Journal of Advanced Biomedical Sciences
Homepage: http://jabs.fums.ac.ir
Online ISSN: 2783-1523
Fasa University of Medical Sciences

The Effect of a Six-Week Home Exercise Program on Pain and Disability in Ultrasound-Diagnosed Patients with Subacromial Subdeltoid Impingement Syndrome: A Randomized Controlled Trial

Vojdani Salman[1, 4], **Hojjati Sarah**[2], **Sadeghi Mazidi Zahra**[1], **Talebi Moghaddam Maryam**[3, 4]

1. Department of Anesthesiology and Pain, Fasa University of Medical Sciences, Fasa, Iran
2. Department of Exercise Physiology, Islamic Azad University, Shiraz Branch, Shiraz, Iran
3. Department of Biostatistics and Epidemiology, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran
4. Noncommunicable Diseases Research Center, Fasa University of Medical Sciences, Fasa, Iran

Article Info

Article Type:
Original Article

Article History:
Received
30 Jul 2023
Received in revised form
22 Oct 2023
Accepted
19 Dec 2023
Published online
15 Jan 2024

Publisher:
Fasa University of Medical Sciences

Abstract

Background & Objectives: There is conflicting evidence regarding the effects of exercise on shoulder impingement syndrome. Exercise therapy is one of the methods used to reduce pain and increase muscle strength in patients with shoulder impingement syndrome. There are several exercise therapy programs available in this area. The purpose of this study is to evaluate the effect of exercise therapy on pain and disability in patients with shoulder impingement syndrome.
Materials & Methods: This randomized clinical trial was conducted in 25 patients with impingement syndrome from the Dastgheib Yasaei Pain Clinic in Fasa. Patients were randomized to receive medication (n=13) or medication plus exercise therapy (n=12). The Oswestry Disability Index (ODI) and the Verbal Numeric Rating Scale were used to measure disability and pain intensity before and after the intervention. Patient satisfaction was measured using the Likert scale. Independent and paired t-test, Mann-Whitney U test, and chi-squared were performed at a significant level of $P \leq 0.05$. Analyses were performed with SPSS software (version 25.0).
Results: There were no differences between groups in pre-intervention demographics ($P>0.05$), pain intensity ($P=0.16$), and ODI scores (0.93). Post-intervention pain and ODI scores were significantly higher in the medication group than in the medication-exercise group ($P=0.06$, $P=0.03$, respectively). There was a significant difference in pain and ODI scores at post-intervention compared to pre-intervention in both groups ($P<0.001$). The difference in pain intensity between pre- and post-intervention in both groups was also statistically significant ($P=0.006$). There was a significant difference in patient satisfaction between groups ($P=0.03$).
Conclusion: These results suggest that a regular exercise program, along with medication, may be effective in reducing pain and disability in patients with shoulder impingement syndrome.

Keywords: shoulder impingement syndrome, pain and disability, Exercise training

Cite this article: Vojdani S, Hojjati S, Sadeghi Mazidi Z, Talebi Moghaddam M. The Effect of a Six-Week Home Exercise Program on Pain and Disability in Ultrasound-Diagnosed Patients with Subacromial Subdeltoid Impingement Syndrome: A Randomized Controlled Trial. JABS.2024; 14(1): 27-35.
DOI: 10.18502/jabs.v14i1.14804

Introduction

Shoulder impingement, also known as subacromial subdeltoid impingement, is a condition that occurs when the tendons of the rotator cuff and subacromial bursa become compressed or irritated as they pass through the narrow space under the acromion and deltoid muscle. This can cause pain, weakness, and limited range of motion in the shoulder. Repetitive overhead activities such as throwing, lifting, or reaching can cause inflammation and swelling in the subacromial space, which may contribute to the development of this condition (1).

