Technical Note

All-Arthroscopic Trillat Procedure Using Screw Fixation for Recurrent Shoulder Instability

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Abstract: The Trillat procedure has been described for the management of shoulder instability in younger patients but also for shoulder instability in older patients with irreparable rotator cuff tears. We describe an all-arthroscopic technique using screw fixation. This technique allows for safe dissection, clearance and osteotomy of the coracoid, and direct visualization during screw tensioning and fixation to minimize the risk of subscapularis impingement. We outline our stepwise approach to medialize and distalize the coracoid process using arthroscopic screw fixation and present pearls to avoid fracture through the superior bone bridge.

The Trillat procedure was described in 1954.[1] Trillat proposed treating chronic anterior shoulder instability with associated bone loss ("glenoid erosion") by performing an incomplete inferior closing-wedge osteotomy of the coracoid process to lower and medialize it, as well as to close down the retro-coracoid space. Trillat fixed the coracoid with a coracoscapular carpenter nail above the subscapularis to the glenoid neck. Latarjet[2]—who worked in the same surgical unit as Trillat—reported another technique for a similar indication of recurrent instability with bone loss, now widely known as the Latarjet procedure, in the same journal issue.

Almost 70years on, the Latarjet procedure has become the most widely used procedure for recurrent anterior instability in which bone loss is evident. It has gained favor over the Trillat procedure by most surgeons because of the improved range of motion, lower complication and redislocation rates observed.[3] In older patients, the Trillat procedure remains an alternative option, especially in the context of massive irreparable rotator cuff tears.[4]

The Trillat procedure has undergone many modifications since its first description. The step-by-step open technique was reported by Housset et al.[5] A mini-open arthroscopy-assisted technique using an opening-wedge osteotomy through the superior coracoid was described in 2018.[6] In 2019, Valenti et al.[7] described the first all-arthroscopic Trillat procedure using Endo-Button fixation (Smith & Nephew, Andover, MA) rather than screw fixation. In 2020, Swan et al.[8] described a modification of this technique in which the pectoralis minor is left attached to reduce the risk of neurovascular injury to the brachial plexus.

We describe an all-arthroscopic modification of the original Trillat technique using screw fixation and present tips and tricks. This technique has been developed through the work of Trillat,[1] Walch et al.,[3,9] and the surgeons in our unit today.

Technique

Indications for Surgery

Our current indications for the Trillat procedure (Video 1) are very narrow. We perform this procedure in patients older than 50 years who have a primary diagnosis of recurrent shoulder instability usually in the context of a rotator cuff tear, preserved range of glenohumeral elevation above 90°, no glenohumeral

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arthritis, and an intact subscapularis still attached to the lesser tuberosity.

Step 1: Patient Positioning and Diagnostic Arthroscopy

Preoperatively, range of motion of the shoulder is examined. The patient is placed in the beach-chair position with the operative arm in an after being sterilized and draped free to allow changes in position throughout the case (Fig 1, Video 1). The procedure is performed with the patient under general anesthesia with muscle relaxation and an interscalene nerve block. It is important that a wide exposure is achieved anteriorly to allow for the anteromedial (AM) portals involved in coracoid and glenoid drilling. The anatomic landmarks are marked. Six arthroscopic portals are used for this procedure (Fig 2). First, the standard posterior portal is created in the palpable soft spot, 2 cm inferior and 1 cm medial to the posterolateral corner of the acromion. Next, the lateral viewing portal is located lateral to the acromion, bisecting it into anterior and posterior halves. The anterolateral (AL) portal is located 1 cm anterior and lateral to the AL corner of the acromion. The AM portal is located close to the coracoid process. During the procedure, a spinal needle will be used to determine the placement of the accessory portal and the anteromedial transpectoral (AMT) portal.

Fig 1. The patient is placed in the beach-chair position with the operative left shoulder arm being sterilized and drapped free to allow changes in position throughout the case.

