neck pain [7].

The DNF muscle group is composed of the rectus capitis anterior and lateralis, and longus colli and capitis. These muscles act as an important stabilizer of the head-on-neck posture because of their ability to support the cervical lordosis and cervical joints. The location of the DNFs suggests that they potentially play an important role in stabilizing the cervical spine. The longus colli and dorsal neck muscles form a sleeve that stabilizes the cervical spine in all positions against the effects of gravity [8].

It is theorized that when muscle performance is impaired, the balance between the stabilizers on the posterior aspect of the neck and the DNFs will be disrupted, resulting in loss of proper alignment and posture, which is then likely to contribute to cervical impairment[5]. This knowledge prompts the significance of testing and training the DNF muscles in cervicogenic pain disorders.

Several methods for evaluating the DNF function have been documented, including cranio-cervical flexion test(CCFT) [9], neck flexor muscle endurance test, cranio cervical flexion dynamometry [10], conventional cervical flexion exercise protocol [11, 12], electromyographic analysis [13], digital imaging [14], magnetic resonance imaging [15], and ultrasonography [16].

Disadvantages of neck flexor muscle endurance test is the test position which use in this test does not give the proper idea about the isolated DNF muscles activation during the test. In addition this test is none instrumented. However, the CCFT which was developed by Jull *et al*, appears to be an easy, non-invasive, low-load, clinical test to specifically assess and retrain DNFs [14, 17-20].

The CCFT requires an individual to perform the head nodding action (cranio-cervical flexion) in 5 progressive stages (22, 24, 26, 28, and 30 mm Hg) from a neutral starting position in supine crook lying [9]. This test uses a pressure biofeedback unit (PBU) consisting of a nonelastic 3-chambered latex pneumatic bag (16.7 × 24 cm), a catheter, and a manometer gauge ranging from 0 to 200 mm Hg with an accuracy of ±3 mm Hg [21].

One advantage of the CCFT is the use of the pressure biofeedback unit, which provides relatively precise measurements which can be used as an outcome measure and as an aid to train Deep neck flexors activation. The test can therefore be used for the purposes of diagnosis and treatment.

The test emphasizes a low load contraction of the DNFs in relative isolation from their superficial synergists. Jull *et al*, (1999) defined the operational definition of endurance capacity for the CCFT as the maximum increase in pressure that can be held steady for 10 seconds from a baseline 20 mmHg (activation score [AS]), multiplied by the number of repetitions [22].

To ensure that the error involved in measurement is small enough to detect actual changes in the variable being measured, clinical tests with high reliability are important [23]. Gill James, *et al*, suggested that the CCFT had excellent intra-tester reliability in asymptomatic individual [24]. Ashokan Arumugam *et al* suggested that the CCFT had high inter-rater reliability in asymptomatic individual [25].

All though Chiu *et al*, demonstrated that patient with chronic neck pain had poor ability to perform the CCFT when compared with asymptomatic subject. However it is not known whether there is more error in CCFT symptomatic group [26]. Gill James *et al*, assumed that using symptomatic participants could mask the actual reliability because of changes in the underlying condition which was proved in Asymptomatic patient [24]. However no studies have yet been performed to test the reliability of CCFT in patient with DNF impairment and hence arise the need for the studies.

2. Materials and Methods

The intra- rater reliability study was performed on 30 subjects with one rater. A convenient sampling of 30 symptomatic group of patients who were diagnosed with cervical spondylosis (17 men and 13 women; mean age, 43.7 years; range 36-51 years) were recruited for the study. Ethical clearance was taken from the concerned hospitals and institutions for the aged. Informed and written consent from each concerned patient was taken. Patients with Subjects who have undergone any cervical surgery, Vertigo, Cervical tumor, Subjects with radiating pain, non-cooperative patients were excluded.

The instruments used in this study included a pressure stabilizer, PBU (Chattanooga Group Inc), and a custom-recorded metronome (Figure 1). The beat of stopwatch was set at the beginning and end of 10 seconds, repeating at regular intervals of 30 seconds to guide during 5 subsequent stages of the CCFT.

