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CASE REPORT

Effects of A Progressive Rehabilitation Program on Shoulder Internal Rotation Range of Motion, Acromiohumeral Distance, And Pain in An Adolescent Female Swimmer with Subacromial Pain (Impingement) Syndrome

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Abstract

Shoulder injuries are common in competitive youth swimmers because of sport-specific changes in upper extremity physical characteristics and acromio-humeral distance (AHD). These physical alterations could cause abnormal scapular kinematics and positioning. Subacromial pain syndrome (SPS), scapular dyskinesis, and SLAP lesions require a multiphase approach. A 14-years-old female athlete who has been swimming for 7 years had SPS symptoms for 14 months. She also had scapular dyskinesis and suspected SLAP lesion. She received 15 treatment sessions. We conducted a progressive and comprehensive rehabilitation program consisting of electrotherapy, thermal agent, mobilization techniques, posterior shoulder stretching exercises, upper and lower extremity strengthening, proprioception, scapular stabilization, and core stabilization exercises, rhythmic stabilization exercises, plyometric exercises, and the advanced thrower's 10 program. Internal rotation range of motion (IRROM) with bubble inclinometer, pain with Visual Analog Scale, and AHD with ultrasonographic imaging were assessed before treatment and at the end of the 9th and 15th treatment sessions. Before treatment, IRROM was 52°, AHD was 10.67 mm, and pain intensity at rest and during swimming was 0 and 3.1 cm, respectively. After 9 treatment sessions, IRROM was 55.6°, AHD was 11.62 mm, pain intensity at rest and during swimming was 3.7 cm and 5.1 cm, respectively. At the end of the treatment, IRROM was 58.33°, AHD was 12.02 mm, pain intensity at rest and during swimming was 0 cm. A progressive and challenging rehabilitation program may positively change the scapular and glenohumeral kinematic patterns leading to an increase in AHD and IRROM, therefore a decrease in pain.

Keywords
Subacromial Pain Syndrome, SLAP Lesion, Scapular Dyskinesis, Women Swimmers, Physical Therapy, Rehabilitation

INTRODUCTION

Shoulder injuries are common in overhead athletes including swimmers. Swimming requires numerous repetitions of the same overhead movement during training and competitions. There can be sudden increases in training load and volume. An elite swimmer older than 13 years typically performs between 0.5 and 1 million arm cycles per arm per year (Bak and Faunø, 1997; Weldon and Richardson, 2001). During overhead activities for synchronized motion, the shoulder must have adequate internal rotation (IR), external rotation (ER), and horizontal adduction range of motion (ROM), as well as strength for rotator cuff (RC), periscapular, trunk, and lower extremity muscles to perform properly coordinated kinematic patterns between the humerus, scapulae, thorax and lower extremity (Burkhart et al., 2003; Kibler et al., 2012). The repetitive nature of swimming

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may fatigue the posterior RC (infraspinatus and teres minor) and periscapular muscles, which may be exposed to more stress on the posterior capsule to maintain joint stability through the swimming stroke and may lead to IRROM deficiency and narrowing of the acromiohumeral distance (AHD) (Hibberd Laudner Berkoff et al., 2016; Su et al., 2004; Torres and Gomes, 2009). The term "swimmer's shoulder" comprises the combination of hypovascularity of the RC tendons (especially supraspinatus), muscle fatigue (especially serratus anterior), poor stroke mechanics, and the progressive instability of a hypermobile glenohumeral joint, and scapular dyskinesis with subacromial pain syndrome (Bak, 2010; Kenal and Knapp, 1996; Sajadi et al., 2019). Swimmer's shoulder is common in swimming, as at least 55% of all injuries in competitive swimmers affect the shoulder (McFarland and Wasik, 1996).