Shoulder impingement syndrome is typically diagnosed by a combination of history and physical examination. However, in some cases, additional medical imaging or a local anesthetic

Corresponding Author: Vojdani Salman, Department of Anesthesiology and Pain, Fasa University of Medical Sciences, Fasa, Iran
Email: vojdanisalman@gmail.com

[DOI: 10.18502/jabs.v14i1.14804]

injection may be needed to confirm the diagnosis. Treatment options for shoulder impingement syndrome include rest, avoidance of activities that cause pain, physical therapy, nonsteroidal anti-inflammatory drugs (NSAIDs), ice packs, and therapeutic exercise. In more severe cases, corticosteroid and local anesthetic injections may be used to relieve symptoms. It's important to seek treatment for shoulder impingement syndrome because untreated cases can lead to chronic pain and disability (2, 3).

Shoulder impingement syndrome can cause significant discomfort and, in severe cases, may require surgery. Depending on the nature and location of the pathology, several treatment options are available, including arthroscopic subacromial decompression, open acromioplasty, and rotator cuff repair. However, further research is needed to improve the efficacy of these interventions and to develop new treatments for shoulder impingement syndrome. One promising area of research is the use of regenerative medicine, such as stem cell therapy, to promote healing and reduce inflammation in the affected area. In addition, physical therapy and lifestyle changes may be recommended to manage symptoms and prevent further injury. As our understanding of this condition continues to evolve, we can hope for more effective and less invasive treatments for shoulder impingement syndrome in the future (4-7).

Therapeutic exercise has been proposed as an important treatment modality for patients with shoulder impingement syndrome. Several studies have shown a reduction in pain and disability following exercise. However, there is conflicting evidence regarding the effect of exercise on this syndrome. A meta-analysis of six randomized controlled trials involving 231 participants, four studies of specific scapular exercises and two studies of specific proprioceptive exercises, did not consistently show significant differences in outcomes between treatment groups. As a result, it was concluded that there is insufficient evidence to support or refute the effectiveness of specific resistive exercise strategies for subacromial impingement syndrome. Therefore, more high-quality research is needed to determine the effectiveness of these exercise strategies (1).

Shoulder impingement syndrome is a common cause of shoulder pain that affects a significant number of people. Although exercise has been suggested as a potential treatment, previous studies have yielded inconsistent results, necessitating further research to identify effective treatment approaches for this condition. This study aims to contribute to this effort by investigating the effects of therapeutic exercise on pain and disability associated with shoulder impingement syndrome. The results of this study could have significant implications for the management and treatment of this condition, potentially improving the quality of life for those affected. Ultimately, this research could reduce the burden of shoulder impingement syndrome on individuals and society as a whole. As such, this study could be a critical step in developing effective treatment strategies and improving outcomes for individuals with shoulder impingement syndrome.

Materials and Methods

In this clinical study, 30 patients with shoulder impingement syndrome were evaluated at the Dastgheib Yasaei Pain Clinic in Fasa, Iran. The local ethics committee approved the study protocol (approval ID: IR.FUMS.REC.1400.100) (IRCT20220302054169N1). Patients were randomized to medication (n=13) or medication-exercise (n=12) groups. To ensure proper randomization, we generated a sequence of unpredictable and non-patterned numbers using a computer program and the random number table. In addition, allocation concealment was achieved through the use of sealed envelopes.

Inclusion criteria were unilateral shoulder pain for more than one week, painful resisted abduction test, positive results on two Neer, Hawkins, and supraspinatous empty can tests, tenderness at the bicipital groove, and painful arc in abduction. In addition, one of the inclusion criteria for this study was the diagnosis of subacromial subdeltoid impingement syndrome (SADS) by

[DOI: 10.18502/jabs.v14i1.14804]

ultrasound. Therefore, patients who presented with shoulder pain but had other pathologies such as rotator cuff tears were not included in the study. Exclusion criteria included systemic disease, neck pain at rest or with active neck motion, history of neck pain or treatment in the previous 12 months, history of spinal or upper extremity surgery, shoulder dislocation or fracture, positive sulcus sign, shift test, and active compression labral test results, and inability to perform sports activities (8).