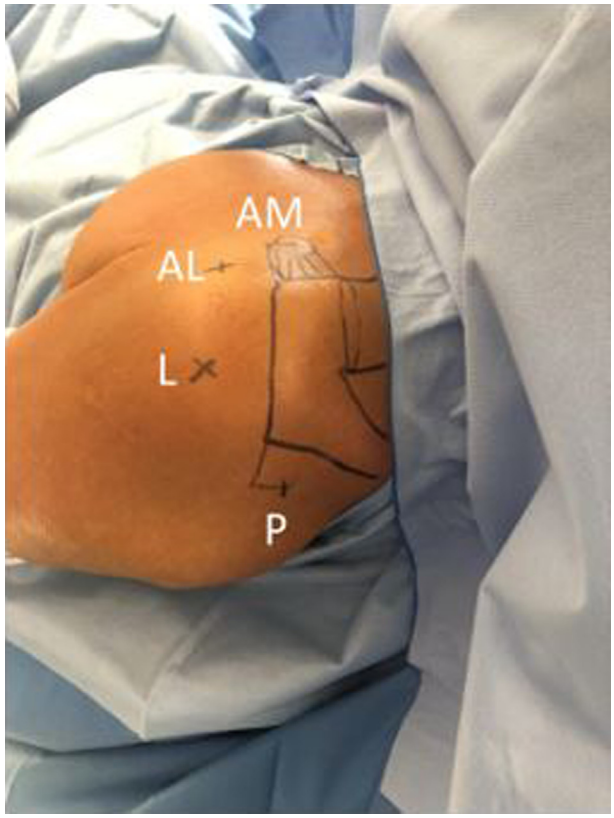

Fig 2. Anatomic landmarks and portal sites: posterior portal (P), lateral portal (L), anterolateral portal (AL), and anteromedial portal (AM). The accessory portal and the anteromedial transpectoral portal are not marked preoperatively because they are determined with a spinal needle during the procedure.

A diagnostic glenohumeral arthroscopy is performed using a 30° arthroscope viewing from a standard posterior portal. The subscapularis is inspected, and the presence of any associated arthritis is assessed. The repairability of the rotator cuff tear is assessed. The indication to proceed is the absence of glenohumeral arthritis and presence of an intact subscapularis with proven clinical and intraoperative instability.

Step 2: Subdeltoid and Subcoracoid Clearance

The rotator interval is entered through the AM portal. The rotator interval is cleared and released extensively. The arthroscope is switched to a lateral viewing portal, and an AL working portal is now used. Through the AL working portal, the superior border of the subscapularis is followed medially to the coracoid and subcoracoid space, which is opened widely. The undersurface of the coracoid is cleared of soft tissue, and the coracohumeral ligament insertion is released. The subcoracoid space can further be dissected in front of the subscapularis

and followed medially to identify the nerves of the brachial plexus to ensure protection throughout the case. The coracoacromial ligament is then released off the lateral margin of the coracoid. The subdeltoid space is opened above the coracoid and anterior to the subscapularis. In case of a tight subdeltoid space, a switching stick might be inserted through the posterior or lateral portal to elevate the deltoid (Table 1).

Step 3: Pectoralis Minor Release

The arthroscope is re-entered into the shoulder through an AL viewing portal, and the AM portal is used to resect the pectoralis minor off the medial aspect of the coracoid. It is important that a clear field is identified above and medial to the coracoid and that the electrocautery device remains on the coracoid bone for this resection, avoiding injury to the brachial plexus, which traverses medial to the coracoid process.

Step 4: Coracoid Drilling

The arthroscope is switched back to enter the lateral viewing portal to allow a wider field of view. A spinal needle is used percutaneously to determine the placement of an accessory portal slightly medial to the AM portal and above the coracoid. A drill sleeve is introduced through it, and the coracoid is drilled with a 1.57-mm pin in a superior-to-inferior direction at an angle that is perpendicular to the coracoid process and 1 cm proximal to the tip of the coracoid process. A 3.2-mm cannulated drill is passed over the pin, and the coracoid is drilled (Fig 3).

Step 5: Coracoid Osteotomy

The sleeve is removed, and attention is turned to the coracoid osteotomy. Through the AL working portal, a 5.5-mm motorized arthroscopic burr is placed, and the osteotomy site is palpated. The landmark for the osteotomy site is the inferior base of the coracoid immediately anterior to the angle (elbow) of the coracoid and coracoclavicular ligaments superiorly.

The osteotomy is made in a lateral-to-medial direction, with care taken to leave a 2-mm bridge of bone and periosteum attached at the superior limit of the coracoid process (Fig 4). A key tip to avoid over-resection of bone from the lateral and superior aspects of the coracoid is to use a Kerrison rongeur to complete the osteotomy of the inferomedial aspect of the coracoid. A completed osteotomy should represent an inferior wedge shape.

