Endoscopic anterior capsulectomy for severe elbow contractures

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Abstract
Elbow stiffness secondary to trauma or surgical reconstruction can sometimes result in a severe contracture with restricted joint space, and arthroscopic access to the joint is difficult. Previous surgery and severe stiffness can also alter the position of neurovascular structures and iatrogenic injury is possible with an inside-out arthroscopic approach. To overcome these technical difficulties, an endoscopic approach to the anterior capsule can be performed as an alternative to open approach. The endoscopic approach utilizes the sub-brachialis space for an outside-in capsular resection under vision. Identification of standard anatomic landmarks is useful as a guide for safe resection in a central to peripheral direction.

Summary of technique

- The all-endoscopic anterior elbow capsulectomy permits a minimally invasive release in severe contractures where joint space restriction prevents arthroscopic access intra-articularly.
- Endoscopic capsulectomy allows visualization and release of the severely restricted joint space, and subsequent intra-articular arthroscopic access is facilitated.
- Standard anatomic landmarks can be identified and these landmarks a safe allow step-by-step release of the capsule.

Advantages and Disadvantages

Advantages

- The all-endoscopic technique is an alternative to more aggressive open approaches for elbow adhesiolysis.
- Initial anterior capsulectomy increases range of motion and permits access to joint space for further arthroscopic adhesiolysis.
- Adequate extra-articular visualization of capsule is useful for safe resection and prevents neurovascular injury.

Disadvantages

- The all-endoscopic technique requires familiarity with neurovascular and musculoligamentous anatomy of the elbow and is recommended for experienced elbow arthroscopists.
- The radial nerve is at risk of injury during lateral capsular resection. The nerve is protected by the brachialis until the radiocapitellar level.
- The median nerve and brachial vessels are at risk of injury during medial dissection.
- The collateral ligaments can be damaged by excessive resection in peripheral zones.
TECHNIQUE

Introduction

Arthroscopic adhesiolysis is a commonly performed procedure for refractory elbow stiffness [1,2]. Arthroscopic release of contracted capsule has good results in mild to moderate elbow stiffness; severe contractures with restricted joint space are relative contraindications for the procedure and necessitate more aggressive open or hybrid approaches [3]. Adequate anterior capsulectomy is an important step in the procedure and is crucial for restoration of range of motion. Anterior capsulectomy is usually performed using an inside-out technique whilst visualising the capsule from the intraarticular aspect. In high-grade contractures, several factors add to the technical difficulty in performing the capsulotomy: (a) the diminished joint capacity prevents access to the intraarticular space, (b) the capsule is thick and fibrotic, and the use of aggressive shavers and radiofrequency ablation is necessary, (c) joint distension and visualisation are limited, and so the assessment of safe zones and adequacy of capsulectomy is difficult, and (d) neurovascular relationships with the anterior capsule are altered, and iatrogenic injury is possible [4,5].

To overcome these difficulties, open and endoscopic (endoscopic-assisted and all-endoscopic) approaches have been described as alternative procedures for release of contracted capsule [2,3,6,7]. An all-endoscopic procedure utilises the sub-brachialis space for an outside-in capsulectomy under vision. Standard anatomic landmarks are then identified and are used as a guide for safe resection in a central to peripheral direction.

Surgical indications/contraindications

Endoscopic capsulectomy is performed as a part of elbow arthrolysis for post-traumatic stiffness. Intra-articular access is difficult in high-grade contractures (>50°), and endoscopic capsulectomy is an alternative technique in such cases.

Traumatic or surgical alteration in the anatomy of the cubital fossa (scarring, heterotopic ossification, vascular or neurological surgery) is a contraindication to the procedure. Surgical experience and a detailed familiarity with the anatomical course of neurovascular structures are necessary. Chronic stiffness is a relative contraindication.

SURGICAL TECHNIQUE

The surgery is performed with the patient in lateral decubitus position, and a tourniquet is used during the procedure. A 2.9-mm arthroscope and sheath (ConMed, Linvatec, Largo) are used, and gravity inflow is used to minimise fluid extravasation into the arm and forearm.

