O TESTE DE FLEXÃO CRANIOCERVICAL E O ÍNDICE DO PEITORAL MENOR SÃO OS TESTES ÚTEIS PARA PACIENTES COM SÍNDROME DE DOR SUBACROMIAL?

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Resumo: Distúrbios cervicais e o encurtamento do músculo peitoral menor são apontados como tendo um papel importante em pacientes com síndrome da dor subacromial, apesar da ausência de evidências. Este estudo teve como objetivo comparar a função dos músculos flexores cervicais profundos e o encurtamento do músculo peitoral menor entre pacientes com síndrome da dor subacromial e controles. Secundariamente, este estudo objetivou analisar a relação dos testes clínicos com a dor e incapacidade entre os pacientes com síndrome da dor subacromial. Trata-se de um estudo caso-controle com 32 pacientes com síndrome da dor subacromial (idade: 33 ± 6,9 anos; sexo: 22 (65,6%) homens; dominância direita: 31 (96,9%) e 32 controles pareados por idade, sexo, lateralidade e lado afetado. Os participantes preencheram a Numerical Pain Rating Scale, o Shoulder Pain and Disability Index, realizaram os testes clínicos e os resultados dos pacientes e controles foram comparados. O comprimento do músculo peitoral menor no grupo de pacientes (mediana = 9,0) foi semelhante ao grupo controle (mediana = 9,7) (U = 421,5; p = 0,22). A função do músculo flexor cervical profundo não apresentou diferença estatística entre pacientes e controles (χ² = 4,319; p = 0,504). Não houve correlação estatisticamente significativa entre os testes clínicos e as medidas relatadas pelos pacientes. Portanto, o músculo flexor cervical profundo e o músculo peitoral menor não foram prejudicados em pacientes com síndrome da dor subacromial e não mostraram relação com medidas autorreferidas.

Palavras-chave: dor no ombro; dor cervical; avaliação da funcionalidade; diagnóstico

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ARE CRANIOCERVICAL FLEXION TEST AND THE PECTORALIS MINOR INDEX USEFUL TESTS FOR PATIENTS WITH SUBACROMIAL PAIN SYNDROME?

Abstract: Cervical disorders and the shortening of the pectoralis minor are advocated to play an important role in patients with subacromial pain syndrome, despite the absence of evidence. This study aimed to compare the deep cervical flexor muscle function and the shortening of the pectoralis minor between patients with subacromial pain syndrome and controls. Secondarily, this study aimed to analyze the relationship of clinical tests with pain and disability among patients. This is a case-control study with 32 patients with subacromial pain syndrome [mean age: 33 ± 6.9 years; sex: 22 (65.6%) men; right dominance: 31 (96.9%)] and 32 controls matched for age, sex, handedness, and affected side. Participants filled the Numerical Pain Rating Scale, the Shoulder Pain and Disability Index; and performed the clinical tests which were compared between patients and controls. Pectoralis minor length of the patient’s group (median = 9.0) was similar to the controls (median = 9.7) (U = 421.5; p = 0.22). The deep neck muscle function presented no statistical difference between patients and controls ($\chi^2 = 4.319; p = 0.504$). There was no statistically significant correlation between clinical tests and patient self-reported measures. Therefore, deep cervical flexor muscle and the pectoralis minor muscle were not impaired in patients with subacromial pain syndrome and did not show a relationship with self-reported measures.

Key words: shoulder pain; neck pain; disability evaluation; diagnosis
Introduction

Shoulder pain affects up to 67% throughout life (1) and some patients are still in pain after one year of the onset (2). Over 40% of the patients with shoulder pain have the diagnosis of Subacromial Pain Syndrome (SAPS) (1,3). Patients with SAPS present pain in activities with arms lifting above the shoulder height (2). The SAPS lead to a notable limitation of mobility and functionality (4).

Structural changes have a discrete contribution to SAPS symptoms while functional impairment of the upper quadrant has a meaningful role. The SAPS has been associated with rotator cuff injury, biceps tendon injury, glenohumeral internal rotation deficit (5), scapular dyskinesis (6), and neck pain (7,8). Abnormal alignment of the scapula may lead to SAPS (9) and the scapulohumeral rhythm is affected in most patients with SAPS diagnosis (8). Patients with SAPS present scapular restriction to posterior tilting, external rotation during humeral elevation (10) and the pectoralis minor shortening (9). Such impairments lead to scapular dyskinesia, which is commonly the focus of rehabilitation (11,12). Although the pectoralis minor shortening presents a role in shoulder injuries, its shortening was showed in the asymptomatic population (13). Moreover, the resting pectoralis minor muscle length did not interfere with the scapulothoracic motion during arm elevation tasks in asymptomatic individuals (14). Therefore, the importance of the length of the pectoralis minor for patients with SAPS is not clearly understood.

