Comparison of isometric muscle strength between painful and non-painful shoulders in patients with symptoms of subacromial impingement

Comparação da força da musculatura isométrica entre ombro doloroso e não doloroso em pacientes com sintomas de impacto subacromial

Elias Pereira de Almeida[1], Marcelo Eder Salgasso[1], Anamaria Siriani de Oliveira[2], Thiele de Cássia Libardoni[2]

DOI 10.5935/2595-0118.20200201

ABSTRACT

BACKGROUND AND OBJECTIVES: The subacromial impingement syndrome is a dysfunction of the glenohumeral joint which can cause pain, functional disability, dependence, and low quality of life. The aim of this study was to compare the muscle strength between painful and non-painful shoulders and to verify the relationship between shoulder pain and disability and isometric muscle strength of the upper limb and kinesiophobia level in individuals with symptoms of subacromial impingement syndrome.

METHODS: Twenty volunteers with symptoms of subacromial impingement syndrome participated in the study. The evaluation was carried out by means of an evaluation form, the Shoulder Pain and Disability Index questionnaire (SPADI - BRAZIL) to assess disability and shoulder pain and the TAMPA questionnaire to analyze the level of kinesiophobia. The evaluation of shoulder isometric muscle strength was performed using the Manual Hand-Held Dynamometer stabilized by a rigid band in the movements of flexion, extension, abduction and internal and external rotation of the shoulder.

RESULTS: In the comparison of muscle strength between symptomatic and asymptomatic side, evidence of significant difference ($p<0.05$) was verified for all movements evaluated. There was a significant negative relationship between shoulder pain and disability index and isometric muscle strength of flexion and internal rotation, and a significant positive relationship with the level of kinesiophobia.

CONCLUSION: Individuals with symptoms of subacromial impingement syndrome showed a significant reduction in muscle strength of the symptomatic shoulder. The shoulder pain and disability index is related to the isometric muscle strength of the shoulder and to the level of kinesiophobia.

Keywords: Muscle strength, Muscle strength dynamometer, Physical therapy modalities, Shoulder impingement syndrome.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A síndrome do impacto subacromial é uma disfunção da articulação glenoumeral, podendo gerar dor, incapacidade funcional, dependência e baixa qualidade de vida. O objetivo deste estudo foi comparar a força muscular isométrica entre ombro doloroso e não doloroso e verificar a relação entre dor e incapacidade no ombro e força muscular isométrica do ombro e nível de cinesiofobia em indivíduos com sintomas de síndrome do impacto subacromial.

MÉTODOS: Participaram do estudo 20 voluntários com sintomas de síndrome do impacto subacromial. A avaliação foi realizada por meio de ficha de avaliação, questionário Shoulder Pain and Disability Index (SPADI - BRASIL) para avaliação da incapacidade e dor no ombro e questionário TAMPA para analisar o nível de cinesiofobia. A avaliação da força muscular isométrica do ombro foi realizada utilizando o instrumento Manual *Hand-Held Dynamometer* estabilizado por faixa rígida nos movimentos de flexão, extensão, abdução, rotação interna e externa do ombro.

RESULTADOS: Na comparação de força muscular isométrica entre lado sintomático e assintomático foi verificada evidência de diferença significativa ($p<0,05$) para todos os movimentos avaliados. Houve relação negativa significativa entre índice de dor e incapacidade no ombro e força muscular isométrica no movimento de flexão e rotação interna, além de relação positiva significativa com nível de cinesiofobia.

CONCLUSÃO: Indivíduos com sintomas de síndrome do impacto subacromial apresentaram redução significativa da força muscular isométrica do ombro sintomático. O índice de dor e incapacidade no ombro está relacionado com força muscular isométrica do ombro e com nível de cinesiofobia.

Descritores: Dinamômetro de força muscular, Fisioterapia, Força muscular, Síndrome do impacto do ombro.

INTRODUCTION

The Subacromial Impingement Syndrome (SIS) is considered a degenerative and inflammatory disease, featuring the impaction

Elias Pereira de Almeida – https://orcid.org/0000-0001-9073-8719;
Marcelo Eder Salgasso – https://orcid.org/0000-0002-4567-8531;
Anamaria Siriani de Oliveira – https://orcid.org/0000-0001-5854-0016;
Thiele de Cássia Libardoni – https://orcid.org/0000-0002-9607-6813.