Fig 1:

All the subjects were attended a two testing session of 40 minutes duration including a familiarization session of 20 minutes. First patient was explained the overall test procedure, followed by a practice session of the recommended CCFT protocol with standardized set of instructions. DNF evaluation was performed by the following CCFT protocol (Figure2) :-

- Patient in supine crook line.
- Place the upper cervical spine in mid position.
- Layers of towel placed under the head to make spine in neutral position.
- Pneumatic bag place under upper cervical. Inflate to 20 mm of Hg.
- Ask subject to do gentle nodding yes.
- 5 progressive stages should achieve with 10 second hold at each stage followed by 30 second rest.
- Check for any incorrect strategies and score will be not.

Fig 2: Patient performing CCFT

After the 24 hours again test was performed and the test scorer was done and tests score had been analyzed. Data analysis was performed by SPSS (version 17) for windows; α value was set at 0.05. Descriptive statistics was used to assess Mean, SD and Range of demographic variable and variables of CCFT test. The intra-class correlation coefficient was used to assess their intrarater reliability Microsoft word, excel was used to generate table and graphs.

3. Results & Discussion

3.1 Results

Thirty symptomatic subjects diagnosed with cervical spondylosis (17 men and 13 women; mean age, 43.7 years; range 36-51 years, mean duration 17.57; range 8-36 months) were evaluated by rater and intra rater reliability were calculated. The Intraclass Correlation Coefficient for single measures was 0.504 which was statistically significant with Þ-value <0.002. The standard error of mean for single measures was 0.574.The Intraclass Correlation Coefficient for average measures was 0.67 which was statistically significant with Þ-value <0.002. The standard error of mean for average measures was 0.553 (Table1). On day one CCFT the mean was 22.60 with standard deviation 0.93 (range 2.00) and on day two CCFT the mean was 22.80 with standard deviation 1.00 (range 2.00).

Table 1: Intra rater reliability, ICC (single& average), 95% CI & results

Sl NO	measurement	ICC	CI	p value	SEM
1	Single Measures	0.504	.181-.728	0.002	0.574
2	Average Measures	0.67	.307-.843	0.002	0.553

3.2 Discussion

The objective of the study was to measure the intra-rater reliability of CCFT in subject with cervical spondylosis. The subjects of either gender with cervical spondylosis with an average age of 43.77 were included in the study. Reliability was calculated using Intraclass correlation coefficient and standard error of mean.

The DNF activity can be assessed using outcome measures such as cranio-cervical flexion test (CCFT), Neck flexor muscle endurance test, Cranio cervical flexion dynamometry, Conventional cervical flexion exercise protocol, Electromyographic analysis, Digital imaging, Magnetic resonance imaging, and ultrasonography. CCFT is used most frequently in clinical setting with high sensitivity and specificity in monitoring the impairment of DNF over time which cannot be measured by neck muscle endurance test, cranio cervical flexion dynamometry, and conventional cervical flexion exercise protocol. It is easy, noninvasive, low load, clinical test to specifically assess and retrain DNFs [9, 14, 17, 18, 25].

The CCFT was commonly being used in research since 2001. It is being used by many people for investigating as well as therapeutic purpose of DNFs. Sensitivity and specificity of CCFT was done by Jull G *et al* on seventy three subjects who was suffering from migraine and cervicogenic headache and conclude that CCFT had 100% sensitivity and 94% specificity to identify cervicogenic headache [6]. Validity were established by Jull GA *et al* on ten volunteer subject and construct validity had been verified in a laboratory setting by direct measurement of deep and superficial flexor muscle activity and concluded that the CCFT exhibits strong construct validity [18].

The current finding involved subject with cervical spondylosis. In accordance with the study the cervical spondylosis affected around 49% of general population which has been shown more prone to get DNF impairment [5-7]. Intra-rater reliability was done by Gill James *et al* on nineteen asymptomatic subjects with average mean of twenty four concluded that the CCFT exhibits excellent intra- tester reliability of ICC 0.983 for DNFs endurance capacity [24]. A study done by Ashokan A *et al* on thirty asymptomatic subjects with mean of thirty three concluded that the CCFT exhibits excellent inter-rater reliability for asymptomatic subject [25].