There is a relationship between shoulder impairment and cervical disorders (15,16). Almost half of shoulder pain cases also report neck pain or neck stiffness (3) and the prevalence of chronic neck-shoulder pain in young adults has increased in recent years (17). However, the mechanism underpinning the relationship between cervical dysfunctions and shoulder symptoms is lacking (18). Patients with neck pain demonstrated an impairment of the cervical deep flexor muscles (19), decrease their activation (20), and show a delay in the activation of these muscles for shoulder movements during the craniocervical flexion test (21).

The craniocervical flexion test is a standard measure used in neck pain patients that present shoulder symptoms frequently. Surprisingly, no studies are investigating the craniocervical flexion test in patients with SAPS. Likewise, the shortening of the pectoralis minor is advocated to be a relevant factor in patients with SAPS despite its occurrence in healthy individuals. Therefore, the current study aimed to compare the deep cervical flexor muscle function and the shortening of the pectoralis minor between patients with SAPS and matched controls. The secondary aim of this study was to analyse the relationship of the clinical tests.
(the craniocervical flexion test and the shortening of the pectoralis minor) with the measures reported by the patients (pain intensity and disability).

Materials and Methods

Study Design

We undertook a secondary analysis of data collected from a previous study by our group aimed to compare the proprioceptive function of the shoulder in patients with SAPS and matched controls (22). The original study was a matched case-control study designed reported following the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) requirements (23). The study included a total of 64 patients, 32 being patients with SAPS and 32 being healthy participants (control group).

Study Participants

Thirty-two patients who sought treatment in the outpatient physiotherapy with symptoms of subacromial pain syndrome in the Physical Functional Rehabilitation Service of the Brazil Navy were included [mean age: 33 ± 6.9 years; sex: 22 (65.6%) men; mean Body Mass Index: 24.9 kg/m2; right dominance: 31 (96.9%)]. The current study included in group SAPS patients with age between 18 and 60 years old; unilateral shoulder pain exacerbated at the end of the range of motion and worsened with prolonged periods of abduction, without significant hypomobility; no previous physical therapy treatment in the last 3 months; and the combination of positive sign in the Hawkins-Kennedy Test and the Neer Sign and negative sign to the Drop Arm Test. The patients were first identified consecutively from the outpatient clinic, and the controls were assembled prospectively. Thirty-two controls matched for age, sex, handedness and affected side who had no complaints of shoulder pain [mean age: 33 ± 6.9 years; sex: 22 (65.6%) men; mean Body Mass Index: 24.4 kg/m2; right dominance: 31 (96.9%)] were selected.

The study excluded participants in both groups who had previous shoulder surgery in the last six months; patients submitted to psychological or psychiatric treatment; patients with bilateral shoulder pain; and patients with a history of glenohumeral dislocation. Besides, we excluded patients suffering from chronic musculoskeletal disorders (i.e., fibromyalgia, rheumatoid arthritis, widespread chronic pain) because of the potential influence of the central sensitization mechanism (24).

The original study was approved by the Research Ethics Committee of the Hospital
Naval Marcílio Dias (number: 50480515.7.0000.5256), in accordance with the Helsinki Declaration for research in humans. All patients who met the eligibility criteria signed the informed consent form before the study procedures. All cases and controls were evaluated at the Laboratório de Pesquisa em Ciências do Exercício at CEFAN, Brazilian Navy (LABOCE – BN, RJ, Brazil).

**Procedures**

Patients were referred for an initial evaluation consisting of the clinical history and physical examination that was performed by a physiotherapist (examiner 1). Participants filled a self-reported questionnaire including the personal information (age, sex, weight, height), pain characteristics (pain region, duration of pain and associated symptoms); and physical examination consisting of the Hawkins-Kennedy Test, Neer Signal, and Drop Arm Test. The Numerical Pain Rating Scale (NPRS) was used for the evaluation of pain intensity and Shoulder Pain and Disability Index (SPADI) questionnaire was used for the assess of shoulder disability. The completion of all questionnaires was supervised by one of the examiners for clarification, in case of uncertainties and the completion lasted approximately 10 minutes per participant. The physiotherapist (examiner 2) who performed the craniocervical flexion test and Pectoralis Minor Index evaluation were blinded to the cases and control groups. The two examiners involved were physiotherapists with 11 years of work experience in treating patients with musculoskeletal disorders.