1. Centro Universitário UNIFAFIBE, Departamento de Fisioterapia, Bebedouro, SP, Brasil.
2. Universidade de São Paulo, Faculdade de Medicina de Ribeirão Preto, Departamento de Ciências da Saúde, Programa de Pós-Graduação em Reabilitação Funcional, Ribeirão Preto, SP, Brasil.

Submitted on January 11, 2020
Accepted for publication on Semptember 11, 2020
Conflict of interests: none – Sponsoring sources: none.

Correspondence to:
Elias Pereira de Almeida
Rua Professor Enjolrras Vampré, 201, Bloco 4, Ap. 43 – Vila Santa Cândida
15091-290 São José do Rio Preto, SP, Brasil.
E-mail: eliasalmeidap@gmail.com

and/or compression of myotendinous structures present in the glenohumeral joint[1]. This syndrome has a progressive character associated with the cumulative effect of the impact, which may result in microlesions in the structures, fibrosis of the subacromial bursa, tendinopathies or even rupture of the rotator cuff[2].

The causes of SIS are: rotator cuff muscle weakness, acromion abnormality, post trauma joint instability, ligament laxity, repetitive trauma and excessive use of the shoulder in work activities[3,4]. It's considered the most frequent of the shoulder disorders and can generate pain, functional disability, dependence and low quality of life[5]. More prevalent in females, it's more common between 25 and 64 years of age[6]. Among chronic diseases that cause shoulder pain, SIS is responsible, on average, for 40 to 60% of diagnoses[1,7,8].

The main symptoms of SIS are pain and loss of shoulder function, which can lead to decreased muscle strength[9]. Some studies demonstrate this association, observing significant loss of strength in external rotation, internal rotation and abduction movements of the painful shoulder[10,11].

Current studies have shown that individuals with SIS tend to present a high degree of kinesiophobia, but it's not certain if these findings are related to shoulder pain and disability, which is important to understand the factors that can alter the functionality of this joint complex[12,13].

There is a belief that individuals with SIS have reduced muscle strength in specific shoulder movements and that pain and disability in this region may be related to this reduction. The knowledge of muscle strength reduction is of great relevance when treating this disorder, specially using equipment of good reliability. In addition to that, this measurement is important for the precise functional-kinetic diagnosis and treatment based on the specific changes of this disorder for the individual.

The present study's objective was to compare isometric muscle strength between painful and non painful shoulder and verify the relation of shoulder pain and disability with isometric muscle strength and level of kinesiophobia in individuals with symptoms of the subacromial impingement syndrome.

METHODS

Cross-sectional observational study, including males and females with a history of unilateral shoulder pain and who tested positive for at least three of the following subacromial impingement tests: Hawkins-Kennedy, Neer, Empty Can, painful arch and resistance to external rotation. Positive results on these tests were considered indicative of subacromial impingement diagnostic symptoms[14].

The individuals excluded from the study were those who had a history of shoulder dislocation, glenohumeral joint instability, shoulder complex fracture, tendinous and/or ligamentous injury or total rupture in the upper limbs, carpal tunnel syndrome, systemic diseases, and who were undergoing physiotherapeutic treatment.

The study participants were selected for convenience. The initial screening was done through the referral guides received at the physiotherapy school clinic of the UNIFAFIBE University Center, in addition, the researchers announced the research in electronic media and posters. Those with potential for inclusion were scheduled to attend the school clinic, where they were evaluated and clarified about the stages and objectives of the research. All individuals who agreed to participate in the research signed the Free and Informed Consent Term (FICT).

Through the evaluation form, the data of pain prevalence, pain intensity, involved shoulder and diagnostic hypothesis were collected. The Shoulder Pain and Disability Index (SPADI - BRASIL) was used to evaluate shoulder pain and disability.

SPADI presents 13 items distributed in a pain subscale with five items and disability with eight items, with each item scored from zero to 10 points. The final questionnaire score and the scores obtained separately for each domain are converted into percentages for values ranging from zero to 100, the highest score indicating the worst condition of shoulder disorder[15]. The TAMPA scale was used for the evaluation of kinesiophobia, containing 17 questions that assess pain, intensity and symptoms. The minimum score is 17 and the maximum is 68 points; the higher the score, the higher the level of kinesiophobia[16].

After initial evaluation, the volunteers were submitted to the assessment of the shoulder's isometric muscle strength, with the help of the manual Hand-Held Dynamometer (HHD), Lafayette, model 01165.