The main factor in the development of a swimmer's shoulder seems to be the high training volume during growth in the absence of a balanced dryland training program (Porter et al., 2020). Most swimming strokes consist of a pull-through phase that generates speed and a recovery phase where the arm is over the water (Bak, 2010). Yanai and Hay demonstrated that impingement on average occurred 24.8% of the stroke time (Yanai and Hay, 2000). At the end of the power phase of the stroke, the arm is in adduction position, compromises blood supply to the insertion of the biceps and supraspinatus tendons (Kenal and Knapp, 1996) This repetitive hypovascularity leads to degenerative changes in these tendons, resulting in tendon pathology (Kenal and Knapp, 1996; McCreesh et al., 2017). Excessive tissue load remains the most substantial causative factor in the development of RC tendinopathy (Porter et al., 2020). The differential effect of loading on normal and symptomatic RC tendons has been investigated by McCreesh et al (McCreesh et al., 2017). They demonstrated that an RC muscle fatigue protocol leads to a short-term decrease in acromiohumeral distance (AHD) and swelling of the supraspinatus tendon in people with RC tendinopathy (McCreesh et al., 2017). Furthermore, it has been reported that decreased IRROM, deriving from bone adaptation (increased humeral retroversion) (Reagan et al., 2002) or soft tissue adaptation (posterior shoulder tightness) (Burkhart et al., 2003; Tyler et al., 2000), causes a change in glenohumeral and scapular kinematics (Burkhart et al., 2003). These kinematic alterations lead to anterior-superior translation of the humeral head and a decrease in subacromial space (Burkhart et al., 2003; Kibler et al., 2013; Maenhout et al., 2012). Muraki et al. indicated that even a small amount of narrowing of the subacromial space may cause significant changes in the subacromial contact pressure (Muraki et al., 2012). Therefore, decreases in IRROM and AHD and an increase in the subacromial contact pressure may induce pain (Burkhart et al., 2003; Desmeules et al., 2004; Maenhout et al., 2012; Navarro-Ledesma et al., 2017).

The rehabilitation program is required a multiphasic approach, consisting of the entire kinetic chain to prepare the swimmer for the high demands of overhead activity. The general rehabilitation program includes electrotherapy agents, mobilization of the shoulder and scapula complex, stretching exercises, proprioceptive exercises, dynamic stability exercises, strength training for the RC, scapulothoracic, core, and lower extremity muscles (Kibler et al., 2001; Wilk et al., 2011). We present an adolescent female swimmer who has SPS, scapular dyskinesis and suspected SLAP lesion. We aimed to investigate the effects of a comprehensive and progressive rehabilitation program on posterior shoulder flexibility, subacromial space, and pain in an adolescent female swimmer with subacromial pain syndrome. We hypothesized that a progressive and comprehensive sports-specific rehabilitation program may increase IRROM and AHD and as a result improve pain. For this purpose, we assessed shoulder IRROM, AHD, and pain.

MATERIALS AND METHODS

Participant

A 14-years-old right dominant-handed female athlete who has been swimming for 7 years. She swims with butterfly and backstroke techniques for 14 hours with a swimming distance of 40 km in a week. She was diagnosed with SPS and scapular dyskinesis 14 months ago. Furthermore, she had SLAP lesion symptoms but it was not confirmed with radiologic diagnosis. Ethical approval was obtained from the ethics committee of Dokuz Eylül University for the study to be performed (Number: 2021/20-54).

Intervention

We conducted a progressive and comprehensive rehabilitation program consisting of electrotherapy, thermal agent, mobilization techniques, posterior shoulder stretching exercises (Wilk et al., 2013), upper extremity and lower extremity strengthening, proprioception exercises, scapular stabilization and core stabilization exercises, rhythmic stabilization exercises, plyometric exercises, and the advanced thrower's 10 exercise program (Kenal and Knapp, 1996; Kibler et al., 2001; Wilk and Arrigo, 1993; Wilk et al., 2013; Wilk et al., 2011). She received 15 treatment sessions (3 times a week) including transcutaneous electrical nerve stimulation (TENS), hot pack/cold pack, mobilization of the shoulder complex and scapula, as well as proprioceptive, dynamic stability, and endurance exercises. The advanced thrower's ten program was added as the specialized and challenging rehabilitation program progressed (Kenal and Knapp, 1996; Kibler et al., 2001; Wilk and Arrigo, 1993; Wilk et al., 2013; Wilk et al., 2011).

According to our four-phased rehabilitation program, we focused on dynamic stability, coactivation, high levels of proprioceptive and neuromuscular control, strength and endurance training of the RC and scapulothoracic stabilizer muscles, as well as core and lower extremity muscles. Strengthening exercises were performed with a resistance band (Theraband®, Hygenic Corp, Ohio, USA). The individual intensity was determined by the BORG scale (RPE of 12-14) and progression was done accordingly (started with 2x10 repetitions and progressed 3x10 repetitions).