Portals

Three standard portals are used in the procedure: (a) proximal anteromedial portal (AM) is the viewing portal and is placed slightly anterior to the usual portal site to permit access for reduction. (b) proximal anterolateral portal (AL) is the working portal and is placed slightly anterior to the usual portal site to permit access for reduction. (c) The “radial head portal” (RH) is useful for initial localisation of the radiocapitellar (RC) joint to mark the safe zone and for instrumentation during the procedure [5,9], and (d) accessory anteromedial and anterolateral portals are used for retraction of brachialis if necessary.

Sub-brachialis space arthroscopy

The brachialis muscle protects vital neurovascular structures from iatrogenic injury, and dissection must be restricted to the subbrachialis zone. Brachialis is loosely attached to the capsule in the mid-capsular region, and dissection of the musculocapsular plane is initiated in the mid region and is extended peripherally. Fibres from the deep aspect of the deep head are attached to the anterior capsule (articularis cubitus) and can be retracted off the capsule using gentle blunt dissection [10].

A blunt obturator is passed via the AM portal in close apposition with anterior humeral cortex and is directed towards the RC joint. No attempt is made to penetrate the joint. In severe posttraumatic contractures, the capsule is thick and adherent to joint surfaces, and intra-articular penetration is difficult to achieve. The obturator is gently swept proximal and distal to create a plane along the anterior capsular surface. Next, the arthroscopic sheath is passed in a similar technique and the sub-brachialis space is visualised. The capsular attachment of the deep head of brachialis is usually visible in the distal field, and the fibres can be gently separated from the capsule using a blunt probe via the AL portal. A 3.5-mm shaver is used via the AL portal to excise adhesions between the anterior surface of capsule and brachialis under vision; the open end of the blade is placed towards the capsule, and suction is not used (Fig. 1).

Radiocapitellar joint localisation

The RC joint can be localised by probing the anterior capsule, and the step-off between the anterior radial head and capitellum is palpated. Next, a RH portal is created as described earlier, and a blunt 3-mm switching stick (SW) is passed from posterior to anterior gradually until tenting of the anterior capsule between the RC surfaces is visualised [8,9]. The SW is advanced to penetrate the capsule; this marks the level of RC joint and is used as a guide to further dissection (Fig. 2).
Lateral safe zone capsulectomy

The radial nerve is the closest structure to the capsule and is at risk of iatrogenic injury during lateral capsulectomy. The articular level is an anatomical landmark for safe dissection and should be located prior to the capsulectomy. The radial nerve is approximately 6 mm away from the capsule at the articular (RC joint) level, and this distance reduces to 3 mm at the radial neck. The radial nerve has been shown to course more medial than its anticipated course and can be located along the medial aspect of the capitellum. The nerve is protected by the brachialis muscle fibres; however, the nerve has been shown to be in contact with the capsule at the radial neck in 50% of the cases [11,12]. The thickness of the brachialis between the nerve and capsule is approximately 4 mm at the joint level and further proximal. Capsular resection is initiated proximal to the RC level marked by SW. A capsular window is created, and the RC articular surfaces are visualised. A blunt obturator is used to extend the sub-brachialis space laterally. A SW or a shaver blade can be used as a retractor for brachialis via an accessory lateral portal if necessary. An angled punch is passed through the RH portal, and the capsule is resected in a medial to lateral direction. Alternately, the AL portal is redirected into the joint, and a shaver is used to excise the capsule from medial (lateral trochlea level) to further lateral. Irrespective of the method, the capsular region that is excised must always be visualised prior to resection, and resection must be done in the sub-brachialis space (Figs. 2 and 3).

Far lateral capsulectomy

The far lateral capsular region is visualised overlying the lateral gutter on the lateral aspect of the RC joint. Using blunt dissection, the plane between brachioradialis and other extensor muscles is created. A shaver or radiofrequency probe is passed in this plane, and the capsule is

Fig. 2. A needle shows the position of the RH portal after initial capsulotomy has been done (Left image). An angled punch (AL portal) is used to perform a lateral capsulectomy (C) under vision in a lateral to medial direction (middle image). However, it is safer to resect the capsule in a medial to lateral direction with the angled punch though the RH portal (right image). Abbreviations: RH, radial head; AL, anterolateral.

