Ultrasound-guided percutaneous treatment of rotator cuff calcific tendinitis: randomised comparison between one- and two-needle procedure

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Purpose

**CALCIFIC TENDINITIS OF THE ROTATOR CUFF**

Etiology
The term "calcific tendinitis" refers to the intratendinous deposition of calcium, predominantly hydroxyapatite, that can affect every tendon in the body and especially the rotator cuff.

This pathological condition is a dynamic process that evolves through pre-calcific and calcific (formative, resorptive, reconstitutive) stages (Fig.1).

![Fig. 1: Calcific stage:(a)Formative,(b)Resorptive,(c)Reconstitutive.](image)

**References:** Radiology, DISSAL - Genoa/IT

In the precalcific stage, microtraumatic factors associated with a local decrease in blood supply can lead to intratendinous fibrocartilaginous metaplasia, with resulting calcification. The subsequent formative phase is considered as a resting period.

Eventually, triggered by unknown factors, there is resorption of the deposit, accompanied by vascular invasion, the migration of phagocytic cells with dissolution of the calcific focus (resulting in a "toothpaste" appearance of the calcific deposit) and edema from intratendinous pressure, such that the condition becomes symptomatic.

After resorption, in the reparative phase, fibroblasts restore the normal tendinous collagen pattern.

Epidemiology
Rotator cuff calcific tendinitis is a commonly seen condition, occurring in up to 20% of painful shoulders and up to 7.5% of asymptomatic shoulders. It is more frequent in women in their 40s and 50s and seems not to be related to physical activity. The supraspinatus tendon (80% of cases), followed by the infraspinatus (15% of cases) and subscapularis (5% of cases) tendons, is the most commonly affected cuff tendon. The lower third of the infraspinatus tendon, the critical zone of the supraspinatus tendon, and the pre-insertional fibers of the subscapularis tendon are the most frequently affected locations. This condition is typically associated with an intact rotator cuff.

Clinical Presentation
The pre-calcific stage is usually asymptomatic. The typical clinical manifestation is low-grade subacute pain that usually increases at night and corresponds to the calcific stage, variably associated with mechanical symptoms according to the size of the deposit. In many cases, however, rotator cuff calcific tendinitis can be a highly disabling disorder, with sharp acute pain that limits shoulder movement and is resistant to high doses of oral anti-inflammatory drugs. This clinical presentation usually coincides with the resorptive stage; fever, reflecting rupture of the calcification into the adjacent structures, is occasionally reported. However, the acute phase of calcific tendinitis of the rotator cuff is regarded as a self-healing condition, with spontaneous resolution in 7-10 days.

**Ultrasound Diagnosis**

Three types of calcifications have been described: type I consists of a hyper-reflexive lesion with a well-circumscribed dorsal acoustic shadow; type II deposits are well-circumscribed, homogeneous hyperechoic foci with a faint posterior shadow; type III are amorphous, inhomogeneous hyperechoic foci without posterior acoustic shadow (*Fig.2*).

![Calcifications: (a) Type I, (b) Type II, (c) Type III.](image)

*Fig. 2*: Calcifications: (a) Type I, (b) Type II, (c) Type III.

**References**: Radiology, DISSAL - Genoa/IT

The consistency is solid for deposits of types I and II and semi-liquid for type III calcifications.

**Treatment Options**

Asymptomatic cases usually do not require treatment, as the process is self-healing. In patients with mild symptoms, the disease can be managed conservatively with physical therapy and a short course of oral NSAIDs. Lithotripsy is only partially effective.

An alternative therapeutic approach is to extract the calcific material in an arthroscopy or imaging-guided procedure.

Imaging-guided treatments:

- fluoroscopy;
- ultrasound guided single or double needle technique.
PURPOSE OF THE STUDY

US-guided percutaneous treatment of RCCT has been demonstrated to be effective using one or two needles, but direct comparison between the two methods has never been performed.

Our aim was to compare the technical and one-year clinical outcome of these two approaches.

Images for this section:

Fig. 1: Calcific stage: (a) Formative, (b) Resorptive, (c) Reconstitutive.

Fig. 2: Calcifications: (a) Type I, (b) Type II, (c) Type III.
Methods and materials

IRB approval and patients' informed consent were obtained.