Before and after the muscle strength measurements, the report of pain was measured using the visual analog scale (VAS). The VAS is considered a reliable and validated measure, and the evaluation is based on the individual's report, represented with numbers from zero to 10, with zero being no pain and 10 the worst possible pain[17,18].

The movements for the muscle strength evaluation were: flexion, extension, abduction and external and internal rotation of the shoulder.

The "make test" format was used for measurements during the tests: the examiner keeps the dynamometer stopped while the volunteer performs the specific movement of each test against the apparatus, producing muscle strength in isometric contraction at specific amplitudes described below, generating greater torque capacity in accordance with the rule of length - muscle tension of each individual[19].

During all movements a rigid band was used as a resistance method for the execution of isometric contraction.

To measure muscle strength in the movement of shoulder flexion, the volunteer sat with the shoulder flexed at 90º, elbow stretched, neutral wrist, with the HHD in the distal region of the humerus involved by the rigid band attached to the chair.

To evaluate the movement of shoulder extension, the volunteer sat with the upper limb set aside the body, elbow stretched, neutral wrist, with the HHD between a wall and the posterior distal region of the humerus.

For the abduction movement, the volunteer sat with the shoulder abducted at 90º, elbow stretched, neutral fist, with the HHD in the distal region of the humerus involved by the rigid band fixed to the chair.

For the external rotation movement, the volunteer sat with the limb set aside the body, Elbow flexed at 90º, neutral fist, with the HHD positioned on the fist involved by the rigid band attached to the chair.

For the internal rotation of the shoulder, the volunteer sat with the limb set aside the body, elbow flexed at 90º, neutral fist, with

the HHD positioned on the fist involved by the band attached to a backrest.

The strength measurement unit used was kilograms (kg). The instrument was programmed with a pressure threshold to trigger the measurement of strength at 5 kg, thus, the measurement was only initiated after expressive muscle activity.

Each movement was performed three times with isometric contraction maintained for 5s against the resistance of the rigid band that was involved in the device, 30s rest interval between the series, considering that the shorter rest interval between measurements could cause fatigue and thus influence the reliability of the measurement[19].

During the intervals the participant was questioned in regard to the intensity of pain and their capacity to continue with the measurements. The verbal command with the intent of stimulating the peak of maximum strength was given during the whole measurement. At the end of each movement, the obtained result was recorded by the evaluator for the posterior data analysis.

Statistical analysis

Both results extracted from the questionnaires, scales and tests were previously evaluated. For the comparison values between painful and non painful shoulder, the dependent t test was used, in which will be presented the Confidence interval, difference between the means, evidence of significant difference - $p<0.05$ and the size of the difference effect: smaller than 5 - moderate effect size; larger than 5 - large effect size.

In order to verify the relationship between the variables, the Pearson's correlation test was used. All statistical analyzes were performed using the Statistical Package for the Social Sciences (SPSS- 20.0) program. The sample size was calculated through post hoc analysis using the G-Power software version 3.1. The Power of the test was 67%.

RESULTS

Twenty individuals participated in the study, 12 males and 8 females, mean age of 41.5±6.7 years old, weight 76.2±11 kg, height 162.3±9.5cm and time of pain in months 33.5±4.4 (Table 1). Of the 20 participants, 19 were right-handed and 1 left-handed. Regarding the painful shoulder, 18 reported pain in the right side and 2 in the left side. 19 participants presented pain in the dominant upper limb and only 1 presented pain in the non-dominant upper limb.

The professions of the participants were: 5 (25%) student, 3 (15%) retired, 2 (10%) stay at home, 2 (10%) salesman, 2 (10%) futsal athlete, 1 (5%) driver, 1 (5%) supervisor, 1 (5%) teacher, 1 (5%) health agent, 1 (5%) clerk and 1 (5%) construction worker.

In the evaluation of pain intensity pre and postmensurations of isometric muscle strength, performed through the VAS, initially 10 (50%) participants reported pain in the symptomatic limb ≤4 and 10 (50%) reported pain >4. After the execution of the tests, 4 (20%) participants reported pain ≤4 and the remaining 16 reported pain >4.

In the shoulder pain and disability evaluation that was performed through the SPADI - BRAZIL questionnaire, the individuals presented a pain score of 32.5±5.7, a disability score of 59.2±8.6 and a total of 41.3±7.8. The total kinesiophobia score, measured through the TAMPA scale, was 42.2±8.66.

