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Proposal of a standardized positioning for rotator cuff treatment with shock waves and radial pressure waves: An anatomo-imaging correlation

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Abstract

One of the keys to successful treatment with radial pressure waves and focused shock waves is being able to deliver the energy to the right area. The shoulder region is characterized by a complex architecture with overlapping structures, which can make it difficult to locate the area to be treated.

The aim of this study is to describe the best upper limb positions and standardized approaches to treat rotator cuff pathology, based on the correlation of radiological and ultrasound images obtained during a joint examination by an imaging expert and a shock wave specialist.

Keywords: Extracorporeal shock wave therapy, Radial pressure waves, Arm positioning, Shoulder ultrasound

Introduction

Radial pressure waves and focused shock waves are frequently used for the treatment of shoulder injuries [1-3]. As in any other region, a correct localization of the treatment area is essential to obtain satisfactory results. The shoulder girdle, with its complex anatomy and overlapping structures, can make this objective difficult to achieve.

Scientific literature proposes several ways to determine the treatment area, including topographic anatomy landmarks [2], patient feedback [2,4,5], maximum tenderness using palpation [2], arm positioning [6], fluoroscopy [7-9], ultrasound [6,10-14], and computed tomography (CT) scanning [15]. However, there is no consensus on the best procedure. While imaging-based approaches and patient positioning have been proposed for other anatomical regions, such as the femoral head [16], there is insufficient information regarding the rotator cuff area.

The aim of this study is to describe standardized approaches to rotator cuff muscle tendons based on ultrasound and radiological examination.

Materials and Methods

This study was conducted at the State Insurance Bank Hospital in Uruguay. The institution's ethical regulations were complied with.

The study involved the collaboration of a volunteer 55-year-old male with no history of shoulder pathology or previous invasive procedures in both shoulder girdles. He also had no history of cervical symptoms.

The left shoulder was chosen for the study. Physical examination of the shoulder revealed preserved range of motion, similar to that of the contralateral one. There were no signs of hyperlaxity. Instability and provocative tests were negative. Integrity tests demonstrated the good condition of the rotator cuff.

Three treatment areas were defined: the supraspinatus tendon, infraspinatus tendon, and subscapularis tendon. The bony anatomical landmarks were drawn on the volunteer's shoulder, including the acromion, distal clavicle, spine of scapula, and the coracoid process (Fig. 1).

The ultrasound evaluation was performed with a General Electric Logiq F8 device. A 12–15 MHz linear transducer was used. The exploration was conducted in a systematic and comparative manner, as well as when the examination is carried out for diagnostic purposes. Ultrasound evaluation confirmed the absence of pathology. The position of the arm with the greatest exposure of the different areas to be treated was documented under ultrasound control. The position where the radial or focused wave applicator would have better access to the area to be treated was marked on the skin. Anteroposterior, lateral, and oblique radiographs were taken with metal markers at the proposed approach points.

Results

Based on the results of the clinical examination and their ultrasonographic correlation, the best approaches for each anatomical

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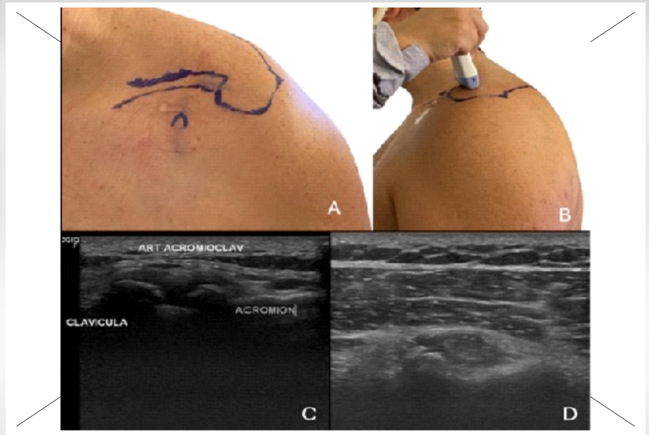

Figure 1: (a) Bony anatomical landmarks are drawn on the volunteer's shoulder, including the acromion, distal clavicle, spine of scapula, and the coracoid process. (b) Systematic ultrasound evaluation. (c) Ultrasound image from medial to lateral: Clavicle-acromioclavicular joint-acromion obtained with the transducer in this tangential position. (d) Identification of the bicipital groove in the neutral position of the upper limb.

