IMPACT OF CHRONIC NON-SPECIFIC NECK PAIN ON SCAPULAR MUSCLES STRENGTH AND STABILITY

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ABSTRACT

Background: Chronic non-specific neck pain (CNNP) follows a recurrent or episodic course and it can result in changes in axio-scapular muscle strength and lead to altered stability of the scapula which can contribute to symptomatic cervical spine mechanical impairment. Currently, the importance of scapular dysfunction in neck pain has only recently begun to emerge and scapular stability in patients with cervical abnormalities has not been studied.

Objective: To investigate the effect of CNNP on the scapular protractor and retractor muscles strength as well as the scapular stability.

Methods: Thirty male volunteers participated in this study. They were distributed into two groups; experimental group (N=15, patients with CNNP) and control group (N=15, healthy subjects). The strength of the scapular protractors and retractors was evaluated using a Biodex System 3 Isokinetic Dynamometer. And scapular stability was estimated using the Lateral Scapular Slide Test (LSST) in which scapular distance was measured in 0°, 45°, and 90° of shoulder abduction bilaterally. Results: At both low and high speeds, there was no significant difference in scapular protractors and retractors strength between the control and study groups (p > 0.05), However, it was noticed clinically in a distinct way. Regarding scapular distance at 0°, 45°, and 90° of shoulder abduction, no statistically significant difference was found between the control and study groups (p > 0.05).

Conclusion: Contrary to what has been observed clinically, CNNP may have no effect on scapular muscular strength or scapular stability. These findings may be beneficial in the management of CNNP.

Keywords: chronic neck pain, scapular muscles, isokinetic dynamometer, scapular stability.

I-INTRODUCTION

Cervical pain is a frequent musculoskeletal complaint in adults, with a 12-month incidence of 30% to 50%. Thirty percent of cervical pain patients acquire chronic symptoms including limited cervical spine mobility, neck muscles weakness, and neck pain that lasts longer than 6 months after the first onset (1). Hence, it was agreed that cervical pain is prevalent and rising globally in different populations (2).

CNNP is pain with a postural or mechanical basis without specific underlying disease causing the pain (3,4). It has a steady or fluctuating clinical course, although it is episodic or recurring in the majority of patients. Periods of relative improvement are interspersed with periods of relative deterioration, implying that complete symptom relief is the exception and not the rule (5).

Since the clavicle's bony stabilization of the scapula through the acromioclavicular joint is essential but limited, scapular stability and motion depend mainly on muscular activity. The activation of scapular muscles is synchronized in task-specific force coupling patterns to permit scapular stability with the arms by the side and throughout all upper-limb tasks (6,7). The upper, middle and lower trapezius muscles are coupled with the
serratus anterior and rhomboid muscles to permit essential scapular stabilization and motion on the thorax, resulting in "force couples" that are considered crucial for proper scapular orientation (6,8).

The evidence supporting the theory that the scapula's function is critical for proper neck function and that it might be disturbed in neck pain patients is growing (9,10). Clinically, individuals with chronic neck pain have axio-scapular muscular strength and scapular stability changes that are comparable to those seen in individuals with painful shoulder conditions (10). Given the strong association between the scapula and the cervical and mid-thoracic regions of the spine via the axio-scapular muscles, this is conceivable (11).

Clinicians frequently include particular strength exercises applied for the neck and scapulothoracic muscles in the rehabilitation of patients with chronic neck pain along with records of patients improvement (12–14). This emphasizes the important role of scapular muscles, not just for symptom reduction but, probably more significantly, for preventing recurring incidents of neck pain, emotional suffering, and decreased work performance (15).

Instead of direct scientific evidence, the relevance of scapular dysfunction in patients with neck pain is now determined by clinical observation and estimation from shoulder research. As a result, it is unclear if chronic neck pain patients' scapulothoracic muscle strength and function are impaired or altered as compared to healthy individuals (16,17). So, here is the significance of our study in filling this research gap and addressing these clinical issues.

II- MATERIALS & METHODS

Trial design

This is a cross-sectional observational study design.

Participants

Thirty volunteers were enrolled from the PT Outpatient Clinics of Cairo University's Faculty of Physical Therapy and Kasr Al Ainy Hospital. Before beginning the study, each patient was informed of the study's objectives and procedures. Each patient provided informed written consent. The Research Ethical Committee of the Faculty of Physical Therapy, Cairo University, Egypt, authorized this study (No: P.T.REC/012/002882).