The medication group received a 15 mg meloxicam tablet every 12 hours and applied Wishca cream every 8 hours in case of pain. The medication-exercise group received the same medication in addition to performing the following physical exercises every day: mid-deltoid stretch, triceps stretch, and passive extension exercises. Each stretch was held as long as possible for up to 30 seconds (5 repetitions of 3 sets) for six weeks (9).

Patients were followed up twice a week for six weeks, either by telephone consultation or in-person visits. Patients were unaware of the existence of the parallel groups. Three patients were assigned to the medication-exercise group and two patients were assigned to the medication group and excluded from the study.

The Verbal Numeric Rating Scale was used to measure pain intensity. The Verbal Numeric Rating Scale (VNRS) is a pain assessment tool that combines a numeric rating scale with a verbal descriptor. Patients rate their pain on a scale of 0 to 10 and provide a verbal descriptor. It is a simple and practical tool used in clinical settings to monitor changes in pain over time. Patients are asked to rate their pain on a scale of 0 to 10, with 0 being no pain and 10 being the worst possible pain.

The Oswestry Disability Index (ODI) was used to assess disability. The Oswestry Disability Index (ODI) is a tool designed to measure the level of disability and functional impairment in individuals. The questionnaire consists of 10 sections that assess various aspects of daily life, including pain intensity, personal care, and social life. Each section is scored from 0 to 5, with higher scores indicating greater disability. The total score is then calculated as a percentage of the maximum possible score, with 0% indicating no disability and 100% indicating maximum disability.

Statical Analysis

Statistical analysis was performed with SPSS software (version 25.0, Chicago, IL, USA). Normality of data distribution was assessed using the Shapiro-Wilk test. Continuous variables were presented as mean (standard deviation, SD) or median (interquartile range, IQR), depending on the normality of the data distribution. Categorical variables were presented as counts (percentages). Independent-samples t-test, paired-samples t-test, Mann-Whitney U test, and chi-squared test were used to compare differences between or within groups, as appropriate. A significance level of $P \leq 0.05$ was considered statistically significant.

The assumptions underlying these tests were tested prior to their use. Specifically, the normality assumption was tested using the Shapiro-Wilk test.

Results

There was no significant difference ($P>0.05$) between groups in demographic characteristics (Table 1).

Table 2 shows the mean (SD) pain score before and after the intervention in two groups. There was no significant difference in pain score between groups in pre-intervention ($P=0.16$). However, the post-intervention pain score was significantly higher in the medication group than in the medication-exercise group ($P=0.06$). There was a significant difference in pain score at post-intervention compared to pre-intervention ($P<0.001$). The difference in pain intensity between the two groups was also statistically significant ($P=0.006$, Table 2).

[DOI: 10.18502/jabs.v14i1.14804]

Table 1. Demographic characteristics

Variables	Group	p-value		
		Medication group N (%)	Exercise group N (%)	
sex	Male	9 (69.2)	7 (58.3)	0.68[a]
	Female	4 (30.8)	5 (41.7)	
Place of residence	Urban	9 (69.2)	7 (58.3)	0.68[a]
	Rural	4 (30.8)	5 (41.7)	
Employment status	Unemployed, retired	3 (23.1)	4 (33.3)	0.67[a]
	Employed	10 (76.9)	8 (66.7)	
Education level	Non-academic	9 (69.3)	9 (75)	0.74[a]
	Academic	4 (30.8)	3 (25)	
Age (years)		Mean ±SD	Mean ±SD	0.85[b]
		50.69±18.42	49.67±18.94	
Weight (kg)		65.92±6.46	66.57±6.51	0.68[b]
Height (cm)		158.92±6.94	160.92±8.14	0.47[b]
Duration of symptoms (day)		3.62±1.85	3.42±1.88	0.76[b]

Table 2 shows the mean (SD) pain score before and after the intervention in two groups. There was no significant difference in pain score between groups in pre-intervention (P=0.16). However, the post-intervention pain score was significantly higher in the medication group than in the medication-exercise group (P=0.06). There was a significant difference in pain score at post-intervention compared to pre-intervention (P<0.001). The difference in pain intensity between the two groups was also statistically significant (P=0.006, Table 2).

