How to Wash the Pain Away

Ultrasound-Guided Lavage for the Treatment of Calcific Tendinitis of the Shoulder

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Calcific tendinitis of the shoulder is a common cause of self-limited, but often debilitating shoulder pain with classic imaging findings.

When conservative management fails, ultrasound (US)-guided lavage is a safe, effective, and relatively simple procedure utilizing readily available equipment that can provide significant symptomatic improvement.

Familiarity with US-guided lavage for calcific tendinitis of the shoulder allows radiologists to offer a valuable service to referring clinicians and their patients.

While this procedure is currently commonly performed in Europe, it remains relatively underutilized in North America, creating opportunity for its easy adoption into many more radiology practices.
1. To review the clinical presentation, natural history and diagnostic imaging features of calcific tendinitis of the shoulder.

2. To discuss the indications, contraindications, interventional methods, potential complications and expected outcomes of US-guided lavage for the treatment of calcific tendinitis of the shoulder.

3. To highlight the single versus double-needle US-guide lavage technique.
• Clinical Presentation and Natural History
  – Shoulder pain and disability with activity or rest
  – Chronic disease with acute exacerbations and periods of remission
  – Usually self-limited after a period of worsening and intense pain
  – Some experience cyclic, progressive course

• Demographics
  – 70% of cases are in women
  – 4th-5th decades most common

• Why should we care?
  – Can be highly incapacitating
  – Reduced ADLs, missed work ➔ economic impact
• The culprit
  – Calcium hydroxyapatite crystal deposition in otherwise healthy tendon
  – Distinguish from calcific enthesopathy secondary to tendon degeneration

• Etiology and pathogenesis
  – Incompletely understood
  – Favored theory:
    • Local ↓ in oxygen tension → fibrocartilagenous metaplasia
      – Tenocyte → chondrocyte → intracellular calcification → rupture of calcium into extracellular space → phagocytosis → tendon remodeling
# Natural History of Calcific Tendinitis

<table>
<thead>
<tr>
<th>Stage</th>
<th>Precalcific</th>
<th>Calcific/Formative</th>
<th>Resorptive</th>
<th>Postcalcific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular</td>
<td>Local decrease in oxygen tension in an otherwise normal tendon</td>
<td>Fibrocartilagenous metaplasia results in calcium formation</td>
<td>Vascular invasion and migration of phagocytic cells with resultant resorption and edema</td>
<td>The deposit has been completely removed with relatively normal remodeled tendon taking its place</td>
</tr>
<tr>
<td>Calcification</td>
<td>None</td>
<td>Chalk-like consistency</td>
<td>Toothpaste consistency</td>
<td>None/minimal residual</td>
</tr>
<tr>
<td>Symptoms</td>
<td>None</td>
<td>low-grade shoulder pain that commonly increases at night</td>
<td>Spontaneous, sharp, severe pain</td>
<td>Usually none, occasional residual stiffness</td>
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**Cellular process**
- Local decrease in oxygen tension in an otherwise normal tendon
- Fibrocartilagenous metaplasia results in calcium formation
- Vascular invasion and migration of phagocytic cells with resultant resorption and edema
- The deposit has been completely removed with relatively normal remodeled tendon taking its place
• The **differential** for shoulder pain is broad and includes
  – Calcific tendinitis
  – Rotator cuff tear or tendinopathy
  – Adhesive capsulitis
  – Glenohumeral joint osteoarthritis
  – Subacromial-subdeltoid bursitis

• Imaging is key as clinical findings are often **nonspecific**
  – No distinguishing specific symptoms for calcific tendinitis
  – Location of pain varies with position of calcification
    • Supraspinatus involvement ➔ exacerbation with abduction
    • Subscapularis involvement ➔ mimics biceps tendon pathology
• How often do we see rotator cuff calcifications?
  – In 7.5-20% of asymptomatic individuals
  – In 7% of symptomatic individuals
  – 50% of individuals with calcifications will develop shoulder pain

• Where do we see them?
  – Supraspinatus – 80%
    • “Critical zone” 1.5-2 cm from insertion
  – Infraspinatus – 15%
    • Lower third of the tendon
  – Subscapularis – 5%
    • Preinsertional fibers

Most common sites of calcific tendinitis in the shoulder. Coronal oblique PD (a), sagittal oblique T1 (b) and axial PD (c) MR images of a normal right shoulder are provided.

