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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 (χ^2 = 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

Afiliação

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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 in balance 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 ($\chi2$). 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 ($\chi 2$= 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.

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

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).

Clinical tests	Pain intensity	Shoulder Pain and Disability Index (Disability)		
		Disability	Pain	Total
Craniocervical Flexion Test	-0.10	-0.17	-0.19	-0.17
Pectoralis Minor Index	-0.16	-0.12	-0.16	-0.16

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 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.

References

1. Luime JJ, Koes BW, Hendriksen IJM, Burdorf A, Verhagen AP, Miedema HS, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. Scand J Rheumatol. 2004;33(2):73–81.
2. van der Windt DA, Koes BW, Boeke AJ, Devillé W, De Jong BA, Bouter LM. Shoulder disorders in general practice: prognostic indicators of outcome. Br J Gen Pract J R Coll Gen Pract. 1996 Sep;46(410):519–23.
3. van der Windt DA, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. Ann Rheum Dis. 1995;54(12):959–64.
4. Skolimowski J, Demczuk-Włodarczyk E, Barczyk K, Anwajler J, Skolimowska B. Analysis of three-dimensional motion of the glenohumeral joint in impingement syndrome. Ortop Traumatol Rehabil. 2008;10(6):554–65.
5. Cools AM, Declercq G, Cagnie B, Cambier D, Witvrouw E. Internal impingement in the tennis player: rehabilitation guidelines. Br J Sports Med. 2008;42(3):165–71.
6. Ludewig PM, Reynolds JF. The association of scapular kinematics and glenohumeral joint pathologies. J Orthop Sports Phys Ther. 2009;39(2):90–104.

7. Abbassian A, Giddins GE. Subacromial impingement in patients with whiplash injury to the cervical spine. J Orthop Surg Res. 2008;3(1):9–12.

8. Chauhan SK, Peckham T, Turner R. Impingement syndrome associated with whiplash injury. J bone Jt Surg. 2003;85:408–10.

9. Borstad JD. Resting position variables at the shoulder: evidence to support a posture-impairment association. Phys Ther. 2006;86(4):549–57.

10. Struyf F, Nijs J, Baeyens JP, Mottram S, Meeusen R. Scapular positioning and movement in unimpaired shoulders, shoulder impingement syndrome, and glenohumeral instability. Scand J Med Sci Sport. 2011;21(3):352–8.

11. Cools AM, Struyf F, De Mey K, Maenhout A, Castelein B, Cagnie B. Rehabilitation of scapular dyskinesis : from the of fi ce worker to the elite overhead athlete. Br J Sports Med. 2014;48(8):692–7.

12. Klintberg IH, Cools AMJ, Holmgren TM, Moser JS, Spunton V, Ginn K. Consensus for physiotherapy for shoulder pain. Int Orthop. 2015;39(4):715–20.

13. Borstad JD, Ludewig PM. The effect of long versus short pectoralis minor resting length on scapular kinematics in healthy individuals. J Orthop Sports Phys Ther. 2005;35(4):227–38.

14. Ebaugh D, Pollen T, Mohring J, Gerrity K, Goodstadt N, Finley M. Brazilian Journal of Pectoralis minor muscle elongation and scapulothoracic motion do not differ in individuals with short versus typical resting pectoralis minor muscle length : a cross-sectional study. Brazilian J Phys Ther [Internet]. 2018;22(6):519–26. Available from: https://doi.org/10.1016/j.bjpt.2018.05.003

15. Caldwell C, Sahrmann S, Van Dillen L. Use of a movement system impairment diagnosis for physical therapy in the management of a patient with shoulder pain. J Orthop Sports Phys Ther. 2007;37(9):551–63.

16. Szeto GPY, Straker L, Raine S. A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. 2002;33:75–84.

17. Hagen K, Linde M, Heuch I, Stovner LJ, Zwart J. Increasing Prevalence of Chronic Musculoskeletal Complaints. A Large 11-Year Follow-Up in the General Population (HUNT 2 and 3). Pain Med. 2011;12(11):1657–66.

18. Wassinger CA, Rich D, Cameron N, Clark S, Davenport S, Lingelbach M, et al. Cervical & thoracic manipulations: Acute effects upon pain pressure threshold and self-reported pain in experimentally induced shoulder pain. Man Ther [Internet]. 2016;21:227–32. Available from: http://dx.doi.org/10.1016/j.math.2015.08.009

19. Kim JY, Kwag K il. Clinical effects of deep cervical flexor muscle activation in patients with chronic neck pain. J Phys Ther Sci. 2016;28(1):269–73.

