Ultrasound guided interventional procedures in musculoskeletal radiology


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Abstract: Ultrasound is a useful diagnostic modality to study many structures such as subcutaneous tissue, tendons, muscles, joints, and nerves. It has low cost, wide availability and high resolution. These advantages make ultrasound a good modality in interventional procedures like soft tissue tumors biopsy, aspiration of cysts and other collections, and also in treating symptomatic calcifications like deposition of hydroxapatite crystals in the rotator cuff, among other indications. Our objective is to present the experience of the authors in performing musculoskeletal interventional procedures by ultrasound.

Keywords: Interventional procedures, Musculoskeletal, Ultrasound.


Introducción

The various examination methods used in the imaging practice are not only intended to the diagnostic study of different diseases, but also to support their treatment.

Amongthem, ultrasound is currently widely used in the musculoskeletal area as a guide for various types of minimally invasive procedures; it is very well tolerated and accepted by patients and imply few complications when performed by trained professionals.

Among the various features of this imaging modality, its ability to image in real-time, multiplanar capability, high spatial resolution, lack of ionizing radiation, low cost and wide availability must be highlighted. It is essential to have high resolution linear transducers of at least 12-5 MHz in order to provide adequate visualization and differentiation of musculoskeletal system structures(1,2).

Additionally, color Doppler function is useful because it allows recognition of the neurovascular bundle adjacent to the area to be punctured, thus avoiding injuries during the procedure.

The aim of this publication is to present the experience gained over the past 5 years in ultrasound-guided interventions in the treatment and management of a wide variety of conditions pertaining to the musculoskeletal area.

Among these we can mention tendinopathies, muscle and ligament injuries (especially sports-related lesions), inflammatory articular processes, and bursal disease and cystic lesions treatment. As experience increases and outcomes improve, acceptance of
The number of ultrasonographic procedures by clinicians increases as well, and new indications are approved.

**Technique**

To carry out interventional procedures, appropriate ultrasound equipment along with thorough knowledge of the regional anatomy and a qualified radiologist highly trained in the use of ultrasound are required. Such interventions are performed with sterile technique, disposable material, using the least traumatic access routes for patients\(^1\),\(^2\). Any medical procedure performed by a radiologist has to comply with a series of steps to maximize the chances of success and minimize risks. Therefore, our medical staff complies with a strict protocol, as described below:

1. Provide the patient with a detailed explanation of the procedure and possible complications that may occur after it. Later, the patient is given a written consent form which must be signed by the patient or other responsible person, in case of patient disability\(^3\).

2. Repetition of ultrasound examination in the affected body area in order to confirm diagnosed pathology and select the best suited access to perform the puncture, i.e. the shortest distance between skin and lesion, as well as the most comfortable position for both the patient and the operator.

3. Make the patient to lie down so as to feel comfortable and relaxed, properly exposing the body part to be treated. These procedures are rarely performed with the patient in sitting position.

4. The radiologist should perform hand washing and then use sterile gloves and mask.

5. Carry out a comprehensive cleaning of skin and then apply a local antiseptic. With sterile drapes a wide work field is delineated.

6. Prepare the sterile material with which the procedure will be performed. The choice of these elements depends on the intervention, but at least includes one set of needles, syringes, drugs (eg corticosteroid solutions), local anesthetic and sterile ultrasound gel (Figure 1).

7. The ultrasound transducer is covered with a sterile cover.

8. Depending on whether the procedure involves infiltration and/or fluid aspiration, the following basic material should be considered:

   a) Needles: For simple cysts infiltration use of large size needles are recommended (18 or 19G). In terms of depth, for superficial injuries, needles 25 to 38 mm in length should be used; for deep lesions, a 7 to 10 cm spinal needle is recommended.

   b) Corticosteroids: Administration of long-acting corticosteroid solutions, volume 1 to 2 cc, normally associated with a small amount of local anesthetic, is preferred.

Patient should be informed about the possibility of developing a post-puncture self-limiting inflammatory regional pain, corresponding to a crystal synovitis, which is treated with local cold and non-steroidal anti-inflammatory drugs. In the event of other complications, the patient is required to report them immediately to the referring physician.

9. The “free hand” technique is preferably used, i.e. one hand operates the transducer whilst the other controls the needle. Following selection of the appropriate access route and performing the smallest possible amount of punctures, the needle should enter longitudinally to the long axis of the transducer and its tip should be continuously visualized throughout the procedure, directing it to the target\(^4\).

![Figure 1. Basic working material on a tray.](image)
require no treatment. Reports have documented spontaneous regression in 40 to 60% of cases\(^3\).

Treatment is performed in those without regression and producing symptoms, usually pain and compressive effect. Surgery exhibits the highest success rate, reaching over 95% of effectiveness; however, complications may be higher\(^5\).

Ultrasound-guided needle aspiration represents a good alternative, given it is a minimally invasive and highly effective technique with low complication rates\(^4,6\). Drainage after the procedure is complemented by an intralesional corticoid injection in order to lessen the chance of recurrence\(^4,6\) (Figure 2).

This technique is also applied to other localizations, such as shoulder and hip paralabral cysts\(^7\).