Table 2. Pain score in medication and medication-exercise groups in pre-/ post-intervention

groups	Medication group Mean ±SD	Exercise group Mean ±SD	p-value
Pre-intervention	6.85± 1.51	7.67± 1.30	0.16
Post-intervention	2.69± 1.10	1.42± 0.99	0.06
Differences	4.16± 1.29	6.25± 1.34	0.006
p-value	<0.001	<0.001	

[DOI: 10.18502/jabs.v14i1.14804]

The mean (SD) of the ODI score is shown in Table 3. There was no significant difference in ODI in pre-intervention between groups (P=0.93). However, in relation to post-intervention, the mean of ODI score in the medication group was significantly higher than that in the medication-exercise group (P=0.03). there was also a significant difference in ODI in post-intervention compared to pre-intervention (P<0.001). However, the differences (pre-intervention minus post-intervention) in both groups were not statistically significant (P>0.05, Table 3).

Table 3. ODI score in medication and medication-exercise groups in pre-/ post-intervention

groups	Medication group Mean ±SD	Exercise group Mean ±SD	p-value
Pre-intervention	33.92± 7.38	33.67 ± 7.97	0.93
Post-intervention	16 ± 5.37	11.17 ± 5.44	0.03
Differences	17.92 ± 5.6	22.5 ± 6.72	0.07
p-value	<0.001	<0.001	

The Mann-Whitney U test showed a significant difference (P=0.03) in patient satisfaction between the medication group (2.54 ±0.96) and the medication-exercise group (3.58 ±1.24; Table 4).

Table 4. Satisfaction score in medication and medication-exercise groups

groups	Medication group	Exercise group	Z score	p-value
Completely Unsatisfied	15.38%	8.33%	-2.212	0.03
Unsatisfied	30.76%	8.33%		
Nor satisfied-nor unsatisfied	38.46%	25%		
satisfied	15.38%	33.33%		
Completely satisfied	0%	25%		
Mean Rank	9.96	16.29		
Mean ±SD	2.54± 0.96	3.58± 1.24		

[DOI: 10.18502/jabs.v14i1.14804]

Discussion

Shoulder pain is a common complaint among people with musculoskeletal problems. It is estimated that approximately 2.11 out of every 1000 people who visit a primary care physician experience shoulder pain each year. Many people with shoulder pain often have symptoms of subacromial impingement, which is characterized by pain and weakness, especially during activities that require raising the arm above shoulder level (10).

In this study, a total of 25 patients with shoulder pain caused by impingement syndrome were divided into two groups: medication and medication-exercise. Both groups consisted mainly of male participants, and no significant differences were observed between the two groups in terms of gender, age, height, weight, duration of symptoms, place of residence, employment status, and education level.

Pre-intervention pain and disability scores based on the ODI were similar in both groups. However, after the intervention, the medication-exercise group had significantly lower mean pain and disability scores than the medication group. Previous studies suggest that focused shoulder exercises using controlled, gentle strokes can increase blood flow to the otherwise limited supraspinatus muscle. These exercises also increase the activity of the supraspinatus, anterior deltoid, and lower trapezius muscles, which may help to reduce shoulder impingement and consequently reduce pain (11).

Our study is similar to others in terms of exercise regimens, study duration, and target population. However, what sets our study apart is its exclusive focus on a specific population with pathologic shoulder pain. Patients with shoulder pain underwent sonographic evaluation and were included in the study only if they had evidence of impingement syndrome. As a result, our study population is uniform and homogeneous, unlike other studies that include a spectrum of patients with shoulder pain. This approach allows for a more focused and precise analysis of the pathology and associated factors. Our findings may contribute to a better understanding of impingement syndrome and its treatment, ultimately leading to improved patient outcomes.