In phase I, we used TENS (20 minutes of high-frequency [50-100 Hz], low-intensity, small pulse width [50-200 µs] conventional transcutaneous electrical nerve stimulation), 20 minutes of hot-pack application before exercises, and 15 minutes of cold-pack application after exercises. Wilk's modified posterior shoulder stretching exercises (PSSE) to improve shoulder IR and horizontal adduction (Hadd) ROM through modified cross-body and modified sleeper stretching exercises were given. Furthermore, active assistive static stretching exercises for upper trapezius, serratus anterior, latissimus dorsi as well as pectoralis minor muscles and anterior capsule were performed. Active-assistive stretching exercises were performed for 15 seconds with 5 repetitions resting 5 seconds between each stretch. Proprioception training was initially performed on stable surfaces. The exercises were performed for a maximum of 30 seconds as long as the movement continued to be done with quality. We mainly focused on scapular control and coupled RC activation in phase I. Concentric strengthening exercises for both RC and scapular muscles were performed. Closed chain dynamic stabilization exercises were performed through rhythmic stabilization drills while the hand on the wall and then on the treatment table (progressed from two hand to one hand). Axial loading exercises began on a stable base of support. Side-lying planks for core endurance, lateral slides with a resistance band, single-leg squat, lunge exercises, and strengthening of the lower extremity external rotators, abductors, and extensors were performed. Progression to phase II was made if the pelvis control over the planted leg (negative Trendelenburg sign), effective hip and trunk extension, scapular control (especially of retraction), and increased posterior shouler flexibility were achieved (Kibler et al., 2001; Wilk et al., 2011).

In phase II she continued to receive electrotherapy and PSSE. We progressed isotonic strengthening of the shoulder and scapulothoracic muscles, as well as thrower's ten program. We continued rhythmic stabilization drills for both shoulders (when the shoulder was elevated 110° in the scapular plan, rhythmic stabilization drills were performed with open kinetic position) and scapula (scapular clock exercises on the wall were performed with rhythmic stabilization drills). Axial loading exercises and proprioception training progressed to an unstable surface using a stability ball and BOSU ball. For core stability training, lumbopelvic region (plank, side plank and push-ups on the knee) and lower extremity (hip extensor, abductor, and external rotator strengthening) endurance program were added.

Phase III included advanced strengthening exercises. We continued to give electrotherapy and PSSE. We focused on mainly the advanced thrower's ten program, as well as plyometric exercises for trunk and upper extremity rotation diagonals with resistance bands. According to the advanced throwers 10 exercise program, she set on a stability ball and performed IR and ER strengthening at 0° of abduction, full can exercise, and lateral raise to 90° of abduction using a resistance band or dumbbells as appropriate. Side-

Side-lying external rotation strengthening progressed to a side-plank external rotation with dumbbells. She performed prone T raises, Y raises, and row into ER on the ball with dumbbells. Ball bounce exercises were performed on the wall while the swimmer was in standing position and shoulder at 90° abduction and 90° ER. Strengthening of the core and lower extremity were progressed.

In phase IV, we continued strengthening and flexibility drills and proprioceptive training. We focused on plyometric exercises for RC, scapulothoracic, as well as core and hip muscles. Rotational diagonal exercises were performed with a resistance band. She performed ball bounce exercises both in the prone and standing position, while shoulder at 90° abduction and 90° ER.

Table 1. The rehabilitation program

Phase I

Electrotherapy agents:

TENS
Hot-pack
Cold-pack

Stretching Exercises:

- Wilk's modified posterior shoulder stretching exercises (Modified cross-body and modified sleeper stretching exercises)
- Upper trapezius, serratus anterior, latissimus dorsi, pectoralis minor, anterior capsule stretching exercises

Proprioception training (on the stable surface)

- Axial loading exercises (progressed from two hands to one hand)
- Closed chain dynamic stabilization exercises

Strengthening exercises (Concentric)

- RC and scapular muscles
- Lower extremity (external rotator, abductor, and extensor lower extremity) as well as single-leg squat and lunge exercises, lateral slides with a resistance band
- Side-lying planks for core endurance

Phase II

Electrotherapy agents:

As in Phase I

Stretching Exercises:

As in Phase I

Neuromuscular training:

- Proprioception training (on the unstable surface)
- Axial loading exercises (progressed from two hands to one hand using a stability ball and BOSU ball)
- Open kinetic chain dynamic stabilization exercises for shoulder (rhythmic stabilization drills were performed while the shoulder was elevated 110° in the scapular plane) and scapular rhythmic stabilization drills were performed during scapular clock exercises on the wall

Strengthening exercises (Concentric)

- RC and scapular muscles, as well as lower extremity strengthening program, were progressed