100 patients (77 females and 23 males, mean age 46 years, range 32-70 y) with RCCT (single calcification, acute/post-acute phase, no tendon tears) were randomized into two groups and were treated with two different US-guided percutaneous techniques.

Group A (50 patients; mean visual analogue scale [VAS]=7.8) was treated using an US-guided 16G double-needle technique (local anesthesia, washing with warm saline, intrabursal steroid injection), while group B (50 patients; mean VAS=7.4) was treated using a 16G single-needle technique (local anesthesia, washing with warm saline, intrabursal steroid injection).

Calcification appearance at US (fluid, soft, hard), procedure time and ease of calcium dissolution (subjectively scored as easy=1, intermediate=2, difficult=3) were recorded.

VAS follow-up was performed at 1, 3, 6 and 12 months.

Complication rate was noted.

Mann-Whitney U and Chi-square statistics were used.

INTERVENTIONAL PROCEDURE

Equipment

- One or Two 16G needles
- One 10-cm 18/20G needle (optional)
- Inox bowl (to collect the washing fluid)
- Sterile saline solution (100-200 ml) warmed to about 38-40°C
- Two syringes (20 ml and 3 ml)
- Lidocaine (10 ml)
- Steroid (1 ml, metilprednisolone acetate 40mg/ml)
- Plaster
- Ice pack

LOCAL ANESTHETIC INJECTION

The patient is either placed in the supine position (subscapularis and supraspinatus calcifications) or is prone (infraspinatus or teres minor calcifications), as seen in Fig.3. A correct US scan should demonstrate the target calcification (C) according to its major axis (Fig.4a,b). After sterile preparation of the skin and probe, a small amount of local
anesthesia is injected under US guidance and using an in-plane approach along the path of the needle (arrowheads), in the SASD bursa (asterisks), and around the calcification (C) (Figs. 4, 5, 6). H humeral head.

**Fig. 3**: A small amount of local anesthetic is injected into the bursal space, with an in-plane approach.

*References*: Radiology, DISSAL - Genoa/IT
Fig. 4: Needle position (arrowheads) in the bursal space (asterisks); H humeral head, C calcification.

References: Radiology, DISSAL - Genoa/IT
Fig. 5: The video shows the intrabursal injection of local anesthetetic.

References: Radiology, DISSAL - Genoa/IT
Fig. 6: The video shows the pericalcic injection of local aneshtetic.

References: Radiology, DISSAL - Genoa/IT

DOUBLE-NEEDLE TECHNIQUE
Fig. 7: The first needle is inserted into the lowest portion of the calcification with a in-plane approach.

References: Radiology, DISSAL - Genoa/IT
Fig. 8: The insertion of the first needle (arrowheads) into the lowest portion of the calcification (C), maintaining the bevel (arrow) open towards the probe. H, humerus.

References: Radiology, DISSAL - Genoa/IT
**Fig. 9:** The video shows the insertion of the first needle into the lowest portion of the calcification with a in-plane approach.

**References:** Radiology, DISSAL - Genoa/IT

**FIRST NEEDLE INSERTION**

As shown in **Figs.7,8,9** the first needle (*arrowheads*) is inserted into the lowest portion of the calcification (*C*), maintaining the bevel (*arrow*) open towards the probe. *H* humerus.
Fig. 10: A second needle is inserted into the calcification parallel and superficial to the first.

References: Radiology, DISSAL - Genoa/IT
Fig. 11: A second needle (curved arrows) is inserted into the calcification (C) parallel and superficial to the first (arrowheads), and its tip is rotated 180° in order to create a correct washing circuit. Arrow, needle bevel opened upwards; circles, artifacts.

References: Radiology, DISSAL - Genoa/IT
**Fig. 12:** The video shows the insertion of the second needle into the calcification parallel and superficial to the first, and its tip is rotated 180° in order to create a correct washing circuit.

**References:** Radiology, DISSAL - Genoa/IT

**SECOND NEEDLE INSERTION**

A second needle (*curved arrows*) is inserted into the calcification (*C*) parallel and superficial to the first (*Figs.10,11,12 arrowheads*), and its tip is rotated 180° in order to create a correct washing circuit. As shown in **Fig.11c**, the deeper needle needs to be inserted first, to avoid artifacts (*circles*) caused by the second, more superficial needle. Needle bevel (*arrow*) is opened upwards.
Fig. 11d shows both needles (arrowheads and curved arrows) within the calcification. *H* humerus.