The study was accomplished at Cairo University's Faculty of Physical Therapy Isokinetic Laboratory and Outpatient Clinic from April to August 2021. Thirty male subjects were enrolled in 2 groups; the experimental group (N=15 males) who were patients with CNNP and the control group (N=15 males) who were healthy subjects. If a participant's neck pain had persisted for more than six months, they were assigned to the experimental group (18). Subjects with cervical discopathy and nerve root compression manifestations, surgery, fracture, cancer, degenerative disorders, and congenital disorders, as well as any pathology or impairment of the shoulder joint, were excluded from the study.

Procedures

Demographic and anthropometric characteristics of age, body weight, and height of all patients were obtained. The following formula was used to compute the body mass index (BMI): Body Mass Index (BMI) = Body Weight (Kg) / Height (m2). Firstly, strength assessment was accomplished using a Biodex System 3 isokinetic dynamometer (Biodex Medical Systems, Inc, Shirley, NY) to measure the scapular protractors and retractors strength in both groups bilaterally. Before each testing session, the equipment was calibrated, and all operations were carried out following the company's service manual's instructions. Secondly, the lateral scapular slide test (LSST) was performed to assess the stability of the scapula bilaterally.

Measuring scapular protractors and retractors strength:

The testing session began with a warm-up routine, that included shoulder ROM in all directions and stretching exercises for the scapular muscles. The individual was examined in the sitting position with the arm horizontal in the scapular plane (30° anterior to the frontal plane) and was asked to keep the elbow straight while the seat was turned to 15° and the dynamometer was rotated to 45°. (Fig. 1). A diagonally fastened strap from the contralateral shoulder across the chest was applied to stabilize the trunk. (19). Before data gathering, participants...
completed 5 familiarization trials, and they all were encouraged verbally. Also, all subjects were instructed to push forward during the scapular protraction testing and to pull backward during the scapular retraction testing. The testing was performed three times at two different speeds: low speed 12.2 cm/sec (angular velocity of 60°/S) and high speed 36.6 cm/sec (angular velocity of 180°/S) with intervals of rest between tests about 10 seconds and then averaging was done (19).

Fig. (1) Using Biodex Isokinetic Dynamometer in measuring scapular protractors and retractors strength

Measuring scapular stability (Lateral Scapular Slide Test):

Two prominent bony landmarks, the inferior angle of the scapula and the T7 spinous process, were identified and marked by a dot point using a marker pen then, using a tape measure, the distance between these two points was measured in three distinct upper extremity postures bilaterally. This measurement was termed the scapular distance, which changed in each position with new points by the moving inferior angles about the same fixed T7 point. For each position, the scapular distance measurement was taken three times and averaged. The participant's arms were loosened at the sides (0° of shoulder abduction) in the first position (Fig. 2 A). The participant's hands were positioned on the hips in the second position, with the fingers pointing anteriorly and the thumbs pointing posteriorly (45° of shoulder abduction with about 10° of shoulder extension) (Fig. 2 B). The participant's arms were placed at 90° of shoulder abduction with full internal rotation of the shoulder joint in the third position (Fig. 2 C). The shoulder positions of abduction at 45° and 90° were determined with a standard goniometer to assure the correct testing positions (20). Furthermore, to keep a constant posture throughout the test, individuals were asked to focus their eyes on an item in the examination area (21).

Fig. (2) Lateral Scapular Slide Test. A, with arms at sides; B, with hands-on-hips; C, with arms at 90° shoulder abduction and full internal rotation.
Statistical analysis

Participants’ characteristics in the two groups were compared using an unpaired t-test. The Shapiro–Wilk test was applied to ensure that the data were normally distributed. The homogeneity of groups was assessed using Levene's test. Multivariate Analysis of Variance (MANOVA) was used to evaluate the impact of CNNP on scapular muscles strength and scapular stability. The results were followed by univariate analysis to determine which variable had a significant difference between groups. For all statistical tests, the level of significance was adjusted at p < 0.05. The statistical package for social studies (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA) was utilized for all statistical analyses.