The Thrower's Ten Program

- PNF D2 Extension and Flexion
- ER and IR at 0° of ABD
- ER and IR at 90° of ABD
- ABD to 90°
- Full can exercise
- Prone Horizontal ABD (Neutral, Full ER, 100° ABD)
- Press-ups seated on a chair
- Push-ups
- Elbow and wrist flexion, extension
- Supination, Pronation

Core stability training

- Lumbo-pelvic region (plank, side plank, and push-ups on the knee)
- Lower extremity (hip extensor, abductor, and ER strengthening) endurance program

Table 1. Continue

Phase III

Electrotherapy agents:

As in Phase I

Stretching Exercises:

As in Phase I

Neuromuscular training:

- Proprioception training (on the unstable surface)
- Axial loading exercises (one hand using a stability and BOSU ball)
- Open kinetic chain dynamic stabilization exercises for the shoulder and scapular rhythmic stabilization drills were performed during scapular clock exercises and multidirectional loading on the wall
- Wall washes

Strengthening exercises (Concentric and eccentric)

Concentric exercises in Phase II was progressed

Eccentric ABD and ER exercises

Core stability training

Exercises in Phase II was progressed

Plyometric exercises for RC, scapulothoracic, as well as core and hip muscles, were progressed

Ball bounce exercises were performed on the wall while the swimmer was in standing position and shoulder at 90° ABD and 90° ER

The advanced thrower's ten exercise program

- IR/ER with resistance band at 0° of abduction seated on a stability ball*
- Full can exercise seated on a stability ball*
- Lateral raise to 90° of ABD seated on a stability ball*
- Side-lying ER*
- T raises prone on a stability ball*
- Y raises prone on a stability ball*
- Prone row into ER on a stability ball*
- Lower Trapezius 5 Series
    - Shoulder extension in ER seated on a stability ball
    - Shoulder extension at 45° in ER seated on a stability ball
    - Standing wall circle slides
    - Standing low row
    - Standing table press-downs with scapular depression
- Biceps curls/triceps extensions seated on a stability ball
- Wrist flexion/extension and supination/pronation

*Exercises were performed with sustained holds.

Short-distance swimming program at the very end of the stage

Phase IV

Stretching Exercises:

As in Phase I

Return to activity:

Strengthening and flexibility drills and proprioceptive training were progressed in top advanced level

Plyometric exercises for RC, scapulothoracic, as well as core and hip muscles, were progressed in top advanced level including rapid eccentric rotational diagonal exercises with resistance band

Medicine ball plyometric exercises

Plyometric push-ups

Ball bounce exercises in the prone and standing position (shoulder at 90° ABD and 90° ER

Swimming program at the of the stage

Outcome Measures

IRROM was assessed with a bubble inclinometer (Baseline; Fabrication End Inc., NY, USA) (Kolber and Hanney, 2010; Manske et al., 2010). In the measurement, the patient lied in a supine position, and her arm was supported with a pillow on the table at 90° shoulder abduction, with 90° elbow flexion, and the wrist neutral. The physiotherapist placed one hand to the acromion and took the patient's arm to the maximum possible ROM with the other hand. At the end of the movement, a trained assistant placed the inclinometer on the dorsal surface of the distal forearm, read and recorded the result. Results of three repetitions were averaged (Kolber and Hanney, 2010; Manske et al., 2010). AHD was assessed with ultrasonographic imaging (LOGIQe, GE Healthcare, Wauwatosa, WI, USA) (Luque-Suarez et al., 2013). We measured the two-dimensional shortest linear distance between the anterior–inferior tip of the acromion and the humeral head via the ultrasound's on-screen calipers. We captured the images at 0º (the arm resting at the side) and then averaged the two measurement results of two locations: first, at the most anterior part of the acromial arch (confirmed with palpation) and second, 1 cm behind the first measure (Luque-Suarez et al., 2013). Pain intensity for rest and activity was assessed with Visual Analog Scale ranging from '0' indicates no pain to '10' indicates worst pain imaginable (Clark et al., 2003).

RESULTS

We assessed pain, AHD, and IRROM values before and at the end of the 9th and 15th treatment sessions. Before treatment, IRROM was 52°, AHD 10.67 mm, and pain intensity at rest and during swimming was 0 and 3.1 cm, respectively. After 9 treatment sessions, IRROM was 55.6°, AHD was 11.62 mm, pain intensity at rest and during swimming was 3.7 cm and 5.1 cm, respectively. At the end of the treatment (after 15 sessions), IRROM was 58.33°, AHD was 12.02 mm, pain intensity at rest and during swimming was 0 cm.