The correlation analysis demonstrated a significant negative relationship between the SPADI-total value and isometric muscle strength of shoulder flexors ($r= -0.51$; $p=0.02$) and internal shoulder rotators ($r= -0.58$; $p=0.06$), as well as a significant positive relationship between SPADI-total and kinesiophobia level ($r= 0.60$; $p=0.02$);

The comparison values of isometric muscle strength between the symptomatic and asymptomatic side are presented in Table 2.

Table 1. General sample characteristics

Variables	Mean	SD
Age (years)	41.5	6.7
Weight (kg)	76.2	11
Height (cm)	162.3	9.5
Time of pain (months)	33.5	4.4

SD = standard deviation

DISCUSSION

The present study's results showed significant reduction of isometric muscle strength in all glenohumeral movements of the painful shoulder in comparison to the non painful shoulder, with less evidence of significant difference in shoulder extension movement.

In addition to that, a significant negative relationship between SPADI-total values and isometric muscle strength in the flexion movement and internal rotation of the shoulder, as well as a positive relationship between SPADI-total and kinesiophobia level were also demonstrated.

The participants in this study presented symptoms of SIS, confirming the hypothesis of diagnosis through the positive result of at least three out of five special subacromial impingement tests, as described by the study[14].

The study[20] evaluated whether the extent of rotator cuff injury in patients with SIS influenced shoulder muscle strength. Initially, the

Table 2. Values of the isometric muscle strength comparison between symptomatic and asymptomatic sides. Data presented in mean, standard deviation, mean difference between the sides (95% CI) and r effect size

Movements	Symptomatic side	Asymptomatic side	Average difference between the sides (95% CI)	r effect size
Flexion	13.2 (4.52)	16.2 (5.61)	-3 (-4.42; -1.49)	0.7*
Extension	11.3 (4.35)	13.4 (4.26)	-2.1 (-2.13; -.01)	0.4*
Abduction	11.3 (4.18)	15.0 (4.43)	- 3.7 (-5.04; -2.14)	0.8*
External rotation	12.3 (4.67)	14.5 (5.30)	-2.2 (-1.88; -.47)	0.6*
Internal rotation	8.6 (2.91)	10.3 (3.44)	-1.7 (-2.72; -.73)	0.6*

* Evidence of significant difference – $p<0.05$; CI = confidence interval

muscle strength of the individuals was measured and after by arthroscopic evaluation checking the extent of the lesions.

The authors observed that the intense weakness in muscle strength in the abduction, flexion and external rotation movements of the shoulder were directly proportional to the extent of the rotator cuff injury.

It is not possible to infer that the decrease in muscle strength in the individuals of the present study may have occurred due to the presence of muscle injury, because this variable was not measured.

The assessment of isometric muscle strength was performed with the manual dynamometer, being stabilized by a rigid band, thus resulting in greater reliability of measures.

The study[21] observed a significant reduction of the isometric muscle strength of lateral rotation and shoulder abduction, however, this reduction was not representative in the internal rotation of patients with SIS.

In any case, the assessments were made using the manual isokinetic dynamometer, being manually stabilized, therefore leading to a questioning of the reliability of its measurements, because in this method the equipment can suffer oscillations that alter the strength resultant.

The results of the present study demonstrated a reduction in isometric muscle strength in all movements of the shoulder on the symptomatic side, with emphasis on the abduction movement. The study[22] also observed a decrease in strength of the scapular muscles and symptomatic shoulder flexors and abductors in individuals with SIS, showing a significant decrease in abduction strength.

These findings, in general, could be explained by the study[23], which suggested, through electromyography, that individuals with SIS present in the symptomatic limb an alteration of neuromuscular activation of the thoracic and glenohumeral scapulae, which may lead to a deficit of muscle function that would justify the reduction in strength.

It's believed that the muscle strength showed a reduction in the symptomatic side in relation to the asymptomatic side due to the presence of shoulder pain. In this context, the study[24] verified whether pain inhibition in individuals with SIS could contribute to increasing the muscle strength. They initially measured glenohumeral muscle strength with the isokinetic dynamometer. Right after that, all individuals received subacromial injection of lidocaine and bupivacaine, and after 5 minutes the sequence of strength tests was repeated.

Inhibition of pain contributes significantly to the increase of muscular strength, being that 93% of individuals show an increase in muscular strength for the movement of abduction and 79% for the movement of external rotation of the shoulder.

It was possible to observe that the index of shoulder pain and disability, measured by the SPADI-total score, presented a significant negative relation with isometric muscle strength in the movements of flexion and internal rotation, that is, the higher the index of pain and disability, the lower was the isometric muscle strength of the respective muscle groups in action during the movements of flexion and internal rotation.