III- RESULTS

Characteristics of participants:

Participants’ characteristics of the study and control groups are shown in Table (1). In terms of mean age, weight, height, and BMI, there was no statistically significant difference between the two groups (p > 0.05).

Table 1. Participants’ characteristics of the study and control groups.

<table>
<thead>
<tr>
<th></th>
<th>Study group</th>
<th>Control group</th>
<th>MD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>41.13 ± 9.54</td>
<td>38.66 ± 7.68</td>
<td>2.47</td>
<td>0.77</td>
<td>0.44</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.73 ± 13.12</td>
<td>87.86 ± 17.41</td>
<td>-1.13</td>
<td>-0.2</td>
<td>0.84</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.4 ± 7.4</td>
<td>173.53 ± 6.05</td>
<td>-4.13</td>
<td>-1.67</td>
<td>0.1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>30.31 ± 4.9</td>
<td>29.25 ± 6.09</td>
<td>1.06</td>
<td>0.52</td>
<td>0.6</td>
</tr>
</tbody>
</table>

x̄, mean; SD, standard deviation; MD, mean difference; p-value, probability value

- CNNP effect on scapular muscles strength and scapular stability:

There was no significant effect of CNNP on the scapular protractors and retractors strength and scapular stability (F= 0.89, p = 0.59). Table 2 and Table 3 show descriptive statistics and between-group comparisons. No significant difference was found in scapular protractors and retractors strength at 60°/sec and 180°/sec between the study and control groups (p > 0.05). no significant difference was found in the scapular distance at 0°, 45°, and 90° of shoulder abduction between the study and control groups (p > 0.05).

Table 2. Mean Scapular protractors and retractors strength of the study and control groups.

<table>
<thead>
<tr>
<th></th>
<th>Study group</th>
<th>Control group</th>
<th>MD</th>
<th>F value</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Scapular protractors strength at 60°/sec (N)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Right arm</td>
<td>117.1 ± 48.41</td>
<td>128.1 ± 47.43</td>
<td>-11</td>
<td>0.39</td>
<td>0.53</td>
</tr>
<tr>
<td>Left arm</td>
<td>109.98 ± 54.04</td>
<td>116.85 ± 53.55</td>
<td>-6.87</td>
<td>0.12</td>
<td>0.72</td>
</tr>
<tr>
<td>Scapular protractors strength at 180°/sec (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right arm</td>
<td>66.89 ± 28.01</td>
<td>75.34 ± 26.32</td>
<td>-8.45</td>
<td>0.72</td>
<td>0.4</td>
</tr>
<tr>
<td>Left arm</td>
<td>65.44 ± 23.95</td>
<td>63.73 ± 23</td>
<td>1.71</td>
<td>0.04</td>
<td>0.84</td>
</tr>
<tr>
<td>Scapular retractors strength at 60°/sec (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Right arm</td>
<td>124.14 ± 46.59</td>
<td>155.62 ± 53.25</td>
<td>-31.48</td>
<td>2.96</td>
<td>0.09</td>
</tr>
<tr>
<td>Left arm</td>
<td>138.22 ± 59.66</td>
<td>146.63 ± 51.83</td>
<td>-8.41</td>
<td>0.17</td>
<td>0.86</td>
</tr>
<tr>
<td>Scapular retractors strength at 180°/sec (N)</td>
<td></td>
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<tr>
<td>Right arm</td>
<td>80.89 ± 30.51</td>
<td>96.14 ± 35.07</td>
<td>-15.25</td>
<td>1.61</td>
<td>0.21</td>
</tr>
<tr>
<td>Left arm</td>
<td>93.09 ± 45.61</td>
<td>94.28 ± 36.44</td>
<td>-1.19</td>
<td>0.006</td>
<td>0.93</td>
</tr>
</tbody>
</table>

x̄, mean; SD, standard deviation; MD, mean difference; p-value, probability value
Table 3. Mean scapular distance at 0°, 45°, and 90° arm abduction of the study and control groups.