![Image of needle and syringe](image)

**Fig. 13**: A 20-ml syringe filled with warm sterile water is connected to one of the needles and a gentle, intermittent pressure is applied.

**References**: Radiology, DISSAL - Genoa/IT
Fig. 14: A slight expansion of the calcification can be visualized during washing. Washing of the target continues until complete emptying of the calcification (C) is demonstrated. Arrowheads, first needle; curved arrow, second needle; H humerus.

References: Radiology, DISSAL - Genoa/IT
Fig. 15: The video shows the washing of the calcification, that continue until complete emptying of the target.

References: Radiology, DISSAL - Genoa/IT

WASHING PROCEDURE

A 20-ml syringe filled with warm sterile water is connected to one of the needles (arrowheads and curved arrows) and a gentle, intermittent pressure is applied. If the positioning is correct, a slight expansion of the calcification can be visualized. If no washing fluid exits and the needles are correctly positioned, an 18G spinal needle could be inserted into one or both 16G needles to slightly penetrate the target calcification, creating enough space for circulation of the fluid. The washing fluid exiting from the second needle is collected in the inox bowl, positioned as shown in Fig.13. Washing of
the target continues until complete emptying of the calcification (C) is demonstrated, as shown in Figs.14,15. Arrowheads first needle, curved arrow second needle, H humerus.

**SINGLE-NEEDLE TECHNIQUE**

*Fig. 16:* The needle is inserted into the calcification with a in-plane approach.

*References:* Radiology, DISSAL - Genoa/IT
Fig. 17: A 20-ml syringe filled with warm sterile water is connected to the needle and a gentle, intermittent pressure is applied.

References: Radiology, DISSAL - Genoa/IT
**Fig. 18:** The video shows the washing of the calcification, that continue until complete emptying of the target.

**References:** Radiology, DISSAL - Genoa/IT

**NEEDLE INSERTION**

As shown in **Figs.16** the needle is inserted into the calcification, maintaining the bevel open towards the probe.

**WASHING PROCEDURE**

As shown in **Figs.17** a 20-ml syringe filled with warm sterile water is connected to the needle and a gentle, intermittent pressure is applied. If the needle is correctly positioned, during the washing a slight expansion of the calcification can be visualized and the sterile
water into the syringe will became opaque because of the mixing of water and calcium (Fig. 18). If no washing fluid exits and the needle is correctly positioned, an 18G spinal needle could be inserted into the needle to slightly penetrate the target calcification, creating enough space for circulation of the fluid. Washing of the target continues until complete emptying of the calcification is demonstrated.

Fig. 19: Double-needle technique: at the end of the procedure one needle is removed and the 3-ml syringe is connected to the remaining needle. Single-needle technique: at the end of the procedure the 3-ml syringe is connected to the needle.

References: Radiology, DISSAL - Genoa/IT
**Fig. 20:** The needle (arrowheads) is then displaced into the SASD bursa and 1 ml of steroid is injected (asterisks). H, humerus; C, treated calcification.

*References:* Radiology, DISSAL - Genoa/IT
Fig. 21: The video shows the intrabursal injection of local steroid.

References: Radiology, DISSAL - Genoa/IT

STEROID INJECTION

Double-needle technique

At the end of the procedure one needle is removed and the 3-ml syringe is connected to the remaining needle (Fig.19). This needle (arrowheads) is then displaced into the SASD bursa (Figs.20,21) and 1 ml of steroid is injected (asterisks). A plaster is then applied to the skin at the puncture site and an ice pack is placed over the shoulder. H humerus, C treated calcification.

Single-needle technique
At the end of the procedure a 3-ml syringe is connected to the needle (Fig. 19). The needle (arrowheads) is then displaced into the SASD bursa (Figs. 20, 21) and 1 ml of steroid is injected (asterisks). A plaster is then applied to the skin at the puncture site and an ice pack is placed over the shoulder. H humerus, C treated calcification.