Research has extensively investigated the effect of exercise on shoulder impingement syndrome, but the results have been inconsistent. Previous research on the effects of exercise on shoulder impingement syndrome has had some limitations and inconsistencies. Some studies have had small sample sizes, making it difficult to draw definitive conclusions. In addition, there have been variations in the types of exercises used, making it difficult to compare results across studies. Finally, some studies did not measure outcomes consistently, making it difficult to determine the effectiveness of exercise interventions for shoulder impingement syndrome (12-16).

A study conducted by Lyng and colleagues examined the effects of home exercise therapy on patients with shoulder impingement syndrome. The study found that although progressive shoulder abduction exercises resulted in some improvement in worst pain intensity, the improvement was not considered clinically significant. However, the exercise did show positive effects on conditioned pain modulation (CPM) and sleep scores. The results also suggest that patients with low pain intensity and high temporal summation of pain (TSP) scores, indicating pain sensitization, may not experience significant pain relief from exercise therapy (12).

A recent meta-analysis found a positive association between the duration of exercise interventions and pain reduction in chronic musculoskeletal pain conditions. This suggests that the duration of the intervention plays a critical role in its effectiveness as a treatment. A study by Holmgren et al. found that a higher dose of exercise

[DOI: 10.18502/jabs.v14i1.14804]

was more effective in improving pain and function than a lower dose of exercise (12-16).

A study was conducted to compare the effectiveness of exercise therapy and exercise therapy combined with corticosteroid injection in patients with rotator cuff disease. The results showed that while exercise therapy may provide some benefit, it was not significantly more effective than corticosteroid injection. However, it is worth noting that other studies have shown that exercise can be an effective treatment for rotator cuff tendinopathy. Exercise is often recommended as a treatment option, but its effectiveness may vary depending on several factors. The severity and duration of the condition are important factors to consider when determining the best course of treatment. For mild cases, exercise therapy can be effective in reducing pain and improving range of motion. However, more severe cases may require additional interventions such as surgery. Individual factors such as age, general health, and physical activity level may also play a role in the effectiveness of exercise therapy (16, 17). A recent study conducted by Mehrpour et al (2020) examined the effects of an aquatic exercise program on elite female swimmers with impingement syndrome. The study found that the experimental group that underwent an 8-week aquatic exercise protocol experienced a significant decrease in pain intensity compared to pre-training. In addition, the group showed significant improvements in range of motion, internal and external rotation, flexion and extension, and joint proprioception compared to pre-training conditions. These findings were statistically significant and consistent with previous studies (18).

A study by Vergili et al in 2020 found that exercise and subacromial injection were effective in improving shoulder function and quality of life in individuals with impingement syndrome, which is consistent with our study. In addition, a systematic review by Dominguez et al. in 2021 found that all exercise programs for RC tendinopathy were effective in improving shoulder pain and function, which is also consistent with our study (19, 20). A 2017 study by Ebrahimian et al. examined the effects of corrective exercises on pain and joint proprioception in girls with impingement syndrome. The study found that corrective exercises resulted in a significant increase in joint proprioception and a significant decrease in pain. In addition, the results indicated that there was a significant difference between joint proprioception and pain in the corrective exercise group compared to the control group after exercise. These findings highlight the important role of corrective exercises in improving shoulder pain and proprioception in individuals with impingement syndrome (21).

Patients in the medication-exercise group reported significantly higher satisfaction than those in the medication-only group. Our results are consistent with previous studies that have shown improvements in pain intensity, satisfaction, shoulder function, and physical performance-related outcomes in patients with impingement syndrome who underwent 12 weeks of eccentric training or a 6-week exercise program (22, 23). In a study by Jonsson et al (2006), positive improvements and satisfaction were observed in 5 of 9 patients with impingement syndrome who underwent 12 weeks of eccentric training. These five patients remained satisfied and were taken off the waiting list for surgery after 52 weeks of follow-up. (22, 23).