a. The white arrow denotes the “critical zone” of the supraspinatus tendon 1.5-2 cm from its insertion on the greater humeral tuberosity.
b. The black arrow denotes the lower third of the infraspinatus tendon.
c. The white arrowhead denotes the preinsertional fibers of the subscapularis tendon.
Large deposit of “quiescent” calcific tendinitis. Large cluster of calcifications (white arrows) in the supraspinatus tendon on (a) radiograph, (b) double oblique sagittal T2 fat sat MRI image and (c) transverse sonographic image. The greater tuberosity (white asterisks) serves as a landmark. Note the lack of surrounding edema and overlying bursitis. Large deposits can result in mild chronic pain and may cause limitations in motion due to the mechanical obstruction.

**ROLE OF DIFFERENT IMAGING MODALITIES**

- **Radiographs**
  - First line imaging
  - Helpful to confirm presence of clinically important amounts of calcification

- **MRI**
  - Helpful to assess integrity of the rotator cuff
  - Can help confirm location of the calcifications
  - Calcifications can be missed if radiographs are not available for correlation

- **Ultrasound**
  - Can identify and localize calcifications
  - Can assess integrity of the rotator cuff and assess the subacromial bursa
Severe acute pain can develop in calcific tendinitis during the resorptive phase. 63-year-old woman presenting with sudden onset of severe shoulder pain without history of trauma. (a) AP radiograph demonstrates calcific deposits (white arrowheads) in the rotator cuff consistent with calcific tendinitis. Note the indistinct, fluffy borders of the calcifications compared to the better defined margins of the quiescent calcifications on the previous slide. (b) A Coronal T1 fat sat post-Gadolinium image from the subsequent MRI again demonstrates calcific tendinitis of the rotator cuff (white arrowhead) with associated marked enhancement of the overlying subdeltoid bursa (black arrows) consistent with bursitis.

Calcific bursitis. 55-year-old woman with shoulder pain. (c) AP radiograph of the right shoulder demonstrates a large calcific deposit overlying the humeral head (black asterisks). (d) an oblique coronal T2 fat sat MR image confirms the location of the calcification to be within the subacromial/subdeltoid bursa (white asterisks). Calcific tendinitis can occasionally spontaneously rupture out of the tendon into the bursa, where it may continue to grow.
Since calcific tendinitis is usually self-limited, any ideal treatment must be effective, safe and minimally invasive.

**Treatment Algorithm**

- **Asymptomatic**
  - No treatment required

- **Symptomatic**
  - Conservative therapy
    - Symptoms improve
    - Symptoms persist
      - Acetic acid iontophoresis
      - Ultrasound therapy
      - Shockwave lithotripsy
      - Surgery/arthroscopy
      - Ultrasound-guided lavage

- **Calcific tendinitis of the shoulder**

- **Short course of oral NSAIDs**
- **Physiotherapy**
- **Subacromial steroid injection**
• Failure of conservative management is not infrequent – 27% per Ogon et al, 2009

• Second line treatments all have drawbacks

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Acetic acid iontophoresis</td>
<td>Safe</td>
<td>No more effective than physiotherapy or placebo</td>
</tr>
<tr>
<td>Ultrasound therapy</td>
<td>Safe</td>
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| Shockwave lithotripsy         | Effective both short and long term with significant clinical improvement in 66-91% | • Frequently very painful  
                                |                                            | • Requires special equipment |
| Arthroscopy or Surgery        | Very effective (substantial improvement in 79-100%) | • Rehabilitation is always required  
                                |                                            | • Surgical complications  
                                |                                            | • Considered last resort |
• Aka barbotage
  – Involves repeated injection and aspiration of small volumes of fluid to break down and wash away calcifications
  – Always followed by subacromial bursa steroid injection (SBI) to minimize bursitis

• A brief history
  – First described in 1978 by Comfort and Arafiles using fluoroscopic-guidance and 2-needle technique
  – Farin, Jaroma et al showed feasibility of ultrasound-guided technique in 1995
  – Aina et al first described a modified single-needle technique in 2001
Some highlights from many clinical trials:

- **De Witte et al, 2013: Lavage + SBI vs SBI alone**
  - Significantly better clinical and radiographic results at 1 year with lavage + subacromial bursa injection versus isolated subacromial bursa injection

- **Del Cura et al, 2007: Efficacy of single-needle lavage**
  - Led to significant improvement in shoulder motion, pain and disability, and radiographic findings both in short term and at 1 year