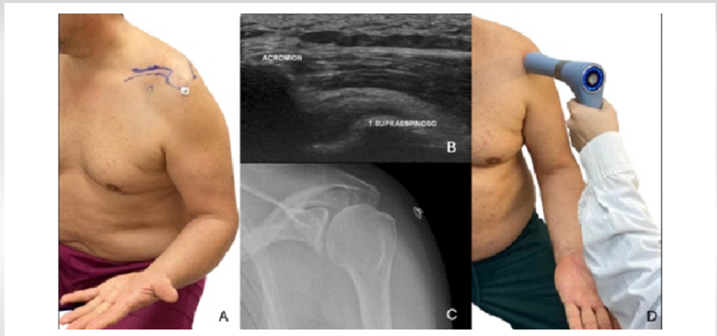

Figure 2: (a) "Asking hand position." (b) Ultrasound view of the anterior fibers of the supraspinatus. (c) Radiological image with the arm in the same position. Metal mark indicating the area of application. (d) Application area.

Figure 3: (a) Jug handle position. (b) Ultrasound view of the middle fibers of the supraspinatus. (c) Application of treatment to the middle insertional fibers of the supraspinatus.

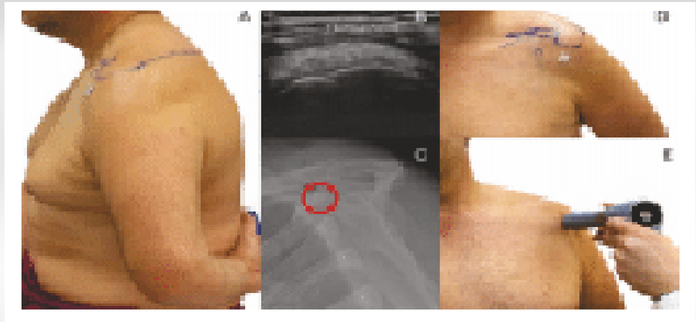

Figure 4: (a) Arm positioning to expose the posterior fibers of the supraspinatus. (b) Ultrasound image depicting the supraspinatus tendon. (c) Sagittal radiographic image of the shoulder girdle. The red circle highlights the metal marker indicating the recommended application site. (d) The application site is marked on the volunteer's shoulder. (e) Simulation of radial pressure waves application at the point of approach.

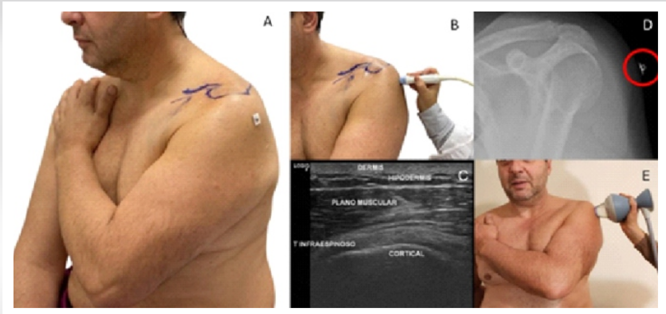

Figure 5: (a) Position to expose the infraspinatus tendon. (b) Ultrasound examination. (c) Ultrasoundview. (d) Sagittal radiographic image of the shoulder girdle. The red circle highlights the metal marker indicating the recommended application site. (e) Simulation of the application of focused shock waves at the point of approach.

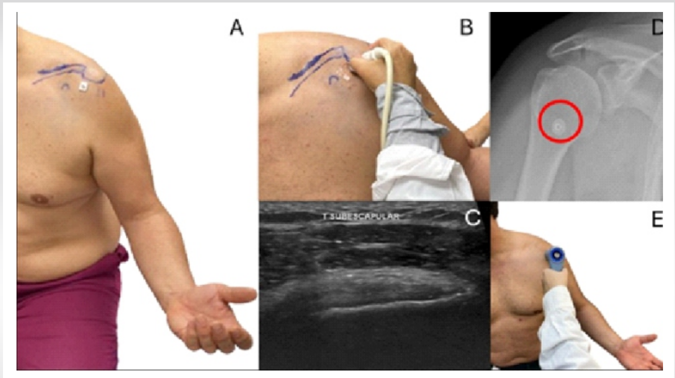

Figure 6: (a) Position to expose the subscapularis tendon. (b) Ultrasound examination. (c) Ultrasound view. (d) Anteroposterior view of the shoulder girdle. The red circle highlights the metal marker indicating the recommended application site. (e) Simulation of the application of radial pressure waves at the point of approach.

structure were defined.