**POST-PROCEDURAL CARE**
The patient is kept under observation for at least 30 min. The ice pack over the treated shoulder should be maintained for at least 2 h. Patients should avoid overhead movements and the carrying of heavy weights for up to 15 days. Pain may occur after treatment and is managed with oral NSAIDs. Post-procedural bursitis is seen in about 15% of patients within approximately 2 months after treatment. In these cases, an intrabursal steroid injection may be useful.

**Images for this section:**

*Fig. 3:* A small amount of local aneshtetic is injected into the bursal space, with an in-plane approach.
Fig. 4: Needle position (arrowheads) in the bursal space (asterisks); H humeral head, C calcification.
Fig. 5: The video shows the intrabursal injection of local anesthetic.
Fig. 6: The video shows the pericalcific injection of local aneshtetic.
Fig. 7: The first needle is inserted into the lowest portion of the calcification with a in-plane approach.
Fig. 8: The insertion of the first needle (arrowheads) into the lowest portion of the calcification (C), maintaining the bevel (arrow) open towards the probe. H, humerus.
Fig. 9: The video shows the insertion of the first needle into the lowest portion of the calcification with an in-plane approach.
Fig. 10: A second needle is inserted into the calcification parallel and superficial to the first.
Fig. 11: A second needle (curved arrows) is inserted into the calcification (C) parallel and superficial to the first (arrowheads), and its tip is rotated 180° in order to create a correct washing circuit. Arrow, needle bevel opened upwards; circles, artifacts.
Fig. 12: The video shows the insertion of the second needle into the calcification parallel and superficial to the first, and its tip is rotated 180° in order to create a correct washing circuit.
Fig. 13: A 20-ml syringe filled with warm sterile water is connected to one of the needles and a gentle, intermittent pressure is applied.
**Fig. 14:** A slight expansion of the calcification can be visualized during washing. Washing of the target continues until complete emptying of the calcification (C) is demonstrated. Arrowheads, first needle; curved arrow, second needle; H humerus.
Fig. 15: The video shows the washing of the calcification, that continue until complete emptying of the target.
**Fig. 17:** A 20-ml syringe filled with warm sterile water is connected to the needle and a gentle, intermittent pressure is applied.
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Fig. 19: Double-needle technique: at the end of the procedure one needle is removed and the 3-ml syringe is connected to the remaining needle. Single-needle technique: at the end of the procedure the 3-ml syringe is connected to the needle.
Fig. 20: The needle (arrowheads) is then displaced into the SASD bursa and 1 ml of steroid is injected (asterisks). H, humerus; C, treated calcification.
Fig. 21: The video shows the intrabursal injection of local steroid.
Results

The calcifications we treated in group A were: 4 fluid, 25 soft, 21 hard (mean dimension 23±5 mm).

The calcifications we treated in group B were: 6 fluid, 27 soft, 17 hard (mean dimension 21±6 mm).

We have had a drop-out of 3 patients from group B (2nd needle insertion).

Overall procedure duration in group A (489±88s) was significantly shorter (P<.001) than in group B (684±187s).

Difference in procedure duration in group A (489±88s) was significantly lower than in group B (684±187s; P<0.001) when dealing with soft and hard deposits, while wasn’t significant regarding to fluid deposits (P=.683; P=.849).

Ease of calcium dissolution was significantly improved in group A (mean score=1; interquartile interval=1-2) compared to group B (2; 1-2, respectively; P<0.001).

No major complication were observed.

Were observed 3 post-procedure bursitis in group A after 61±10 days and 4 in group A after 56±7 days (P=.874, N.S.)

As regarding the follow-up, in group A VAS was 3.1±0.2 at 1 month, 1.8±0.3 at 3 months, 1.4±0.2 at 6 months, 1.0±0.3 at 1 year, while it was 3.0±0.1 at 1 month, 1.9±0.4 at 3 months, 1.3±0.5 at 6 months, 1.1±0.5 at 1 year in group B; overall no outcome differences between group A and group B (P#.244).

Conclusion

Single- and double-needle procedures are equally effective in treating RCCT with no major complications.

Double-needle procedure allows for significantly reducing treatment time and appears to be much easier when dealing with soft and hard calcium deposits.

Improvement in ease of calcium dissolution with double-needle technique when dealing with harder calcifications.
Single needle could be dedicated to acute phase and double needle for harder chronic phase.

**Personal information**

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**References**