- **Sarafini el al, 2009: Long-term follow-up of two-needle lavage**
  - Led to significantly better shoulder function and pain relief versus no treatment at 1 month, 3 months and 1 year, and similar outcomes at 5 and 10 years
  - Only mild vagal-type reactions in 5% and no major complications.
• Average procedure duration: about 10 minutes

• Serafini et al, 2009:
  – Cost for lavage: $120
  – Cost for cycle of lithotripsy: $4,500
  – Cost for arthroscopic debridement: $34,000
**Indications**

- Failed conservative management
- Calcific deposit measuring at least 5 mm
- Appropriate for acute severe pain or chronic discomfort

**Contraindications**

- Active infection
- Blood thinners
  - Should be stopped
- Contraindication to corticosteroids
- Allergy to anesthetics or corticosteroids
• Share many similarities

• No study has confirmed one to be superior to the other
  – Some research (Ferrero et al, 2014) suggests no significant difference in clinical outcomes between the two techniques

• Ultimately comes down to user preference

• We use the **one-needle technique** at our institution and so will focus on this in this presentation with a quick review of the two-needle technique at the end
• We will walk through a real case step by step

• Pre-procedure workup, correct equipment and proper patient positioning all help make calcific tendinitis lavage easier for the patient to tolerate and more straightforward for the practitioner to perform
• Review prior imaging
  – Radiographs are essential
• Examine patient sonographically
  – Confirm presence and location of calcification
  – Exclude a tendon tear or other pathology
• Obtain informed consent
Ultrasound machine with linear probe (we prefer 12-5 MHz linear array probe) and sterile probe cover

**Temperature and solution composition**
- Some authors use saline
- Some authors (Sconfienza et al, 2012) promote warmed solutions
- We feel a 50:50 mix with lidocaine decreases discomfort
- We use a room-temperature mixture for convenience

**Equipment**
- Sterile cleaning and drape kit
- Sterile gloves
- For local anesthetic:
  - 1x 10 mL syringe with 10 mL buffered 1% lidocaine
  - 1 x 25 G 1.5 inch needle
  - (Optional: 1 x 30 G 0.5 inch needle for initial skin anesthetic)
- For lavage:
  - 4 x 10 mL syringe with 50:50 mixture of 1% lidocaine and bacteriostatic sterile saline
  - 1 x 18 G 1.5 inch needle
- For subacromial bursa injection:
  - 1 x 5 mL syringe with 1 mL Triamcinolone 40 mg/mL, 1 mL preservative-free 1% lidocaine and 1 mL 0.5% ropivacaine
Patient positioning for lavage. (a) The patient is semi-reclined in a supine position with the arm placed behind her back. This results in anterior rotation of the greater tuberosity of the humeral head along with the distal supraspinatus tendon, uncovering it from the overlying acromion. (b) Sonographic image demonstrating a large calcific deposit (white arrows) in the distal supraspinatus tendon. The greater tuberosity of the humeral head (white asterisk) serves as a useful landmark. Due to appropriate patient positioning, the calcific deposit is easily accessible by needle.
**Appropriate probe positioning and needle approach.** To minimize potential injury to the supraspinatus tendon, the needle should approach the calcific deposit along the long axis of the rotator cuff. The needle should be directed cranially to allow gravity to assist with aspiration of the calcific debris. (a) The yellow line indicates the orientation of the ultrasound probe to allow visualization of the supraspinatus in long axis. The red dot indicates the skin entry site of the needle. (b) Sonographic image demonstrates an 18-gauge 1.5 inch needle (white arrowheads) traversing the soft tissues and contacting the calcific deposit (white asterisk) in the supraspinatus tendon.
**Washing away the pain.** Calcific tendinitis lavage works by repeated injection and aspiration of small volumes of fluid into the calcification to break it up from the inside. Once the needle tip is positioned within the calcific deposit, continuous small pumps (a) of the syringe plumber are applied, causing breakdown of the calcification due to dissolution and pressure waves from the injected fluid (b). Between each pump, the build up of **backpressure** pushes fluid and calcific debris back into the syringe without the operator needing to actively aspirate (c and d). It is **important to avoid fenestrating** the calcific deposit, as doing so might allow the injected fluid to decompress through the resultant holes and prevent backpressure from building up.
Calcific tendinitis before and after lavage. Rather than attempt to fenestrate the calcification, the needle tip is buried in the center of the calcific deposit with a single pass, which allows for greater build up of internal pressure from the pulsatile injection of a 50:50 solution of sterile saline and 1% lidocaine, resulting in improved probability of disrupting the calcific deposit. (a) Demonstrates the needle tip (black arrowhead) buried in the echogenic calcific deposit (white arrows) prior to lavage. (b) Demonstrates the calcific deposit after lavage. The deposit has been disrupted from the inside with an “exploded” appearance and hypoechoic fluid (white asterisk) now in its center. It is not necessary to aspirate all the calcium, as disrupting the deposit will incite an inflammatory reaction that usually results in resorption of most remaining calcium. Following the lavage we always inject a mixture of steroids and local anesthetic into the subacromial bursa to decrease symptoms from bursitis incited by the procedure.
We will breakdown the procedure step by step on the following slides.
SINGLE-NEEDLE LAVAGE