Step 6: Scapular Preparation and Drilling

A spinal needle is used to determine the placement of the AMT portal. A cannulated trocar is then applied through the AMT portal for neurovascular protection. A 1.57-mm pin is passed medial to the coracoid tip, through the retro-coracoid space, above the subscapularis, and onto the scapula, at the 9-o'clock position in a left shoulder (3-o'clock position in a right

Table 1. Pearls and Pitfalls

Step and Procedure	Pitfall	Pearls
Step 2: subdeltoid clearance above coracoid	Tight subdeltoid working space	Introduce a switching stick from the posterior or lateral portal to elevate the deltoid.
Steps 2 and 3: neurovascular identification and protection	Iatrogenic injury to axillary or musculocutaneous nerve	Identify the brachial plexus in the retro-coracoid area after opening the retro-coracoid bursa by following the superior border of the subscapularis. Furthermore, keep the electrocautery device on the coracoid bone while resecting the pectoralis minor.
Step 5: coracoid osteotomy	Fracture of superior coracoid at osteotomy site	Perform the coracoid osteotomy using an oscillating burr and complete the cut medially with a Kerrison rongeur to avoid over-resection and fracture.
Step 6: drilling of glenoid tunnel	Difficulty in passing guidewire through coracoid hole	Drill the guidewire throughout the posterior aspect of the shoulder and clamp it posteriorly with a Kocher device.
Step 7: fixation of osteotomy	Screw cutout of coracoid process	Fix the coracoid with a 4.5-mm screw and washer to avoid cutout in the coracoid process.
Step 7: closure of subcoracoid space	Impingement of subscapularis muscle	Tension the screw progressively under direct vision to avoid subcoracoid impingement of the subscapularis while taking the shoulder through range of motion in internal and external rotation.

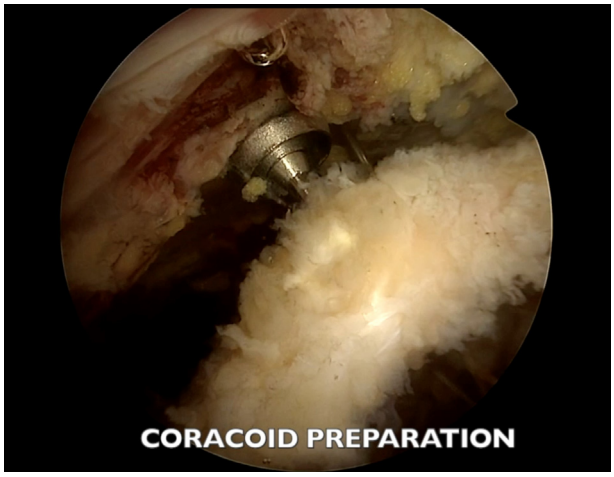

Fig 3. Arthroscopic view through lateral portal showing site of coracoid drilling.

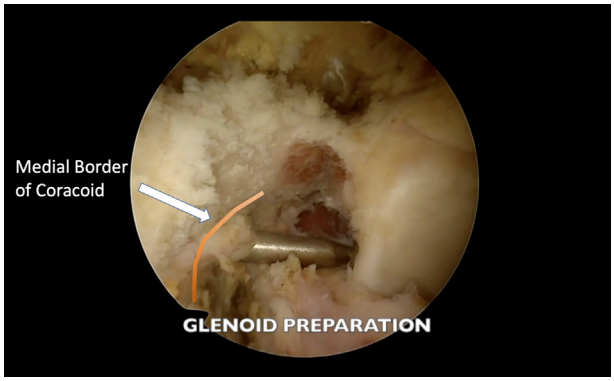

Fig 5. Glenoid drill site position and wire. A 1.57-mm pin is passed medial to the coracoid tip, through the retro-coracoid space, above the subscapularis, and onto the scapula, at the 9-o'clock position in a left shoulder, 5 mm medial to the glenoid surface.

shoulder), 5 mm medial to the glenoid surface. A key pearl is to drill the pin throughout the posterior aspect of the shoulder and clamp it posteriorly with a Kocher device. Over the pin, a 3.2-mm unicortical drill hole is created in the anterior scapula (Fig 5).

