US-guided percutaneous treatment of calcific tendinitis of the rotator cuff: tips & tricks

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Learning objectives

To review some tips & tricks that can improve the practical performance of a double-needle procedure for treating rotator cuff calcific tendinitis (RCCT), also emphasizing the advantages in using warm instead of room temperature saline solution.

Background

Rotator cuff calcifications are a common finding which affect 2.5% to 7.3% of healthy shoulders in adults and up to 20% of symptomatic painful shoulders [1-5].

It mainly occurs in women in their 4th to 5th decade, usually with intact rotator cuff and it seems not to be related to physical activity [6].

RCCT is considered a self-healing condition, often characterized by low-grade subacute pain that increases at night. However, it can be a very disabling disorder with pain highly resistant to oral anti-inflammatory drugs [6].

RCCT consists of deposits of calcium, predominantly hydroxyapatite [7], which may be found in numerous tendons of the body, but mostly in rotator cuff. There, the tendons most commonly involved are the supraspinatus (65%), especially in the critical zone [8], the infraspinatus, mainly its lower third (10%), or both the supraspinatus and infraspinatus (18%) and subscapularis (7%), mostly in its preinsertional fibres [4-6].

This condition probably depends on local oxygen tension decrease and local pressure increase [3], although its etiopathogenesis is still not completely understood. The term tendonitis is not really appropriate, as inflammatory cells are rarely encountered, while it can be considered a fibrocartilaginous metaplasia [3,6].

Different stages corresponding to different radiological features have been recognized: precalcific and calcific stage. In turn, calcific stage consists of formative, resorptive, and postcalcific stage. Resorptive stage is characterized by vascular invasion, oedema, migration of phagocytic cells, and increased intratendinous pressure and it is the most incapacitating for patients, as calcium crystals migration into the subacromial bursa may cause sharp acute pain that limits shoulder movements [9].
As far as the treating options are concerned, there are different possibilities but no standard of care has been established. Being RCCT a self-limited condition, the chosen treatment should be effective, complication free, and minimally invasive. Nevertheless, no treatments are required for asymptomatic patients, while mild symptoms can benefit from conservative treatments, such as physical therapy and oral non-steroidal anti-inflammatory drugs [6].

Different treatment options have been reported.

- **Iontophoresis** has not proven to be more effective than physiotherapy or placebo on long-term follow-up [10-12].
- **Shockwave** therapy resolves calcifications in 57-60% of the shoulders and achieves substantial or complete clinical improvement [13-15] but it is frequently painful [16] and relatively expensive because of the needed equipment.
- **Arthroscopy** [17-19] achieves substantial or complete clinical improvements in 79-100% of the shoulders but rehabilitation is always required and it is not free of complications. Nowadays, it is considered the last option when other methods have failed
- **Imaging-guided procedures** are considered alternative and effective treatments. Slightly different approaches have been described, performed under fluoroscopic [20] or ultrasound (US) guidance, all implying the use of a fluid (local anesthetic or saline solution) to dissolve calcific deposits. Percutaneous treatment is currently most often performed under US guidance [2, 21-33] instead of fluoroscopy thanks to some advantages: absence of ionizing radiation, easier localization of calcification, real-time monitoring during needle placement and decreased risk of injury to the neighboring, and real time confirmation of procedure success [34].

**US-guided procedures** can be performed using one or two needles to inject fluid within calcifications. Some authors used one needle, believing that double needle insertion could be harmful to the tendon [25], but safety of two-needle technique has been proven up to one year and it actually is an effective, quick and low-cost therapy [2, 30, 33].

Purposes of using two needles are to create a continuous in- and outflow of saline solution to remove calcium and to control saline pressure inside the calcification during injection. This also provides escape for fluid, avoiding disruption of the peripheral calcific rim that causes calcium to spread throughout the periarticular soft tissues, possibly promoting the occurrence of post-procedural calcific bursitis [2, 33].

**Imaging findings OR Procedure details**
We will discuss the role of the following items when performing a double-needle treatment of RCCT:

- probe's disinfection;
- use of a two-step skin cleaning procedure (colored/uncolored antiseptics);
- anesthesia injection;
- needles' positioning in respect to the US probe;
- tip needles’ positioning in respect to each other and to calcifications;
- use of warm saline;
- calcium removal.

**US probe's disinfection**

Preliminary disinfection of instruments and patient's skin is necessary before starting the procedure [6], as US machines are ideal vectors for cross infections [35] and objects should be sterile because microbial contaminations could transmit diseases. So US-probe's disinfection is a very important item.