1. Supraspinatus approaches:

• Anterior fibers: The best approach to the anterior fibers of the supraspinatus was with the shoulder in neutral rotation, the elbow flexed to 90°, and the elbow in maximum supination ("asking hand position") (Fig. 2). In this position, the bicipital groove is easily palpable on the anterior aspect of the shoulder. The anterior fibers of the supraspinatus muscle are located immediately lateral to it and caudal to the anterior border and anterolateral angle of the acromion. In this position, the posterior fibers of the supraspinatus are hidden beneath the acromion (Fig. 2).

• Middle fibers: The most effective position to expose the middle fibers of the supraspinatus was with the shoulder internally rotated and the palm on the iliac crest ("jug handle position") (Fig. 3).

• Posterior fibers: To expose the posterior fibers of the supraspinatus, the shoulder should be placed in internal rotation behind the trunk with the hand in a prone position (Fig. 4).

2. Infraspinatus approach: The best position to expose the infraspinatus was with the shoulder in adduction and internal rotation

in front of the trunk, placing the hand on the opposite shoulder. A lateral approach below the acromion in the posterior region of the subacromial space will allow good access to the distal insertion of the infraspinatus, as shown in Fig. 5.

3. Subscapular approach: The best access to the subscapularis tendon was with the shoulder in 15° of abduction, 60° of external rotation, and the elbow in maximum supination (Fig. 6). The bicipital groove is a key landmark since the subscapularis lies immediately medial to it.

Discussion

Being able to deliver the treatment to the desired area is essential when using any medical procedure. Radial pressure waves and focused shock waves are not the exception.

While anatomo-imaging correlations have been described for other anatomical areas, there is still no solid consensus for applications on the shoulder.

One of the alternatives for focusing on the treatment with radial pressure waves and shockwaves is patient feedback [4, 5]. While this is effective in some locations, it may not be valid for shoulder pathology. Frequently, pain is referred to other areas, for instance, the distal insertion of the deltoid, so patient feedback is not always reliable.

Initially, treatment of rotator cuff calcifications was typically performed under fluoroscopic guidance, with the best results achieved by focalizing the treatment to the area where the calcification was located [7-9]. Sabeti et al. [7] reported satisfactory results using navigation with a three-dimensional localization device and fluoroscopy. The computer calculated the angle and distance of the target to be treated [7].

Ultrasound has been used as a focusing method with good results [6,10-14]. Charrin and Noel [10] were the first to use ultrasound when treating rotator cuff calcifications, placing the arm in external rotation. However, they reported less success compared to localization by fluoroscopy [10].

Tornese et al. [6] compared two ultrasound-guided techniques and found that when treating rotator cuff calcifications, the rate of resorption was higher in patients treated with the arm positioned in hyperextension and internal rotation (66.6%) compared with those treated in neutral position (35.3%). Thus, the author shows that the positioning of the arm influences the results. Other authors have applied focused waves in internal rotation [12]. However, other authors preferred to perform the treatment in external rotation [10] or even abduction [14].

The findings of the anatomical imaging evaluation make it clear that a single position or approach will not be sufficient to access all areas amenable to treatment. Calcifications, for instance, can be found in any of the rotator cuff tendons [17], and the best approach for each case must be used.

Satisfactory results have also been reported with the use of CT scans. Sabeti-Aschraf et al. [15] compared the results of low-energy shock waves applied in one group according to feedback from maximum tenderness by palpation and in the other group by three-dimensional CT, with clinical improvement in both; however, the CT group was more effective at 12 weeks.

CT is not always readily available, and this leads to radiation exposure and higher costs. Using approaches based on anatomical imaging correlation is a cheap, versatile option that can be easily applied.

This initial description standardized approaches to rotator cuff muscle tendons based on a correlation between clinical examination with ultrasound and radiological examination, should be supplemented in the future with clinical studies to support its effectiveness in the treatment of various rotator cuff pathologies.

Conclusion

Proper positioning of the upper limb exposes the different rotator cuff areas to be treated depending on the location of each patient's pathology. The use of standardized treatment approaches based on the correlation between anatomy and imaging studies allows for more accurate application of both radial and focused waves.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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