The isometric measures of shoulder rotation provide reliable parameters on the functional integrity of the rotator cuff muscles, in addition to that, the measures of isometric rotation strength, when reduced, were predictive of shoulder disability[25]. The study[22] correlated the isokinetic shoulder muscle strength and pain, suggesting that the cause of scapular and rotator cuff muscles weakness is directly linked to the presence of symptoms.

The present study's results cannot affirm relation of causality between muscle weakness and shoulder pain and disability.

Another finding was the positive relation of the pain and disability index with the kinesiophobia score, suggesting that the higher the index of SPADI-total, the higher was the TAMPA score. The individuals that reported a high index of pain and disability may present higher expectations of intensified symptoms during the limb movement, being that one of the explanations of high degrees of kinesiophobia[26,27].

In the same context, it should be taken into account that the sample in general presented high pain time. Current studies have found that pain experienced over a prolonged period may lead to the fear of moving the affected limb in order to prevent relapses or further injury, limiting their perceived maximum physical capacity[28-30].

One of the study's limitations was the small sample size. Another limitation was not having carried out a comparison taking into account the time of symptoms. For this reason, it's suggested that other studies be conducted taking these limitations into consideration.

CONCLUSION

The individuals with symptoms of unilateral SIS presented a significant reduction of isometric muscle strength in all movements of the glenohumeral joint when compared to the asymptomatic side. There was a significant negative relation of pain and disability with isometric muscle strength of the shoulder and a significant positive relation with the kinesiophobia score.

REFERENCES

1. Saito H, Harrold ME, Cavalheri V, McKenna L. Scapular focused interventions to improve shoulder pain and function in adults with subacromial pain: a systematic review and meta-analysis. Physiother Theory Pract. 2018;34(9):653-70.
2. Singh B, Bakti N, Gulihar A. Current concepts in the diagnosis and treatment of shoulder impingement. Indian J Orthop. 2017;51(5):516-23.
3. Turner N, Ferguson K, Mobley BW, Riemann B, Davies G. Establishing normative data on scapulothoracic musculature using handheld dynamometry. J Sport Rehabil. 2009;18(4):502-20.
4. Nazligul T, Akpinar P, Aktas I, Unlu Ozkan F, Cagliyan Hartevioglu H. The effect of interferential current therapy on patients with subacromial impingement syndrome: a randomized, double-blind, sham-controlled study. Eur J Phys Rehabil Med. 2018;54(3):351-7.
5. Garving C, Jakob S, Bauer I, Nadjar R, Brunner UH. Impingement syndrome of the shoulder. Dtsch Arztebl Int. 2017;114(45):765-76.
6. Alizadehkhaiyat O, Roebuck MM, Makki AT, Frostick SP. Subacromial impingement syndrome: An electromyographic study of shoulder girdle muscle fatigue. J Electromyogr Kinesiol. 2018;38:136-42.
7. Kinsella R, Cowan SM, Watson L, Pizzari T. A comparison of isometric, isotonic concentric and isotonic eccentric exercises in the physiotherapy management of subacromial pain syndrome/rotator cuff tendinopathy: study protocol for a pilot randomised controlled trial. Pilot Feasibility Stud. 2017;14;3:45.
8. Haider R, Bashir MS, Adeel M, Ijaz MJ, Ayub A. Comparison of conservative exercise therapy with and without Maitland Thoracic Manipulative therapy in patients with subacromial pain: clinical trial. J Pak Med Assoc. 2018;68(3):381-7.
9. Clausen MB, Bandholm T, Rathleff MS, Christensen KB, Zebis MK, Graven-Nielsen T, et al. The Strengthening Exercises in Shoulder Impingement trial (The SExSI-trial) investigating the effectiveness of a simple add-on shoulder strengthening exercise programme in patients with long-lasting subacromial impingement syndrome: Study protocol for a pragmatic, assessor blinded, parallel-group, randomised, controlled trial. Trials. 2018;19(1):154.
10. Tyler TF, Nahow RC, Nicholas SJ, McHugh MP. Quantifying shoulder rotation weakness in patients with shoulder impingement. J Shoulder Elbow Surg. 2005;14(6):570-4.