In terms of potential infections, **US-guided procedures are argued to be safe** for patients and operators with ordinary antisepsis [36]. Although most operators use either sterile gels or liquids in combination with sterile sheaths, condoms or gloves or they use non-sterile gel-filled condoms or gloves, this may be an unnecessary procedural effort.

According to a study by Caturelli et al. [37] no infection was observed when the US transducer was simply cleaned with a 70% alcoholic solution prior to each intervention. No drapes or covers were needed and no needles were contaminated.

Since double-needle procedure for treating RCCT can be considered a minimally invasive technique, in our reported experience of 681 patients [2, 33], we observed no infective complications. In that series, the probe was cleaned with didecyldiethylammonium chloride solution. A sterile probe cover can be used, but it can be uncomfortable in a procedure that lasts more than seconds.

**Use of a two-step skin cleaning procedure (coloured/uncoloured antiseptics)**

We currently use a two-step antiseptic procedure for skin cleaning. It consists of cleaning with a coloured disinfectant (e.g. 7.5%-10% iodopovidone solution) for at least two minutes, immediately followed by a second cleaning with an uncoloured disinfectant (e.g. banzalkoniumchlorididine solution + alcohol ethylic) (Figure 1). This approach allows
for an improved antisepsis of the shoulder. Also, as we use no sterile covers, the US probe is not stained by coloured antiseptic solution.

Another practical advantage is to keep a peripheral ring of coloured antiseptic solution which allows a better control of the sterilised area during the entire procedure. Thus, not only the area is perfectly sterilized, but also we are aware of the external borders of the cleaned area. This allows not to use sterile draping, thus increasing the cost of the procedure.

Use of sterile contact gel

Some authors do not use any sterile contact gels during US-guided procedures [23-25]. This is absolutely correct, as for short procedures (e.g. injections, biopsies) it is enough to keep both the skin and the probe wet with the antiseptic solution. However, in longer procedures, such as US-guided percutaneous treatment of RCCT, this approach is suboptimal, as the antiseptic solution gets dry quite quickly and it needs to be reapplied frequently. For this reason, the use of a small amount of sterile lubricant contact gel (e.g. Glissen12.5 g) can make the procedure smoother.

How correctly inject local anaesthesia

Different anaesthetic solutions can be used (e.g. 2% Mepivacainechloridrate without adrenaline, 2% Lidocainechloridrate or 0.5 Bupivacainechloridrate).

Whatever solution is used, the maximum recommended dose for adults is 400 mg to be administered during the entire procedure [38, 39].

Anaesthetic solution must be injected mostly (almost two thirds) into the subacromial subdeltoid (SASD) bursa, thus allowing for its complete distension. The remaining solution should be injected in the subcutaneous tissues and around calcification. In order to preserve the peripheral calcific rim, no anesthetic should be injected directly within the calcification (Figure 2).

No anaesthetic injection is required directly in the muscle (e.g. deltoid muscle), as muscle fibers are not directly innervated.

How to position the needles
In **musculoskeletal procedures**, selection of type and size of the needles depends on the joint and on the planned procedure. Aspiration normally needs thicker needles of 18-21 gauge (G), while for injection can be used thinner needles of 22-27 G [40, 41].

When dealing with RCCT, needle size must be chosen in order to **maximize calcium retrieval and avoid obstruction**. Aina et al. in their study indicated that 22 G needles are adequate for performing calcification fragmentation, aspiration, and reduction, without the need of larger and more traumatic needle sizes.

The caliber of the needles used in published studies for RCCT treatment **varies between 16 and 22 G** [2, 21-30, 33]:

- Farin et al. [24] and Galletti et al. [22] in their studies used 18 G needles
- del Cura [25] one 20-G needle
- Aina et al. [23] one 22-G needle.

In our experience [2, 33], introduction of **two 16-G** needles has been demonstrated to **be safe** without risk of tendon tears and a **good compromise** between calcium retrieval and avoiding obstruction caused by more thinner needles [2, 27, 30, 33].

**Correctly positioning** of the needle and an adequate visualization of the needle tips are crucial [6].

**Different aspects** must be taken into account, first of all positioning of needle in respect to the US probe and second, but not less important, positioning of the two needles in respect to each other and to calcifications.

As far as the **position of the needle in respect to the US probe** is concerned, methods used to insert the two needles may vary, according to location, accessibility and calcification’s size but both **needles must be inserted as parallel as possible to US probe** so they will be as perpendicular as possible to US beam. In this way, needles can be well and completely visualised and anisotropic effect should be avoided (Figure 3).