**Measuring Instruments**

**Pain intensity**

Pain intensity was measured during the initial evaluation using the Numeric Pain Rating Scale (NPRS) from 0 (no pain) to 10 (worst pain possible). Patients were oriented to rate their pain intensity at the moment of the initial evaluation. The NPRS has a Portuguese Brazilian version valid and reliable for assessing patients with shoulder disorders (25).

**Functional Capacity Assessment**

The functional capacity was assessed by Brazilian version of Shoulder Pain and Disability Index (SPADI) (26). Pain and disability associated with shoulder dysfunctions are often assessed by SPADI (27), which is the most used measure to evaluate activity limitations in patients with shoulder pain, among patient-reported outcomes (28). The SPADI
demonstrated strong psychometric properties. Positive evidence was found indicating internal consistency, high values of reliability, moderate positive evidence for construct structural validity, and responsiveness for the use of the SPADI in the assessment of patients with shoulder pain (28). Scores were calculated for the Pain Domain (5 items), Disability Domain (8 items), and Total score (the average of the two domains) for last week period. The questions are scored from 0 (best) to 100 (worst).

Clinical Tests

*Craniocervical Flexion Test (CCFT).* The evaluation of the deep neck muscles function was performed using the CCFT (29). The test was conducted with participants in the supine position with a neutral neck position. The biofeedback unit deflated (Chatanooga Ltd Hixson, USA) attached to a pressure transducer was placed behind the neck, at the occipital region. The equipment was inflated to a stable baseline pressure of 20 mmHg. In the initial phase, a smooth nodding action, as saying “Yes” with the head, was requested. This progressive movement increases the pressure from 20 mmHg to 22, 24, 26, 28 and 30 mmHg. The patient tries to maintain the isometric contraction for 2 to 3 seconds in each position. In the second phase, participants had to maintain an isometric contraction for 10 seconds on the target pressure specified by the assessor before returning to the neutral position. Three 10-seconds repetitions were performed without the use of replacement strategies for the progression of the test until the new target pressure (29). The CCFT shows substantial reliability to near-perfect between the same examiners and almost perfect between different examiners (30–32).

*Pectoralis Minor Index (PMI).* Participants were evaluated in the supine position with the elbow extended, arms along the body and hand palms on the stretcher to reduce postural imbalance and optimize the relaxation of the muscles involved (33). Two anatomical landmarks that represent the pectoralis minor length (PML) were used: (1) the medial-inferior angle of the coracoid process, and (2) the inferior aspect of the fourth rib. The distance between these two points was measured by a calliper and the average of three measures for each participant was calculated. Patients were evaluated in the affected side while the controls were evaluated in the same matched side of the symptomatic group. Participants were instructed to exhale before measurement and to inhale after measurement to neutralize variations in muscle length resulting from breathing variation. The PMI was expressed as a percentage of the subject’s height using the following formula PMI = PML/height x 100, in cm (13). We calculated the mean value of three attempts and asked the subject to raise between the measures (34). The measure of the
PMI was previously described and shows good to excellent reliability among the same examiners and low to moderate among different examiners (35).

**Statistical Analysis**

The demographic and clinical variables of the study population were presented as mean and standard deviation for continuous variables. Categorical variables are presented numerically and as a percentage of the sample. The normal distribution of the clinical tests was verified by the Shapiro-Wilk test. The groups (symptomatic and control) were compared by Mann-Whitney U-test for the shortening of the pectoralis minor, due to the non-parametric distribution. The deep neck muscles function was investigated by the proportions of the highest-pressure level achieved on the craniocervical flexion test among groups using the chi-square test ($\chi^2$). The correlation analysis between clinical measures (the craniocervical flexion test and the shortening of the pectoralis minor) and the patient self-reported measures (pain intensity and disability) among patients with SAPS was performed using the Spearman’s correlation coefficient. The correlation above 0.90 was interpreted as very high, from 0.70 to 0.89 as high, from 0.50 to 0.69 as moderate, from 0.30 to 0.49 as low and below 0.29 as mild (36). A significance level of less than 5% (P < .05) was considered for all analyses. The statistical analysis was performed using Statistical Package for Social Sciences (SPSS version 22.0, IBM Corporation, Armonk, New York, USA). Given the lack of sample size calculation due to the secondary analysis, a post hoc power analyses were performed to determine whether the sample size was large enough for the findings to be statistically valid and to examine the potential for type II errors. The post hoc analysis was conducted in G*Power Software version 3.1.9 (Heinrich-Heine-Universität, Düsseldorf, Germany).