DISCUSSION

After a 15-session progressive and comprehensive sport-specific rehabilitation program IRROM, AHD, and pain improved in the swimmer diagnosed with SPS who has also scapular dyskinesis and suspected SLAP lesion.

During overhead activities, the shoulder must have adequate ROM, as well as coordinated proper kinematic patterns between the humerus, scapulae, and thorax for synchronized motion (Burkhart et al., 2003; Kibler et al., 2012). It has been proposed that scapular upward rotation, slight ER, and decreased anterior tilting are necessary during glenohumeral elevation to maintain the adequate size of the subacromial space (Hibberd Laudner Kucera et al., 2016; Kenal and Knapp, 1996; Maenhout et al., 2012). The inflexibility of the posterior shoulder structures, including thickened posterior capsule and glenohumeral internal rotation deficit (GIRD), acquired loss of IRROM (Burkhart et al., 2003; Harshbarger et al., 2013), has been well documented in the literature in overhead athletes having SPS. Specifically, GIRD (Torres and Gomes, 2009) and PST were reported in swimmers (Hibberd Laudner Berkoff et al., 2016). In this case, glenohumeral and scapular biomechanics can be deteriorated and lead to anterior and superior migration of the humeral head as well as scapular IR (protraction) and anterior tilting (Harryman et al., 1990; Ludewig and Cook, 2000; Lukasiewicz et al., 1999; Tyler et al., 2000). Reports on kinematic alterations give us reasons to believe that IRROM deficiency could compromise the width of the subacromial space (Atalar et al., 2009; Maenhout et al., 2012; Solem-Bertoft et al., 1993). We performed Wilk's modified PSSE to improve IR ROM (Wilk et al., 2013). IRROM improved both at the end of the 9th and 15th treatment session compared to baseline. Researchers reported that IRROM (Maenhout et al., 2012; Yamauchi et al., 2016) and AHD (Maenhout et al., 2012) improved in overhead athletes after traditional PSSE (Maenhout et al., 2012; Yamauchi et al., 2016). However, during traditional PSSEs, inadequate scapula stabilization results in accessory abduction of the scapula as the humerus goes into horizontal adduction. Furthermore, traditional cross-body stretching allows the humerus to externally rotate as the shoulder moves into the outer ranges of motion, and tension is generated in the shoulder external rotators. In contrast, modified PSSEs could isolate and more effectively stretch posterior RC, posterior capsule, and the glenohumeral ligament while providing adequate scapular stabilization without the aggravation of the shoulder pain (Wilk et al., 2013). In the first randomized controlled trial on modified PSSEs, Tahran and Yesilyaprak concluded that both modified sleeper and cross-body stretches are effective to improve GIRD, PST, and shoulder disability and function even in non-athletic patients having SPS with GIRD, over

4 weeks (Tahran and Yeşilyaprak, 2020). Recovery of normal shoulder and scapular kinematics with PSSEs by improving posterior shoulder mobility might be responsible for the improvement in IRROM therefore in AHD.

In the present study, the swimmer had a forward head and rounded shoulder posture, increased thoracic kyphosis, and an anterior tilt of the head. These postural adaptations usually occur in swimmers because of the swimming techniques and this situation contributes to the narrowing of the subacromial space (Hibberd Laudner Kucera et al., 2016). Our competitive adolescent swimmer's main techniques were butterfly and backstroke. These techniques, especially butterfly, may have contributed to these postural adaptations within the 7 years and then to scapular dyskinesis and SPS. It has been suggested that the decreased subacromial space may be due to the lack of scapular control in overhead athletes with SPS (Silva et al., 2010). Furthermore, previous researchers have demonstrated that competitive adolescent swimmers' scapula became more internally rotated, protracted, and elevated over the first 6 weeks of the training season, and they had significantly less subacromial space in both the dominant and nondominant limbs over the first 12 weeks of the training season when compared with the non-overhead athletes (Hibberd Laudner Kucera et al., 2016). These studies revealed that long-term swimming training leads to a decrease in subacromial space in swimmers. We conducted a comprehensive rehabilitation program. RC and periscapular muscle strengthening were performed through isotonic and eccentric exercises. In addition to this strengthening program, core and lower extremity exercises could contribute to improving scapular and glenohumeral kinematics to achieve better posture and leads to an increase in subacromial width assessed by AHD. Furthermore, modified PSSE can affect glenohumeral biomechanics and may contribute to IRROM gain (Kibler et al., 2001; Wilk and Arrigo, 1993; Wilk et al., 2013; Wilk et al., 2011). The advanced throwers ten program was added to our rehabilitation program when appropriate (Wilk et al., 2011). As a result, improved biomechanics may provide an increase in subacromial width and a decrease in subacromial compression in the adolescent swimmer. In parallel with our proposition, Maenhout et al. suggested a relationship between the IRROM gain and AHD improvement (Maenhout et al., 2012).