Needles are inserted into calcification under **continuous US monitoring** with a **free-hand technique**. In fact, normally, no needle guidance kit is required, because freehand technique allows for a faster and more flexible (no fixed angle) intervention [42].

In respect to each other and to calcifications, firstly to insert the needle which would be deeper so it can be clearly seen, avoiding it being covered by the superficial one (Figure 4). Needles should be inserted in the same coronal plane such that both needles form a
maximum angle of 25-30° each other and their tips should be very close to each other (maximum distance 2-3 mm) so to be easily visualised with minimal movements of the probe.

Flute-beak tip of the first needle must be rotated upward and flute-beak tip of the second one down-ward so needle tips are facing each other (Figure 5).

**Use of warm saline solution**

All percutaneous treatments for RCCT imply the use of a fluid (saline or anesthetic) to dissolve calcium. Most authors reported the use of room temperature fluid [2, 23-25]. However, we recently demonstrated that use of warm saline solution improves treatment of RCCT [33]. This hypothesis has been tested starting from the well known concept that most salts dissolve better in high temperature liquids [43, 44].

Using warm saline solution when treating RCCT allows for significantly reduce the procedure duration if compared to the same procedure performed using room temperature saline solution, improving also calcium dissolution. Also, it helps in reducing the occurrence of post-procedural bursitis, maintaining a similar efficacy of the treatment.

**How to increase calcium removal and post-procedural care**

Some tricks must be taken into account to increase calcium removal.

Saline solution should be injected by one needle and let it to freely flow out through the other one, using each needle alternatively (Figure 6). This allows for obtaining a continuous in- and outflow of saline solution that removes calcium until aspirate is free from visible calcific particles [2, 33].

Sometimes, however, hard calcifications are difficult to melt. Thus, needles can be gently rotated and laterally displaced (Figure 7) to increase calcium disaggregation and fragmentation. Then, calcium washing usually results easier and more effective.

**Post-procedural care** can improve treatment. At the end of the procedure an injection of slow-release corticosteroid in the SASD bursa (1 ml of methylprednisolone acetonide) under US guidance can be useful in preventing bursitis and inflammation possibly caused by widespread local diffusion of the calcific material [2, 6].
Even if routine protocols usually do not include any routine medication in our experience [2, 33] it is useful to locally apply ice to the treated shoulder up to 4-6 hours after procedure, use of analgesic if requested, and physiotherapy after treatment.

Images for this section:
**Fig. 1:** Two-step skin cleaning procedure (coloured/uncoloured antiseptics). The peripheral ring (yellow arrows) of coloured antiseptic solution obtained with this procedure allows for a better control of the sterilised area and the external borders of the cleaned area can be clearly seen in order to be aware of them during the procedure.

**Fig. 2:** Injection of local anaesthesia - Anaesthetic solution should be injected in subacromial subdeltoid (@) to obtain its complete distension, in subcutaneous tissue (SC) and around calcification (#) but not directly within it in order to preserve the peripheral calcific rim.
**Fig. 3:** Positioning of the needles in respect to the US probe. The best visualization of needle is obtained when it is as parallel as possible to the US probe (a) which means it is as perpendicular as possible to the cone beam; when it is oblique (b) to the US probe needle becomes less evident.
**Fig. 4:** Positioning of needles in respect to each other and to calcifications. Firstly to insert the deeper needle so it can be clearly seen, avoiding it being covered by the superficial one.
**Fig. 5:** Needles should be inserted in the same coronal plane such that they form a maximum angle of 25-30° and their tips are very close to each other (maximum distance 2-3 mm). Flute-beak tip of the first needle must be rotated upward and flute-beak tip of the second one downward so needle tips are facing each other.
Fig. 6: Increasing calcium removal - Needles should be used alternatively, injecting saline solution by one needle and let flow out through the other one in order to obtain a continuous in- and outflow.
Fig. 7: Increasing of calcium removal - Needles can be gently rotated and laterally displaced to increase calcium disaggregation and fragmentation.
Conclusion

Double-needle US-guided percutaneous treatment of RCCT has been demonstrated to be an effective, quick, minimally invasive and low-cost therapy.

It facilitates prompt shoulder function and prompt pain relief and post-procedural complications are almost absent.

This procedure can be practically improved taking the above-mentioned items into consideration.

Personal Information

References

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