**Results**

**Participants Characteristics**

Patients with SAPS showed mild pain intensity (mean: 3±2) and moderate levels of impairment in the three domains of SPADI questionnaire (total mean: 35.6±19.1%; pain mean: 46.7±25.1%; disability mean: 28.6±17.1%).

**Clinical tests comparison between patients with SAPS and controls**

Table 1 describes the comparison of the pectoralis minor index and the craniocervical flexion test between the SAPS group and matched controls. The Mann-Whitney U test showed
no significance difference between the PMI median of the SAPS group (median = 9.0; 95% Confidence intervals (95%CI) = 8.8-9.4) and the PMI median of the control group (median = 9.7; 95%CI = 8.8-9.8) (U=421.5; p = 0.22; power = 0.52). Similarly, the deep neck muscles function presented no statistical difference between the SAPS group and controls (χ²= 4.319; p = 0.504) (Table 1). The power analysis based on z-tests for testing the independent proportions showed a power between 0.06 and 0.45.

Table 1 – Comparison of the Craniocervical Flexion Test and the Pectoralis Minor Index between patients with subacromial pain syndrome and controls.

<table>
<thead>
<tr>
<th>Clinical Tests Variables</th>
<th>SAPS Group</th>
<th>Control Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectoralis Minor Index, median (IQR)</td>
<td>9.0 (8.4-9.6)</td>
<td>9.7 (8.3-10.2)</td>
<td>0.22</td>
</tr>
<tr>
<td>Craniocervical Flexion Test, mmHg</td>
<td></td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>Level 1 – 20 mmHg</td>
<td>10 (31.3%)</td>
<td>6 (18.8%)</td>
<td></td>
</tr>
<tr>
<td>Level 2 – 22 mmHg</td>
<td>8 (25.0%)</td>
<td>7 (21.9%)</td>
<td></td>
</tr>
<tr>
<td>Level 3 – 24 mmHg</td>
<td>10 (31.3%)</td>
<td>9 (28.1%)</td>
<td></td>
</tr>
<tr>
<td>Level 4 – 26 mmHg</td>
<td>1 (3.1%)</td>
<td>5 (15.6%)</td>
<td></td>
</tr>
<tr>
<td>Level 5 – 28 mmHg</td>
<td>2 (6.3%)</td>
<td>3 (9.4%)</td>
<td></td>
</tr>
<tr>
<td>Level 6 – 30 mmHg</td>
<td>1 (3.1%)</td>
<td>2 (6.3%)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Data are presented as median (IQR 25-75%) for continuous variables and as frequency counts (%) for categorical variables. Significant differences between groups were tested using the nonparametric test of Mann-Whitney U for continuous variables or the Chi-square test for categorical variables. Abbreviations: SAPS Group, Subacromial Pain Syndrome. IQR, Interquartile range.

Correlation of the clinical tests with pain intensity and shoulder disability

There was no statistically significant correlation between the deep cervical flexor muscle function and the shortening of the pectoralis minor with pain intensity and shoulder disability, as shown in Table 2. The power analysis based on the bivariate normal model for testing the correlation showed a power between 0.43 and 0.73.
Table 2 – Correlation analysis between clinical measures and the patient self-reported measures among patients with Subacromial Pain Syndrome (n=32).

<table>
<thead>
<tr>
<th>Clinical tests</th>
<th>Pain intensity</th>
<th>Shoulder Pain and Disability Index (Disability)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Disability</td>
</tr>
<tr>
<td>Craniocervical Flexion Test</td>
<td>-0.10</td>
<td>-0.17</td>
</tr>
<tr>
<td>Pectoralis Minor Index</td>
<td>-0.16</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Note: Values expressed were obtained using the Spearman’s correlation coefficient. There was no statistical significance for any correlation ($p>0.05$).

Discussion

Participants with SAPS presented a similar performance for the clinical tests assessing the deep cervical muscles and pectoralis minor compared to a matched control group. Moreover, the activation of the deep cervical muscles and the length of the pectoralis minor muscle were not associated with the pain intensity and shoulder disability. Our findings challenge the clinical usefulness of those two clinical tests for the evaluation of patients with SAPS.