Step 7: Reduction and Fixation

A grasper is introduced through the AL portal to allow for progressive mobilization of the coracoid medially to be aligned with the pin. The guidewire is then pushed from posterior to anterior through the coracoid hole and subsequently pulled out through the AMT portal with a grasper.

A 4.5-mm titanium, partially threaded, cannulated low-profile screw (LPS; Arthrex, Naples, FL) with a washer is inserted over the pin under direct vision. As the screw is tightened, the coracoid osteotomy site is closed to ensure compression of the cancellous bone surfaces and reduction of the subcoracoid space without impingement with the subscapularis (Fig 6). The arm is taken through a range of internal and external rotation to ensure there is no impingement on the subscapularis tendon or muscle belly. An examination of the shoulder with the patient under anesthesia is also conducted to ensure that no residual instability occurs. The patient is immobilized in a shoulder immobilizer sling for a period of 4 weeks; early active-assisted range of shoulder elevation and external rotation are encouraged.

Discussion

Anterior shoulder instability most often occurs in younger patients owing to trauma. Several treatments

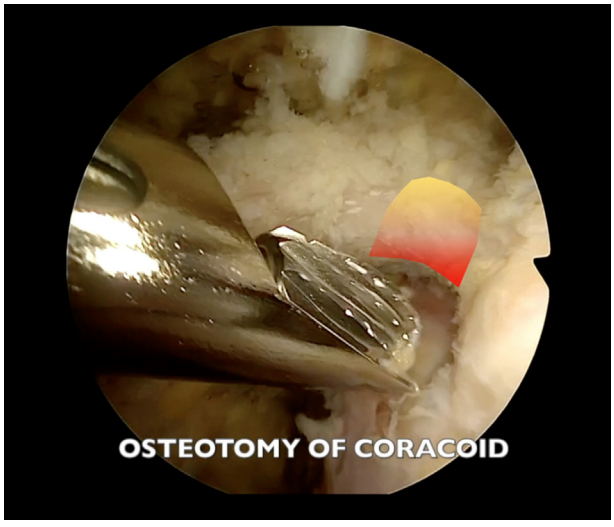

Fig 4. Partial inferior wedge osteotomy of coracoid process performed with 5.5-mm motorized arthroscopic burr.

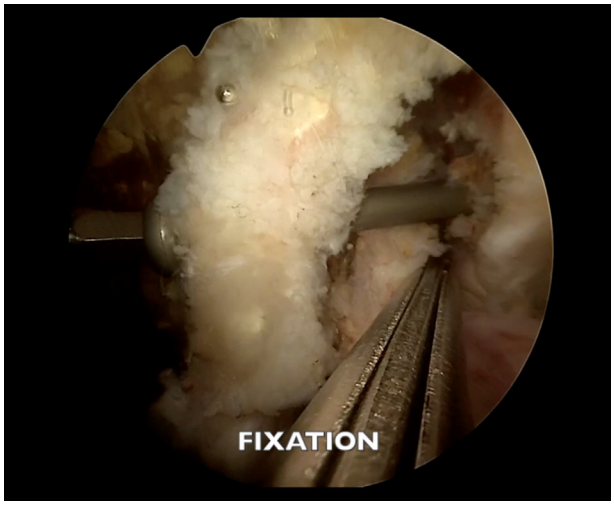

Fig 6. Screw fixation with closing of retro-coracoid space. As the screw is tightened, the coracoid osteotomy site is closed to ensure compression of the cancellous bone surfaces and reduction of the subcoracoid space without impingement with the subscapularis.

have been proposed, including Bankart repair, the open or arthroscopic Latarjet procedure, and the remplissage procedure. Although these procedures are often successful in younger patients, they are associated with higher complication and failure rates in older patients.

The incidence of anteroinferior instability in older patients is growing because of the increase in the average age of the population and increasing activity and sports participation in this age group. In patients older than 50 years, anterior shoulder instability is frequently associated with rotator cuff tears, which can contribute further to shoulder instability. There is ongoing debate regarding how to manage these patients and which surgical treatment options are most efficacious with the lowest complication rates. When performed in patients older than 60 years, the Latarjet procedure has an increased risk of complications including coracoid fracture, avulsion fracture, and nonunion.[10] In older patients, performing a coracoid transfer via a subscapularis split may also cause subscapularis injury and potentially result in shoulder pseudoparalysis.[10] Furthermore, because older patients might have more extensive glenoid and humeral bone lesions owing to reduced bone quality and a higher rate of infraspinatus tear, the Bankart procedure alone or combined with remplissage can lead to poor outcomes.[11,12]