Conclusion

Although our study suggests that exercise therapy may be effective in reducing pain and disability in patients with shoulder impingement syndrome, there are some negative aspects that should be considered. The sample size of only 25 patients is relatively small, which may limit the generalizability

[DOI: 10.18502/jabs.v14i1.14804]

of the findings. In addition, the study only evaluated the short-term effects of exercise therapy, and it is unclear whether the benefits are sustained over time. Finally, the study did not compare different types of exercise programs, so it is unclear which specific program is most effective. Despite these limitations, the study provides valuable insight into the potential benefits of exercise therapy for patients with shoulder impingement syndrome. Further research is needed to confirm these findings and to identify the most effective exercise programs for this patient population.

Acknowledgement

Fasa University of Medical Sciences approved the study protocol in 2019-06-17 (Approval ID: IR.FUMS.REC.1398.043). The authors are very grateful to the patients who participated in the study.

Conflicts of Interest

The authors declare no competing interests.

Funding

This study was conducted with the financial support of Fasa University of Medical Sciences.

Ethical Considerations

The current study was conducted according to the Helsinki guidelines and was approved by the Ethical Committee of Fasa University of Medical Sciences (IR.FUMS.REC.1400.100). In addition, written informed consent was obtained from all participants in the current study.

Code of Ethics

IRCT20220302054169N1.

Authors' Contributions

Study conception and design: Sarah Hojjati, Salman Vojdani

Data collection: Salman Vojdani, Sarah Hojjati, Zahra Sadeghi Mazidi

Analysis and interpretation of results, Sarah Hojjati, Maryam Talebi Moghaddam

Manuscript preparation: Sarah Hojjati, Salman Vojdani.

Data Availability Statement

The data analyzed in this study will be available to researchers who request the dataset from the corresponding author with ethical approval. However, the Noncommunicable Diseases Research Center of Fasa University of Medical Sciences requires all researchers to respect data confidentiality. Therefore, access to the database is subject to the approval of the Ethics Committee of Fasa University of Medical Sciences.

References

1. Diercks R, Bron C, Dorrestijn O, Meskers C, Naber R, De Ruiter T et al. Guideline for diagnosis and treatment of subacromial pain syndrome: a multidisciplinary review by the Dutch Orthopaedic Association. Acta orthopaedica. 2014;85(3):314-22.
2. Lewis JS. Rotator cuff tendinopathy/ subacromial impingement syndrome: is it time for a new method of assessment? British journal of sports medicine. 2009;43(4):259-64.
3. Kuhn JE. Exercise in the treatment of rotator cuff impingement: a systematic review and a synthesized evidence-based rehabilitation protocol. Journal of shoulder and elbow surgery. 2009;18(1):138-60.
4. Wahba MM, Selim M, Hegazy MM, Elgohary R, Abdelsalam MS. Eccentric Versus Concentric Exercises in Patients With Rheumatoid Arthritis and Rotator Cuff Tendinopathy: A Randomized Comparative Study. Annals of Rehabilitation Medicine. 2023;47(1):26-35.
5. Lewis J, McCreesh K, Roy J-S, Ginn K. Rotator cuff tendinopathy: navigating the diagnosis-management conundrum. Journal of orthopaedic & sports physical therapy. 2015;45(11):923-37.
6. Horowitz EH, Aibinder WR. Shoulder Impingement Syndrome. Physical Medicine and Rehabilitation Clinics. 2023;34(2):311-34.
7. Dubé M-O, Desmeules F, Lewis JS, Roy J-S. Does the addition of motor control or strengthening exercises to education result in better outcomes for rotator cuff-related shoulder pain? A multiarm randomised controlled trial. British Journal of Sports Medicine. 2023;57(8):457-63.