**Figure 2. Synovial cyst of the wrist: US-guided puncture and aspiration of wrist cyst. Color Doppler function enables detection of adjacent vessels, thus avoiding damage.**

**Figure 3. Subdeltoid subacromial bursitis: Intrabursal puncture and corticosteroid infiltration performed under US guidance. By applying this technique, a minimal effective dose may be administered, while avoiding intra-tendon and / or extrabursal puncture.**

### Aspiration of rotator cuff calcifications

Ultrasound is very sensitive in identifying intrasubtendon calcifications. Under direct ultrasound vision and using a needle technique, puncture of the calcified area is made with a thick needle (18G), lavage is performed with a physiological saline solution and lidocaine; subsequently, aspiration is carried out (Figure 4). Initially, a “milky” fluid is observed. This procedure is performed until a crystalline liquid is obtained. In cases when calcification is fairly compact and does not allow lavage, its fragmentation (as complete as possible) is indicated, avoiding to damage the adjacent tendon, so that the calcific content is released into the adjacent bursal cavity, from where it will reabsorb spontaneously. Residual calcifications in the tendon may undergo the same evolution, thus their persistence should not be considered as treatment failure. Moreover, during the procedure the subacromial-subdeltoid bursa may be infiltrated with corticosteroid deposit. Clinical improvement is significant, achieving an important relief of symptoms in almost 90% of cases\(^10-12\).

**Figure 4. Rotator cuff calcific tendinopathy: Thick intratendon supraspinatus calcification. Puncture and subsequent aspiration is performed.**

### Bursitis

Non-septic bursal inflammatory process is a common entity in sports, being the subacromial-subdeltoid bursitis the most commonly observed pathology in our daily practice. Administration of corticosteroids and local anesthetics permits relieving of pain caused by this condition (Figure 3). Dosage and type of drug to be used will depend on both the importance of the inflammatory process and its availability, or operator and/or treating physician preferences\(^4,8,9\). Puncture technique described above is used with the patient positioned supine with the upper extremity disposed parallel to the longitudinal axis of the body or with the forearm resting on the abdomen, depending on the position that allows better visualization of the bursa.
Tendon Pathology

Among the wide range of tendon injuries, radiology has a therapeutic role in the treatment of tendinosis and small intrasubstance tears\(^{(13)}\).

In the pathophysiology of tendinosis three phases may be observed: inflammatory, proliferative and remodeling. During the first phase, some procedures may be performed in order to shorten this period by using peritendinous injections of steroids and lidocaine\(^{(13,14)}\). Concerning the following phases, indication of the use of platelet-rich plasma (PRP) intendent to promote regression and repair of these lesions is currently increasing (Figure 5)\(^{(15)}\). Among the most frequently treated conditions are the Achilles and patellar tendinopathies\(^{(15)}\).

The PRP is a type of platelet concentrate containing, at least, five times normal values of platelet serum concentration, which on average is 200,000 platelets x uL (range 150,000 to 350,000 x microL). This high concentration of platelets also results in increased concentration of a number of bioactive growth factors that may favor wound healing processes\(^{(16)}\). PRP is obtained through a venipuncture performed on the patient to collect about 30 cc of whole blood that is associated with an anticoagulant before undergoing a centrifugation process designed to separate the different blood components in three distinct layers. The most superficial layer consists of platelet-poor plasma (PPP); a second layer is composed of PRP and leukocytes, whilst a third layer corresponds mainly to red blood cells. PRP volume is approximately 10% of the initially collected volume.

When performing this puncture technique, no intratendon anesthetic should be used since it inactivates the PRP. In these procedures, intermediate or thin gauge needles may be employed. PRP is distributed in the tendon tear and in the adjacent tendon through multiple fenestrations. This procedure may cause early or late intense pain in some patients, being the use of analgesics recommended for treatment; administration of NSAIDs must be avoided since they inactivate PRP function\(^{(16)}\). Ideally, we recommend withdrawal of these drugs for two weeks, both before and after treatment.

Muscle injury

They are caused by direct contusion or by overdistrention. The end result is disruption of muscle fibers and the formation of local hematomas of varying size. By using ultrasound-guided intervention it is possible to aspirate significant bruises (with corresponding improvement of symptoms) and administration of PRP\(^{(15)}\), thus achieving, on the one hand, acceleration of recovery time, and on the other, diminishing of excessive fibrosis (Figure 6)\(^{(16)}\).
A decrease in healing time at up to 50% when compared with estimated healing times without administration of PRP has been documented\(^{11,12}\). These aspects are crucial to high performance athletes to whom activities resumed promptly is fundamental.

This treatment is indicated mainly in fascicular muscle tears and other small-sized lesions, only strictly following indications of the treating physician\(^{17}\).

The technique involves the local hematoma aspiration and subsequent infiltration with PRP in similar or lower volume than initial amount. The lengths of the needles will vary depending on the depth of the lesion.

**Conclusions**

Ultrasound is a diagnostic technique widely used in the study and diagnosis of musculoskeletal pathology, currently considered as a highly effective tool for guiding minimally invasive interventional procedures. It should be emphasized that an experienced operator is vital to ensure the success of the procedure and to minimize potential complications. Sonographic techniques are also applied in the therapeutic management of cysts, bursa infiltration, and aspiration of intra-tendon calcifications. Ultrasound procedures also play an important role as adjuvant therapy in various types of sports-related tendinopathies and muscular injuries, by injecting stimulators for tissue regeneration and scarring. The radiologist performing the procedure should be familiar with the condition to be treated, the regional anatomy and the pharmacologic arsenal to be used to achieve the maximum possible clinical benefit.

**Bibliography**