11. Clausen MB, Witten A, Holm K, Christensen KB, Attrup ML, Hölmich P, et al. Glenohumeral and scapulothoracic strength impairments exists in patients with subacromial impingement, but these are not reflected in the shoulder pain and disability index. BMC Musculoskelet Disord. 2017;18(1):302.
12. Witten A, Clausen MB, Thorborg K, Attrup ML, Hölmich P. Patients who are candidates for subacromial decompression have more pronounced range of motion deficits, but do not differ in self-reported shoulder function, strength or pain compared to non-candidates. Knee Surg Sports Traumatol Arthrosc. 2018;26(8):2505-11.
13. Dabholkar AS, Sha IK, Dabholkar TA. Assessment and correlation of perceived harmfulness with psychological variables in patients with chronic shoulder pain. Ind J Pain. 2018;32(2):76-80.
14. Michener LA, Walsworth MK, Doukas WC, Murphy KP. Reliability and diagnostic accuracy of 5 physical examination tests and combination of tests for subacromial impingement. Arch Phys Med Rehabil. 2009 Nov;90(11):1898-903.
15. Martins J, Napoles BV, Hoffman CB, Oliveira AS. Versão brasileira do shoulder pain and disability index: tradução, adaptação cultural e confiabilidade. Rev Bras Fisioter. 2010;14(6):527-36.
16. Cordeiro N, Pezarat-Correia P, Gil J, Cabri J. Portuguese language version of the Tampa Scale for Kinesiophobia [13 items]. J Musculoskel Pain. 2013;21(1):58-63.
17. Gallagher EJ, Bijur PE, Latimer C, Silver W. Reliability and validity of a visual analog scale for acute abdominal pain in the ED. Am J Emerg Med. 2002;20(4):287-90.
18. Martin KD, McBride T, Wake J, Van Buren JP, Dewar C. Comparison of visual analog pain score reported to physician vs nurse in nonoperatively treated foot and ankle patients. Foot Ankle Int. 2018;39(12):1444-8.
19. Schrama PP, Stenneberg MS, Lucas C, van Trijffel E. Intraexaminer reliability of hand-held dynamometry in the upper extremity: a systematic review. Arch Phys Med Rehabil. 2014;;95(12):2444-69.
20. McCabe RA, Nicholas SJ, Montgomery KD, Finneran JJ, McHugh MP. The effect of rotator cuff tear size on shoulder strength and range of motion. J Orthop Sports Phys Ther. 2005;35(3):130-5.
21. Marcondes FB, Rosa SG, Vasconcelos RA, Basta A. Rotator cuff strength in subjects with shoulder impingement syndrome compared with the asymptomatic side. Acta Ortop Bras. 2011;19(6): 333-7
22. Celik D, Sirmen B, Demirhan M. The relationship of muscle strength and pain in subacromial impingement syndrome. Acta Orthop Traumatol Turc. 2011;45(2):79-84.
23. Ludewig PM, Cook TM. Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. Phys Ther. 2000;80(3):276-91.
24. Ben-Yishay A, Zuckerman JD, Gallagher M, Cuomo F. Pain inhibition of shoulder strength in patients with impingement syndrome. Orthopedics. 1994;17(8):685-8.
25. MacDermid JC, Ramos J, Drosdowech D, Faber K, Patterson S. The impact of rotator cuff pathology on isometric and isokinetic strength, function, and quality of life. J Shoulder Elbow Surg. 2004;13(6):593-8.
26. Engebretsen K, Grotle M, Bautz-Holter E, Ekeberg OM, Brox JI. Determinants of the shoulder pain and disability index in patients with subacromial shoulder pain. J Rehabil Med. 2010;42(5):499-505.
27. Trost Z, France CR, Thomas JS. Examination of the photograph series of daily activities (PHODA) scale in chronic low back pain patients with high and low kinesiophobia. Pain. 2009;141(3):276-82.
28. Barth RJ. Clinician and patient-reported outcomes are associated with psychological factors in patients with chronic shoulder pain. Clin Orthop Relat Res. 2016;474(9):2040-3.
29. George SZ, Wu SS, Wallace MR, Moser MW, Wright TW, Fazendeiro KW, et al. Biopsychosocial Influence on shoulder pain: influence of genetic and psychological combinations on twelve-month postoperative pain and disability outcomes. Arthritis Care Res. 2016;68(11):1671-80.
30. Thorpe AM, O'Sullivan PB, Mitchell T, Hurworth M, Spencer J, Booth G, et al. Are psychologic factors associated with shoulder scores after rotator cuff surgery? Clin Orthop Relat Res. 2018;476(10):2062-73.