The Trillat procedure has been proposed as an alternative option in these patients owing to the higher success rate and lower complication rate.[1] Distalizing and medializing the coracoid tip places the conjoint tendon anterior to the glenohumeral joint. This enables the conjoint tendon to act dynamically as a sling and push the humeral head posteriorly during abduction. By stabilizing the glenohumeral joint and sparing the subscapularis, the Trillat procedure has 2 key advantages: (1) It avoids further anterior dislocations, and (2) it delays the onset of cuff tear arthropathy. The Trillat procedure can also be revised to the Latarjet procedure if shoulder instability reoccurs.

The outcome of the Trillat procedure has been studied extensively in younger and middle-aged patients. At a mean follow-up of 69 months, Gerber et al.[13] reported the clinical outcomes of 52 patients who underwent the open Trillat technique at an average age of 30.7 years. The results were excellent in 53% of patients, good in 10%, fair in 7%, and poor in 10%. The rates of recurrence and a positive apprehension test were 4% and 19.2%, respectively. Residual pain was noted in 44% of shoulders. Early-stage osteoarthritis was diagnosed in 62% of shoulders.

Walch et al.[9] described the results of 24 patients older than 40 years who underwent the open Trillat procedure without any associated procedures on the rotator cuff at a mean follow-up of 10 years. Overall, 68% achieved "good" results on objective functional outcome scores and 88% of patients were satisfied.

At a mean follow-up of 2 years, Kazum et al.[14] evaluated 19 consecutive shoulders that underwent the Trillat procedure associated with anteroinferior capsuloplasty. Postoperatively, no recurrent dislocations and/or subluxations or positive apprehension tests were reported. Coracoid union was achieved in 94% of cases, with only 1 case of fibrous asymptomatic coracoid nonunion.

Chauvet et al.[15] evaluated 52 shoulders that underwent the arthroscopic Trillat technique with a mean follow-up period of 40 months. The rate of recurrent instability was 3.8%.

In addition, a few case series have reported on the outcomes of the Trillat procedure in older patients. Jouve et al.[4] compared 19 patients who underwent an isolated Trillat technique with 9 patients who underwent the Latarjet procedure associated with rotator cuff repair at a mean follow-up of 73.5 months. All cases had full-thickness rotator cuff tears. The average age at surgery was 59.3 years in the Trillat group and 40 years in the Latarjet group. The recurrence rates were 16% and 0%, respectively.

Labattut et al.[6] reported on 18 patients treated with an arthroscopically assisted variant of the Trillat procedure at an average of 2 years of follow-up. The patient satisfaction rate was 94%, with no recurrences recorded.

To our knowledge, this is the first article describing an all-arthroscopic surgical technique to perform the Trillat procedure using screw fixation. The technical challenges in performing the Trillat procedure through an all-arthroscopic technique using screw fixation include gaining wide arthroscopic exposure and performing a multiplanar closing-wedge osteotomy without coracoid fracture. Through careful arm positioning at each stage of the exposure, both the subdeltoid and retro-coracoid spaces can be opened widely. By drilling the coracoid and glenoid separately and opening the aperture of the glenoid drill site, a closing-wedge osteotomy using a guide pin and cannulated screw fixation can be performed safely and without coracoid fracture. Finally, performing this technique arthroscopically allows for the diagnosis and simultaneous treatment of associated pathologies and for assessment of the subscapularis, avoiding subcoracoid impingement with loss of external rotation (Table 2).

In conclusion, the Trillat procedure is indicated for anterior instability and rotator cuff tears in patients greater than 50 years. This article describes a stepwise approach to perform osteotomy, medialization, and distalization of the coracoid arthroscopically using screw fixation while minimizing the risk of coracoid fracture.

Table 2. Advantages and Disadvantages of Arthroscopic Trillat Procedure Using Screw Fixation

Advantages
Minimally invasive arthroscopic procedure
Assessment of associated lesions
Precise control of coracoid partial osteotomy
Intraoperative assessment of excursion of subscapularis
Disadvantages
Long learning curve
Need for pectoralis minor release from coracoid process
Increased operative time in performing osteotomy arthroscopically
Risk of neurovascular lesion during dissection
Need for arthroscopic devices (more expensive procedure)

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