Notably, the participants with SAPS did not demonstrate a shortening of the pectoralis minor, and its length was not related to the intensity of pain. The pectoralis minor shortening test is one of the most used tests by clinicians to assess the scapular evaluation (34). The pectoralis minor muscle is shortened in people with scapular protraction (37) and this stretching is suggested in rehabilitation algorithms of scapular dyskinesis and shoulder pain (11,12). However, the association between shortening of the pectoralis minor muscle and SAPS is not so evident. Possibly, the pectoralis minor muscle may influence the scapular dynamics and not the static positioning of the scapula in patients with SAPS (13,38), despite the absence of the relationship between scapular motion and resting pectoralis minor muscle length on asymptomatic individuals (14). The decrease of the pectoralis minor muscle stiffness leads to an increase in the external rotation and posterior tilt of the scapula in healthy individuals (39). Thus, the assessment of the pectoralis minor muscle in a static position should be avoided during the exam of the SAPS due to the lack of clinical advantage.

The activation of the deep cervical muscles was not impaired as well as the scapular misalignment in participants with SAPS. Changes in scapular alignment or dysfunctional shoulder movements have the potential to alter the biomechanics of the cervical spine, leading to neck pain (16,40). However, this hypothesis was not confirmed in the current study. The tests
used in the present study did not evaluate the dynamic function of the shoulder with scapular motion and cervical dysfunction synchronously. Previous studies have evaluated these relationships dynamically but in isolation, finding an association in the patterns and corrections with the symptoms present in the impact syndrome impingement (41–44). Reasonably, the presence of the neck dysfunction and the changes in scapular position may only occur in a dynamic analysis, which is recommended to be investigated in future studies of patients with SAPS.

The neck dysfunction and the resting pectoralis muscle length were not related to shoulder pain in the current study. The relationship between shoulder pain and neck dysfunction cannot be neglected for patients with SAPS (7). Moreover, there is a relationship between shoulder pain with thoracic spine disorders (45,46) and neck dysfunctions (3,17,18,47). The assessment of the neck dysfunction comprises many tests (i.e., cervical flexion-rotation test, passive accessory intervertebral movements, Spurling test, traction/distraction test, and Upper Limb Tension Test) which can be useful for the identification of the neck dysfunction in subsequent research (48,49). The craniocervical flexion test may not be the appropriate test to identify the neck dysfunction. The SAPS may represent a particular condition among the shoulder pain diagnoses that do not influence the neck dysfunction. On the other hand, the pectoralis minor length was poorly associated with the level of pain intensity in individuals with chronic shoulder pain (50) corroborating our findings in participants with SAPS.

The treatment of patients with SAPS is performed by managing several factors, in addition to scapular alignment and cervical dysfunction, since pain is a multifactorial experience. A daily home stretching protocol of the pectoralis minor muscle reduced pain and improved function in patients with shoulder pain, despite the similar pectoralis minor length at the post-intervention evaluation (51). Thus, the mechanisms underpinning the clinical improvement of shoulder pain is not related to the pectoralis minor muscle length. Also, psychological and social factors can affect shoulder pain (52), therefore, a neurocognitive rehabilitation should be considered to treat these patients. These factors were not evaluated in the current study and should be considered in future researches investigating SAPS.

**Limitations of the Study**

We recognize some limitations of the present study. The participants with SAPS were predominantly men in their 30s which is different from the patients with shoulder pain previously described (i.e. female predominance and middle-aged adults) (53). Though, the
A previous study with the military population showed a higher risk of SAPS in men (54). The power analysis found low values in all tests, which represent an excessive risk of type II error. For this reason, our results should be interpreted with caution. We performed the power analysis because the sample size calculation was determined for a previous study. Therefore, the lack of a statistically significant difference in the clinical tests observed in our study may be due to inadequate power or a true absence of difference between patients with SAPS and controls. Future studies with larger sample sizes should investigate the deep cervical flexor muscle function and the shortening of the pectoralis minor in patients with SAPS.

**Conclusion**

The performance of the deep cervical flexor muscle and the length of the pectoralis minor muscle showed similar results in participants with Subacromial Pain Syndrome and asymptomatic controls. Also, there was no correlation between self-reported measures (pain and disability) and neck dysfunction and pectoralis minor shortening in Subacromial Pain Syndrome group.

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