Fig. 3. A shaver is used via the anterolateral portal and is redirected for intra-articular placement to resect the capsule (C) from inside-out in a medial to lateral direction (Left image). Further lateral, the plane between the most lateral capsular region and brachioradialis and other extensor muscles (Ex) is created (middle image). Lateral capsule is resected anterior to midcapitellar region to protect lateral ligaments. Proximal capsulectomy is performed medial to lateral and the capsule is detached at its supracondylar (SC) attachment [Cp: capitellum].

Fig. 4. The medial capsule (C) and brachialis are visualised via the anterolateral portal and the medial musculocapsular plane is dissected further using a blunt obturator (Left image). Medial capsulotomy (CP) is performed using a punch (right image) in a medial-lateral direction (right image).
resected anterior to mid radiocapitellar region to prevent injury to the lateral ligaments. Lateral capsulectomy is continued proximally until the extensor carpi radialis brevis and longus tendons are visible (Fig. 3).

Proximal (supracondylar) capsulectomy

The anterior elbow capsule attaches at the lateral and medial peripheral margins of the trochlea and capitellum. The proximal attachment has been described as a “wave shape” or “double-arch” insertion [13]. The capsular attachment is approximately 10 mm proximal to the cartilage bone junction and encloses the periphery of radial and coronoid fossae. The synovial membrane insertion follows the double-arch insertion pattern and inserts 11–13 mm proximal to the transepicondylar line. Proximal capsulotomy is initiated by visualising the proximal aspect of the capsular window, and a 70° arthroscope may be used here for better visualisation. Resection is performed using a 3.5-mm shaver that is passed through the AL portal and is redirected intra-articularly. The capsule is resected in a medial to lateral direction and is finally detached at its proximal supracondylar attachment (Fig. 3).

Medial capsulectomy

The median nerve and brachial artery on the medial side are approximately 10 mm away from the capsule at the articular (ulnotrochlear) level [11]. The arthroscope sheath is passed through the AL portal over a SW that is directed extra-articularly. The medial capsule and brachialis are visualised, and the medial musculocapsular plane is dissected further using a blunt obturator (Fig. 4). Retraction may be used as described earlier via accessory portals. The medial capsule is excised using an angled punch or with a shaver passed though the AM portal. Resection is performed until the coronoid process and medial trochlea are exposed. Finally, capsule is resected over the coronoid process and the proximal radioulnar joint is visualised. Further medial adhesiolysis is performed from the intra-articular aspect, and fibrosis along the medial aspect of trochlea is carefully excised (Figs. 5 and 6).

Intraarticular and posterior adhesiolysis

Once anterior capsulectomy is completed, a SW is passed under vision via the AM portal and is directed intra-articularly. Alternately, the RH portal can be utilised for visualisation of the RC joint and anterior capsule, and adhesiolysis is continued. Finally, the posterior compartment is accessed, and olecranon fossa scarring is excised. The portals are closed, and a compression dressing is applied.

TIPS AND TRICKS

- Preoperative sonography is useful to assess the course of radial and median nerves and brachial vessels.
- Brachialis is a guide to safe resection and should be always visible.
- The anterior capsule is loosely attached to brachialis in the mid region. Sub-brachialis space dissection is initiated in this zone and is extended to the peripheral regions.
- anterior capsule should be clearly visible as a white layer, and brachialis is visualised as brownish fibres prior to resection.
The resection end of the shaver blade should always be facing the capsule, and suction is turned off to prevent injury to brachialis.

Retractors (switching stick) are used as necessary via accessory portals to better visualise the capsule.

Resection should not be performed distal to the RC-joint level. Proximal resection is safer as compared to distal excision.

CONCLUSION

Endoscopic capsulectomy is an effective procedure for adhesiolysis in severe elbow stiffness. The procedure is technically difficult and should be performed by experienced surgeons who are familiar with the neurovascular and musculoligamentous elbow anatomy.

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Declaration of competing interest

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References