<table>
<thead>
<tr>
<th></th>
<th>Study group</th>
<th>Control group</th>
<th>MD</th>
<th>F value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scapular distance at 0° abduction (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>11.39 ± 0.82</td>
<td>10.98 ± 1.12</td>
<td>0.41</td>
<td>1.27</td>
<td>0.26</td>
</tr>
<tr>
<td>Left</td>
<td>11.06 ± 0.81</td>
<td>10.93 ± 1.22</td>
<td>0.13</td>
<td>0.11</td>
<td>0.74</td>
</tr>
<tr>
<td>Difference</td>
<td>0.72 ± 0.4</td>
<td>0.56 ± 0.49</td>
<td>0.16</td>
<td>0.95</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Scapular distance at 45° abduction (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>12.15 ± 0.86</td>
<td>11.78 ± 0.93</td>
<td>0.37</td>
<td>1.27</td>
<td>0.26</td>
</tr>
<tr>
<td>Left</td>
<td>12.06 ± 0.71</td>
<td>11.67 ± 1.01</td>
<td>0.39</td>
<td>1.46</td>
<td>0.23</td>
</tr>
<tr>
<td>Difference</td>
<td>0.66 ± 0.46</td>
<td>0.7 ± 0.41</td>
<td>-0.04</td>
<td>0.04</td>
<td>0.82</td>
</tr>
<tr>
<td><strong>Scapular distance at 90° abduction (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>13.96 ± 0.95</td>
<td>13.46 ± 1.04</td>
<td>0.5</td>
<td>1.87</td>
<td>0.18</td>
</tr>
<tr>
<td>Left</td>
<td>13.73 ± 0.75</td>
<td>13.36 ± 1.08</td>
<td>0.37</td>
<td>1.16</td>
<td>0.29</td>
</tr>
<tr>
<td>Difference</td>
<td>0.76 ± 0.48</td>
<td>0.51 ± 0.49</td>
<td>0.25</td>
<td>2.02</td>
<td>0.16</td>
</tr>
</tbody>
</table>

x̄, mean; SD, standard deviation; MD, mean difference; p-value, probability value

IV- DISCUSSION

The present study was conducted to determine the influence of CNNP on the scapular muscles strength which measured by the Biodex isokinetic dynamometer and on the scapular stability which measured by the lateral scapular slide test (LSST).

The finding of this study revealed that there was no significant effect of CNNP on the scapular protractors and retractors strength and scapular stability. No statistically significant difference was found in scapular protractors and retractors strength between the control and study groups at both speeds; low speed 12.2 cm/sec (angular velocity of 60°/S) and high speed 36.6 cm/sec (angular velocity of 180°/S) (p > 0.05). However, it was clinically different and observed in the patients. Also, no statistically significant difference was found in the scapular distance between the control and study groups at 0°, 45°, and 90° shoulder abduction (p > 0.05).

Concerning scapular muscles, neck pain patients have a pattern of altered scapular stabilizers activity, as demonstrated by Helgadottir et al. (7), who reported markedly delayed onset of Serratus Anterior (SA) activation and shorter duration of muscle activity in neck pain patients compared to asymptomatic participants. However, they did not identify any significant differences in upper (UT), middle (MT), or lower trapezius (LT) activity in these individuals, which to somewhat agrees with our finding.

Also consistent with our results, a systematic review by Castelein et al. (16) which review EMG activity of scapular muscles in idiopathic neck pain patients found no clear discrepancy in EMG activity of UT during rest and activities beneath shoulder level, between neck pain patients and a healthy control group, which contradicts with what is often thought for UT. Furthermore, they found some evidence that activity of UT was greater in neck pain patients for LT, and finally, conflicting results were reported for MT. Additionally, because of the great variety of results observed during overhead activities, no conclusion for all scapular muscles EMG activity could be reached.

In contrast to our findings, it was found that there was a weakness of the SA, LT, and MT muscles in neck pain patients compared to asymptomatic subjects noting that LT and MT were weaker on the neck pain side than on the contralateral side (22). Their inclusion criteria were limited to patients with restricted cervical and thoracic segmental mobility and they assessed muscle strength with manual muscle testing which may explain the contradiction with our findings. Also, Dabholkar and Yardi (17) reported that there was a statistical difference between the strength of scapular muscles (SA, UT, MT, LT) on the affected and unaffected sides in patients with mechanical neck pain. They showed that on the affected side, there was a general weakness in scapular muscle strength. They included subjects with mechanical neck pain, change in cervical symptoms on scapular reposition test, positive on scapular dyskinesis test (SDT), and tightness of upper trapezius and levator scapula and measured...
scapular strength with a handheld dynamometer. Their subjects' selection was based on the abnormality in scapular muscle balance which explains their results.