[DOI: 10.18502/jabs.v14i1.14804]

8. Kuhn JE, Dunn WR, Sanders R, An Q, Baumgarten KM, Bishop JY, et al. Effectiveness of physical therapy in treating atraumatic full-thickness rotator cuff tears: a multicenter prospective cohort study. Journal of shoulder and elbow surgery. 2013;22(10):1371-9.
9. Page P. Current concepts in muscle stretching for exercise and rehabilitation. International journal of sports physical therapy. 2012;7(1):109.
10. Van der Windt D, Koes BW, De Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. Annals of the rheumatic diseases. 1995;54(12):959-64.
11. Mirhassan Zadeh Kuhkamar M, Sadeghi H. The Effect Of Eight Weeks Of Scapular Focused Training On Pain, Electrical Activity Of Selected Shoulder Muscles, And Upper Extremity Performance In Male Volleyball Players With Shoulder Impingement Syndrome: A Randomized Clinical Trial. Studies in Medical Sciences. 2020;31(7):515-24.
12. Lyng KD, Andersen JD, Jensen SL, Olesen JL, Arendt-Nielsen L, Madsen NK et al. The influence of exercise on clinical pain and pain mechanisms in patients with subacromial pain syndrome. European Journal of Pain. 2022;26(9):1882-95.
13. Clausen MB, Hölmich P, Rathleff M, Bandholm T, Christensen KB, Zebis MK, et al. Effectiveness of adding a large dose of shoulder strengthening to current Nonoperative care for subacromial impingement: a pragmatic, double-blind randomized controlled trial (SExSI trial). The American Journal of Sports Medicine. 2021;49(11):3040-9.
14. Polaski AM, Phelps AL, Kostek MC, Szucs KA, Kolber BJ. Exercise-induced hypoalgesia: A meta-analysis of exercise dosing for the treatment of chronic pain. PloS one. 2019;14(1):e0210418.
15. Holmgren T, Hallgren HB, Öberg B, Adolfsson L, Johansson K. Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome: randomised controlled study. British journal of sports medicine. 2014;48(19):1456-7.
16. Hopewell S, Keene DJ, Marian IR, Dritsaki M, Heine P, Cureton L, et al. Progressive exercise compared with best practice advice, with or without corticosteroid injection, for the treatment of patients with rotator cuff disorders (GRASP): a multicentre, pragmatic, 2× 2 factorial, randomised controlled trial. The Lancet. 2021;398(10298):416-28.
17. Littlewood C, Ashton J, Chance-Larsen K, May S, Sturrock B. Exercise for rotator cuff tendinopathy: a systematic review. Physiotherapy. 2012;98(2):101-9.
18. Mehrpour Z, Bagheri S, Letafatkar A, Mehrabian H. The Effect of a Water-Based Training Program on Pain, Range of Motion and Joint Position Sense in Elite Female Swimmers with Impingement Syndrome. Journal of Advanced Sport Technology. 2020;4(1):72-81.
19. Vergili O, Oktas B, Canbeyli ID. Comparison of kinesiotaping, exercise and subacromial injection treatments on functionality and life quality in shoulder impingement syndrome: A randomized controlled study. Indian Journal of Orthopaedics. 2021;55:195-202.
20. Dominguez-Romero JG, Jiménez-Rejano JJ, Ridao-Fernández C, Chamorro-Moriana G. Exercise-based muscle development programmes and their effectiveness in the functional recovery of rotator cuff tendinopathy: a systematic review. Diagnostics. 2021;11(3):529.
21. Ebrahimi Ghrehghoyonloo M, Sahebozamani M, Beyranvand R, Karimi Afshar F. The effect of corrective exercises on shoulder pain and joint position sense in females with functional impingement syndrome. Daneshvar Medicine. 2020;25(4):17-24.
22. Jonsson P, Wahlström P, Öhberg L, Alfredson H. Eccentric training in chronic painful impingement syndrome of the shoulder: results of a pilot study. Knee Surgery, Sports Traumatology, Arthroscopy. 2006;14:76-81.
23. McClure PW, Bialker J, Neff N, Williams G, Karduna A. Shoulder function and 3-dimensional kinematics in people with shoulder impingement syndrome before and after a 6-week exercise program. Physical Therapy. 2004;84(9):832-48.

[DOI: 10.18502/jabs.v14i1.14804]