CCFT is used in assessment of DNFs impairment and also in rehabilitation of patient who suffering from any condition which leads to DNFs impairment. Additionally, it is used to assess DNFs impairment in subject with cervicogenic headache[7], chronic neck pain [26], whiplash- associated disorder[27], chronic tension- type headache [27]. CCFT has been used to improve DNFs strength and endurance during rehabilitation in patient with cervicogenic headache [5], neck pain [26].

Studies done by Chiu TT *et al* and Jull G *et al* showed that CCFT had been shown less highest pressure level achievement in subject with chronic neck pain and in individual with whiplash- associated disorder and insidious onset of neck pain when compared to healthy subjects. Similar result was found in this study also. This could be due to poor contractile capacity of the deep neck flexors to reduce cervical lordosis, particularly in the last 3 levels of the test. Individuals in the chronic neck pain group had difficulty achieving the higher pressure levels associated with the CCFT which suggest that those patients with chronic neck pain may tend to develop an increased cervical lordotic posture associated with a forward head posture [26-29].

In present study, the manometer dial was positioned on a stand instead of subjects holding it. This was accordance to study done by Hudswell S *et al*. The subjects were made to hold the pressure dial with 1 hand while performing the CCFT. This would have introduced the possibility of feed forward (FF) activation of neck muscles with arm movement associated with holding the manometer, thus affect the validity of the CCFT scores [30]. Although there was no study on FF activation of neck muscles with arm movement in the CCFT position. Falla *et al* [31] have shown such FF activity in DCF, sternocleidomastoid, and anterior scalene muscles with arm movements during standing.

In this study, other factors were controlled, which may have resulted in very consistent scores (AS) among the trials were include consistent positioning of the pneumatic bag under the subject's neck to standardize the contact area, consistent timing of the CCFT stages through stopwatch, and the calibration procedures conducted thrice during the data collection period to ensure a consistent and linear relationship between the applied load (CCF force) and pressure change. This was done accordance to study done by Helewa A [32].

In this study, the scoring of the CCFT is based on the substitution strategies observed from the unilateral side of the subject's neck. This may affect the validity of the holding capacity, if there could be asymmetric activation of superficial neck muscles during the CCFT. In accordance with the EMG study done by Falla *et al*, [13] which has been found that there was no asymmetric activation of sternocleidomastoid and anterior scalene muscles was not reported during incremental stages of the CCFT, although their activity was recorded at every stage of the test.

The precision of the PBU is variable up to ±3 mm Hg [21] depending on air fluctuations within the pneumatic bag, which could cause random error between the trials [24, 32, 33]. Nevertheless, by maintaining same area of contact between the neck and pneumatic bag for all the trials, a linear output between CCF force and pressure change might have occurred.

The Intraclass correlation coefficient for single measure was 0.504. The Intraclass correlation coefficient for average measure was 0.67. This result was similar in accordance to study done by Hudswell S *et al* CCFT showed high Intraclass correlation coefficient values of 0.92 on second measurement were included osteopaths practitioners, here author hypothesized that this could be due to knowledge of the action of DNFs which enhanced their performance compared to the general population [30]. The current study also showed a difference in mean value of first measurement and second measurement being low on first measurement. The Intraclass correlation coefficient for single measure was 0.504. The Intraclass correlation coefficient for average measure was 0.67 which represent slight bias in second measurement possible because of learning effect in the same way concluded by Atkinson and Neil *et al* [34].

Following were the limitations of the study. Sample size was small. The study was aimed at assessing reliability only for the holding capacity and not the endurance of DNF. The study followed routine clinical CCFT protocol. EMG analysis of superficial neck muscle activity was not done. In this study it

was not possible to blind the investigator or participants to the immediate results. As the mean duration affected was less (maximum upto three years). this also could have resulted in more accuracy.

Further studies on DNF performance can be validated such as EMG analysis of superficial muscle to monitor their level of activity during CCFT procedure. Concurrent validity & predictive validity can be validated. Inter-rater reliability of CCFT with symptomatic group can be performed. CCFT can be done in other different patient population with various neck disorders.

4. Conclusion

The objective of the studied was to test the intra rater reliability of cranio cervical flexion test in subject with cervical spondylosis. An evaluation of cranio-cervical flexion test trials by raters resulted in moderate intra-rater reliability in subject with cervical spondylosis. cranio-cervical flexion test can use as a measurement tool to rule out the Deep neck flexor activity in cervical spondylosis.

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