Our rehabilitation program included plyometric exercises, a combination of both eccentric and concentric exercises, especially in phase III and phase IV. The challenging rehabilitation program may explain the increase in both rest and activity pain at the end of the 9th session. However, at the end of the treatment, the pain was completely resolved. As a result of suspected SLAP lesions, instability, concordant with scapular dyskinesis as well as SPS may increase the narrowing of the AHD in the adolescent swimmer (De Martino and Rodeo, 2018; Jobe et al., 2000). The RC tendons are usually at risk for inflammation and degeneration in overhead sports due to increased load as the swimmer performs overhead movements. McCreesh et al. investigated the differential effect of loading on normal and symptomatic RC tendons and concluded that an RC muscle fatigue protocol leads to a short-term decrease in AHD and swelling of the supraspinatus tendon in people with RC tendinopathy (McCreesh et al., 2017). A combination of narrowing of AHD which creates mechanical compression and intrinsic tendon mechanism may lead to shoulder pain in swimmers (Porter et al., 2020). Continuous loading of RC tendons may result in the changes in the extracellular matrix composition affecting diameter and organization of the collagen fibers resulting in a reduced capacity to resist tensional forces and may contribute to degeneration and pain, especially in the supraspinatus tendon (Riley et al., 1994). A recent systematic review pointed out that there is no consistent pattern related to the correlation between subacromial space and pain in patients with SPS (Park et al., 2020). However, the supraspinatus tendon occupation ratio (STOR) which is the supraspinatus tendon thickness as a percentage of subacromial space, appears to be greater in patients with SPS compared to controls without shoulder pain (Park et al., 2020). After our rehabilitation program, AHD improved. Perhaps the internal structure of the tendon parallel to the improvement in AHD may have changed and STOR may have improved as well. However, because we did not measure the supraspinatus tendon thickness and calculate STOR no definitive conclusion is possible. Furthermore, IRROM improved after treatment. We performed modified PSSEs to ensure proper collagen fiber organization and alignment for the posterior shoulder muscles and shoulder capsule. In addition to this, we conducted a specific sports rehabilitation program including the advanced thrower's ten exercise program. We increased the intensity of the exercises gradually, considering the RC tendon irritability. We aimed to provide proper loading on the RC tendon via our exercise program. We ensured an increase in the posterior shoulder flexibility with this comprehensive rehabilitation program. Gradual increase of exercise load may have provided realignment of the proper intrinsic tendon mechanism leading to improvement of STOR. Periarticular connective tissues, based on the biological principle, remodel over time in response to the type and proper amount of physical stress they receive and this may lead to an increase in the IRROM. Soft tissue remodeling along the lines of imparted stress, also known as plastic deformation, occurs when microtrauma at the cellular level breaks cross-links of the periarticular connective tissue thereby creating elongation of collagen bundles (Manske et al., 2013). Consistent with the literature, we performed 15 sessions of modified PSSE (Manske et al., 2010; McClure et al., 2007; Tahran and Yeşilyaprak, 2020). This number of treatment sessions seems to be sufficient to create the abovementioned changes.

Conclusion

A comprehensive progressive sport-specific rehabilitation improved IRROM and AHD, and resolved the pain in the swimmer with SPS, scapular dyskinesis, and suspected SLAP lesion. The effects of our treatment program on IRROM, AHD, and pain in a larger sample of women swimmers with similar demographic characteristics and diagnoses should be investigated.

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Conflict of interests

The authors have no conflict of interests to declare. No financial support was received for this study.

Ethics Statement

Ethical approval was obtained from the ethics committee of Dokuz Eylül University for the study to be performed (Number: 2021/20-54). In addition, verbal and written informed consent was obtained from the family of the female swimmer who is under 18 years of age. Nevertheless, we also obtained verbal consent from herself.

Author Contributions

Study Design, SSY; Data Collection, HET, DK; Data Interpretation, SSY, HET; Manuscript Preparation, SSY, HET, DK; Literature Search, SSY, HET, DK. All authors have read and agreed to the published version of the manuscript.

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