Additionally, by using a handheld dynamometer (HHD), Petersen and Wyatt (23) found considerably lower strength of LT on the same side of neck pain in individuals with unilateral neck pain than on the contralateral side. Therefore, their results suggested a possible correlation between neck pain and LT muscle weakness. Besides that, Shahidi et al (24) found that patients with chronic neck pain had considerable bilateral weakness of the rhomboids and MT muscles when compared to healthy individuals, providing the first proof of strength deficits in the middle trapezius and rhomboids muscles in chronic neck pain patients. However, they observed no significant differences in LT strength across groups. These discrepancies with our present study's findings might be attributed to the concept that not every subject experiencing neck pain responds and adapts in the same manner, as well as methodological variations across research.

Cools et al. (25) used the Biodex isokinetic dynamometer to design an isokinetic procedure for measuring scapulothoracic protraction and retraction muscle strength. They applied the testing with the shoulder elevated to 90° in the scapular plane, which is 30–40° anterior to the frontal plane. We used the same approach in our testing because it lowers stress on the anterior capsuloligamentous tissues, reduces rotator cuff entrapment under the acromion, and improves congruency between the glenohumeral joint's articular surfaces. Furthermore, it is believed that the scapular plane is a highly functional plane for daily and sports activities (25).

In this study, testing at a higher speed (36.6 cm/sec) resulted in significantly lower strength levels than testing at a lower speed (12.2 cm/sec). This conclusion is consistent with the widespread consensus in the literature that peak isokinetic torque decreases with increasing velocity (25–28).

Although it was assumed that scapular stability is reduced in patients with neck disorders, dynamic scapular stability had not been studied in cervical disorders patients, and treatment guidelines to reestablish normal scapular function in these patients are based on the findings of shoulder studies due to a lack of research in this topic (29). This is, to the best of our knowledge, the first research to use LSST to assess scapular stability in neck pain patients.

The LSST was developed and investigated by Kibler (30) to assess the potential of the scapular stabilizers to control the scapula under different loading positions which necessitate muscular activity from the serratus and trapezius, challenging scapular stabilizers (31). Thus, it was for this reason that we used it in our study.

Unlike the results of Kibler (30), Koslow et al (32) observed that nearly 70% of asymptomatic athletes who received the LSST had not less than 1.5 cm asymmetry in at least one of the three positions, indicating that substantial scapular asymmetry existed in the asymptomatic population. Also, Wright et al. (33) found that scapular asymmetry in both position or motion is unlikely to be a sign of shoulder dysfunction and is not exclusive to people with shoulder disease. In patients with and without shoulder pain, the proportion of those with changed scapular mobility and position (altered stability) was observed to be relatively similar. These findings may be comparable to our own.

Although the LSST is a simple 2-dimensional method for measuring the linear translation of the scapula on the ribs, it is not a comprehensive dynamic test because it cannot account for scapular motions involving rotation and twisting, such as tilting, tipping, and winging of the scapula, but it does rely on static positions (30,31). As a result, its clinical utility in determining substantial scapular positional changes in patients may be limited and debatable.

It is essential to recognize the study's significant limitations. Participants in our study were mostly in their middle age, with chronic neck pain. As a result, the outcomes of the present study would not apply to the elderly or those experiencing acute symptoms. The fact that all of the participants were males could be a major limitation. Our findings should be taken with caution because the female sex has been widely reported as among the greatest and most persistent risk factors for new-onset neck pain (34,35). Although the sample size (30 people) who completed this study provided appropriate data from which some conclusions might be drawn, this sample size may be insufficient to completely answer the research question posed in this study. It's worth mentioning that the Covid-19 restrictions were the reason for our sample size and gender limitations. Future studies will need to use significantly larger sample sizes and include female participants. In addition, we recommend that more precise instruments be used in the assessment procedures.

V- CONCLUSION

CNNP has no statistically significant effect on the scapular muscular strength and scapular stability, however, it does have a clinically relevant effect on patients. These findings may be taken into account in the future treatment of chronic neck pain patients.
REFERENCES