20. Jull G, Kristjansson E, Alba PD. Impairment in the cervical flexors : a comparison of whiplash and insidious onset neck pain patients. Man Ther. 2004;9(2):89–94.

21. Falla D, Hons B, Bilenkij G, Hons B, Jull G. Patients With Chronic Neck Pain Demonstrate Altered Patterns of Muscle Activation During Performance of a Functional Upper Limb Task. Spine (Phila Pa 1976). 2004;29(13):1436–40.

22. Gomes BSQ, Coelho VK, Terra BS, Bunn PS, Saragiotto BT, Ferreira AS, et al. Patients with Subacromial Pain Syndrome Present no Reduction of Shoulder Proprioception : A Matched Case-Control Study. Pm&r. 2019;11(9):972–8.

23. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. Bull World Health Organ. 2007;85(11):867–72.

24. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. Pain. 2011;152(3):S2–15.

25. Alouche SR, Oliveira L, Costa P, Puga VO, Lopes AD, Shiwa SR, et al. Clinimetric testing supports the use of 5 questionnaires adapted into Brazilian Portuguese for patients with shoulder disorders. J Orthop Sport Phys Ther. 2013;43(6):404–13.

26. Martins J, Napoles B V, Hoffman CB, Oliveira AS. The Brazilian version of Shoulder Pain and Disability Index: translation, cultural adaptation and reliability. Rev Bras Fisioter. 2010;14(6):527–36.

27. Roach KE, Budiman-muk E, Songsiridej N, Lertratanakul Y. Development of a Shoulder Pain and Disability Index. Arthritis Rheum Off J Am Coll Rheumatol. 1991;4(4):143–9.

28. Thoomes-de Graaf M, Scholten-Peeters, G. G. M., Schellingerhout JM, Bourne AM, Buchbinder R, Koehorst M, Terwee CB, et al. Evaluation of measurement properties of self-administered PROMs aimed at patients with non-specific shoulder pain and '"activity limitations"': a systematic review. Qual Life Res. 2016;25(9):2141–60.

29. Jull G, O'Leary S, Falla D. Clinical assessment of the deep cervical flexor muscles: the craniocervical flexion test. J Manipulative Physiol Ther. 2008;31(7):525–33.

30. Arumugam A, Mani R, Raja K. Interrater reliability of the craniocervical flexion test in asymptomatic individuals - a cross-sectional study. J Manipulative Physiol Ther [Internet]. 2011;34(4):247–53. Available from: http://dx.doi.org/10.1016/j.jmpt.2011.04.011

31. James G, Doe T. The craniocervical flexion test: Intra-tester reliability in asymptomatic subjects. Physiother Res Int. 2010;15(3):144–9.

32. Juul T, Langberg H, Enoch F, Søgaard K. The intra- and inter-rater reliability of five clinical muscle performance tests in patients with and without neck pain. BMC Musculoskelet Disord. 2013;14:1–15.

33. Cools AM, Johansson FR, Cambier DC, Velde A V., Palmans T, Witvrouw EE. Descriptive profile of scapulothoracic position, strength and flexibility variables in adolescent elite tennis players. Br J Sports Med. 2010;44(9):678–84.

34. Borstad JD. Measurement of pectoralis minor muscle length: validation and clinical application. J Orthop Sport Phys Ther. 2008;38(4):169–74.

35. Struyf F, Meeus M, Fransen E, Roussel N, Jansen N, Truijen S, et al. Interrater and intrarater reliability of the pectoralis minor muscle length measurement in subjects with and without shoulder impingement symptoms. Man Ther [Internet]. 2014;19(4):294–8. Available from: http://dx.doi.org/10.1016/j.math.2014.04.005

36. Hinkle DE, Wiersma W, Jurs SG. Applied statistics for the behavioral sciences. Vol. 663. Houghton Mifflin College Division; 2003.

37. Borstad JD, Ludewig PM. Comparison of three stretches for the pectoralis minor muscle. J shoulder Elb Surg. 2006;15(3):324–30.

38. Araújo ADS, Nogueira LAC. Relação entre a coluna torácica e a função do ombro: relação estática ou dinâmica? Fisioter Bras. 2011;12(21):147–53.