STEP-BY-STEP (AFTER SKIN CLEANING AND STERILE DRAPING)

• The needle is directed cranially to allow gravity to assist with aspiration of the calcific debris.
• The needle tip is advanced into the calcification, preferably in one pass.
• Repeatedly pump and release the plunger to break up the calcification.
**SINGLE-NEEDLE LAVAGE**

**STEP-BY-STEP PART 2**

- Periodically check the syringe for calcific debris and switch syringes if there is build up.
- Continue until you are satisfied with the amount of calcium removed. If there are multiple deposits, reposition the needle tip into each one and repeat.
- Finally reposition the needle tip in the subacromial bursa with your 18 gauge needle, switch to the syringe containing your steroid mixture, and inject into the bursa.

Black arrowheads outline the distending bursa.
Continuous small pulsations are produced with a 20 mL syringe. The injected fluid breaks down the calcifications and carries the debris into the other needle tip. Note that both needle bevels face each other to enable this.

- Usually requires two 16 G needles
- Two needles allow continuous inflow and outflow of solution to remove calcium

A QUICK SUMMARY

TWO-NEEDLE LAVAGE

The injected solution and calcific debris drains from the hub of the needle tip. Note that both needle bevels face each other to enable this.
Pre- and post-barbotage imaging. Radiographs of the left shoulder in a patient with calcific tendinitis (a) before and (b) four week following lavage. There has been complete radiographic resolution of the calcific deposit (black arrow) seen prior to the procedure with no residual rotator cuff calcifications identified (white arrow).
i.e. what to tell the patient to expect

- Rest for 48 hours
- NSAIDs for pain relief after procedure
- Avoid heavy lifting for 2 weeks
- Resume physiotherapy after 1 week
- Pain may get worse for the first few days until the steroid injection takes affect
• Infection is main concern, but extremely rare if proper sterile technique is used

• Subacromial bursitis is commonly induced by the procedure
  – This is why a subacromial bursa steroid injection should always be performed after lavage

• Serafini et al, 2009:
  – Mild vagal reactions in 12 (5.1%) of 235 procedures
  – No other immediate complications documented
• Is it necessary to try and remove all of the calcifications?
  – No: lavage incites a reaction by the body that usually leads to removal of most if not all of the residual calcifications

• Is it a bad sign if I don’t see any calcium debris in my syringe?
  – No: for the reason listed above, aspiration of calcium is not absolutely necessary for the procedure to be clinically successful

• What if the needle becomes blocked?
  – Try switching the syringe first. If necessary, you may need to switch to a new needle, but this is uncommon.

• What if I can’t do ANYTHING to the calcification with lavage?
  – Fenestration can be used as a last ditch effort. While this will not allow aspiration of debris, the mechanical disruption of the calcific deposit will usually elicit a reaction from the body that will result in resorption of most of the calcium

• Will I tear the tendon with lavage?
  – It is a theoretical risk, but very uncommon when proper technique is used, including ensuring a needle approach along the long axis of the tendon

• Do I always need to do a subacromial bursa injection at the end?
  – Yes: the procedure itself will likely irritate the bursa, and patients may experience a significant flare up of shoulder pain if a steroid injection is not performed
• Calcific tendinitis is a common cause of shoulder pain for which radiographs should always be obtained.

• Ultrasound-guided lavage is a quick, safe and effective procedure to manage symptomatic calcific tendinitis recalcitrant to conservative management.

• There is no significant different in clinical outcomes between the one- and two-needle techniques.

• This procedure should be offered in every ultrasound practice!
REFERENCES

THANK YOU!