39. Umehara J, Nakamura M, Nishishita S, Tanaka H, Kusano K, Ichihashi N. Scapular kinematic alterations during arm elevation with decrease in pectoralis minor stiffness after stretching in healthy individuals. J Shoulder Elb Surg [Internet]. 2018;27(7):1214–20. Available from: https://doi.org/10.1016/j.jse.2018.02.037

40. Griegel-Morris P, Larson K, Mueller-Klaus K, Oatis CA. Incidence of Common Postural Abnormalities in the Cervical , Shoulder , and Thoracic Regions and Their Association with Pain in Two Age Groups of Healthy Subjects. Phys Ther. 1992;72(6):425–31.

41. Kibler W Ben, Sciascia A, Dome D. Evaluation of Apparent and Absolute Supraspinatus Strength in Patients With Shoulder Injury Using the Scapular Retraction Test. Am J Sports Med. 2006;34(10):1643–7.

42. Lewis JS. Rotator cuff tendinopathy/subacromial impingement syndrome: is it time for a new method of assessment? Br J Sports Med. 2009;43(4):259–64.

43. Rabin A, Irrgang JJ, Fitzgerald GK, Eubanks A. The intertester reliability of the scapular

assistance test. J Orthop Sports Phys Ther. 2006;36(9):653–60.

44. Tate AR, Mcclure P, Kareha S, Irwin D. Effect of the scapula reposition test on shoulder impingement symptoms and elevation strength in overhead athletes. J Orthop Sport Phys Ther. 2008;38(1):4–11.

45. Michener LA, Kardouni JR, Sousa CO, Ely JM. Validation of a sham comparator for thoracic spinal manipulation in patients with shoulder pain. Man Ther [Internet]. 2015;20(1):171–5. Available from: http://dx.doi.org/10.1016/j.math.2014.08.008

46. Riley SP, Bialosky J, Cote MP, Swanson BT, Tafuto V, Sizer PS, et al. Thoracic spinal manipulation for musculoskeletal shoulder pain: Can an instructional set change patient expectation and outcome? Man Ther. 2015;20(3):469–74.

47. Xie YF, Szeto G, Madeleine P, Tsang S. Spinal kinematics during smartphone texting – A comparison between young adults with and without chronic neck-shoulder pain. Appl Ergon [Internet]. 2018;68(February 2017):160–8. Available from: https://doi.org/10.1016/j.apergo.2017.10.018

48. Bier JD, Scholten-peeters WGM, Staal JB, Pool J, Van MW, Beekman E, et al. Clinical Practice Guideline for Physical Therapy Assessment and Treatment in Patients With Nonspecific Neck Pain. Phys Ther. 2018;98(3):162–71.

49. Rubio-Ochoa J, Benítez-Martínez J, Lluch E, Santacruz-Zaragozá S, Gómez-Contreras P, Cook CE. Physical Examination Tests for Screening and Diagnosis of Cervicogenic Headache: A Systematic Review. Man Ther [Internet]. 2016;21:35–40. Available from: http://dx.doi.org/10.1016/j.math.2015.09.008

50. Navarro-Ledesma S, Fernandez-Sanchez M, Luque-Suarez A. Does the pectoralis minor length influence acromiohumeral distance, shoulder pain- function and range of movement? Phys Ther Sport [Internet]. 2018;34:43–8. Available from: https://doi.org/10.1016/j.ptsp.2018.08.009

51. Rosa DP, Borstad JD, Pogetti LS, Camargo PR. Effects of a stretching protocol for the pectoralis minor on muscle length, function , and scapular kinematics in individuals with and without shoulder pain. J Hand Ther [Internet]. 2016;30(1):20–9. Available from: http://dx.doi.org/10.1016/j.jht.2016.06.006

52. Wolfensberger A, Vuistiner P, Konzelmann M, Plomb-holmes C, Le B. Clinician and Patient-reported Outcomes Are Associated With Psychological Factors in Patients With Chronic Shoulder Pain. Clin Orthop Relat Res. 2016;474(9):2030–9.

53. Juel NG, Natvig B. Shoulder diagnoses in secondary care, a one year cohort. BMC

Musculoskelet Disord. 2014;15(1):1–8.

54. Hsiao MS, Cameron KL, Tucker CJ, Benigni M, Blaine TA, Owens BD. Shoulder impingement in the United States military. J Shoulder Elb Surg [Internet]. 2015;24(9):1486–92. Available from: http://dx.doi.org/10.1016/j.jse.2015.02.021