Endoscopic anterior capsulectomy for severe elbow contractures

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TITLE: ENDOSCOPIC ANTERIOR CAPSULECTOMY FOR SEVERE ELBOW CONTRACTURES

RUNNING TITLE: All-endoscopic anterior elbow capsulectomy

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ENDOSCOPIC ANTERIOR CAPSULECTOMY FOR SEVERE ELBOW CONTRACTURES

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.

Keywords: elbow stiffness; arthroscopic adhesiolysis; radiocapitellar joint; elbow capsule; brachialis; elbow endoscopy.

SUMMARY OF TECHNIQUE

- The all-endoscopic anterior elbow capsulectomy permits a minimally invasive release in severe contractures where joint space restriction prevents arthroscopic access intraarticularly.

- Endoscopic capsulectomy allows visualization and release of the severely restricted joint space, and subsequent intraarticular 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 extraarticular visualization of capsule is useful for safe resection and prevents neurovascular injury.

**DISADVANTAGES**

- The all-endoscopic technique requires familiarity with neurovascular and musculo-ligamentous 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 while visualizing 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 use of aggressive shavers and radiofrequency ablation is necessary, (c) joint distension and visualization are limited and 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 utilizes 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. Intraarticular access is difficult in high grade contractures (>50 degrees) 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 minimize 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 throughout the procedure. (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 localization of RC joint to mark the safe zone, and for instrumentation during the procedure [8,9], 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 sub-brachialis zone. Brachialis is loosely attached to the capsule in the mid-capsular region and dissection of the musculo-capsular plane is initiated in the mid region and extended peripherally. Fibers from the deep aspect of the deep head are attached to the anterior capsule. (*articularis cubitus*) and can be erased 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 intraarticular 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 visualized. 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 AL portal. A 3.5mm shaver is used via 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 (figure 1).

Radio-capitellar joint localization: The RC joint can be localized 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 3mm switching stick is passed from posterior to anterior gradually until tenting of the anterior capsule between the RC surfaces is visualized [8,9]. The switching stick (SW) is advanced to penetrate the capsule; this marks the level of RC joint and is used as a guide to further dissection (figure 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 6mm away from the capsule at the articular (RC joint) level, and this distance reduces to 3mm 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 4mm 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 visualized. A blunt obturator is used to extend the sub-brachialis space laterally. A switching stick 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 a RH portal and 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 visualized prior to resection and resection must be in the sub-brachialis space (figure 2 and 3).

Far lateral capsulectomy: The far lateral capsular region is visualized overlying the lateral gutter on the lateral aspect of 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 resected anterior to mid radio-capitellar region to prevent injury to the lateral ligaments. Lateral capsulectomy is continued proximally until the extensor carpi radialis brevis and longus tendons are visible (figure 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]. 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 11-13mm proximal to the transepicondylar line. Proximal capsulotomy is initiated by visualizing the proximal
aspect of the capsular window, and a 70 degree arthroscope may be used here for better visualization. Resection is performed using a 3.5mm shaver that is passed through the AL portal and redirected intraarticular. The capsule is resected in a medial to lateral direction and finally detached at its proximal supracondylar attachment (figure 3).

**Medial capsulectomy:** The median nerve and brachial artery on the medial side are approximately 10mm away from the capsule at the articular (ulnotrochlear) level [11]. The arthroscope sheath in passed through the AL portal over a switching stick that is redirected extra-articularly. The medial capsule and brachialis are visualized and the medial musculo-capsular plane is dissected further using a blunt obturator (figure 4). Retraction may be used as described earlier via accessory portals. 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 visualized. Further medial adhesiolysis is performed from the intraarticular aspect and fibrosis along the medial aspect of trochlea is carefully excised (figures 5 and 6).

**Intraarticular and posterior adhesiolysis:** Once anterior capsulectomy is completed, a switching stick is passed under vision via AM portal and directed intraarticularly. Alternately, the RH portal can be utilized for visualization of 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 visualized 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 visualize 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.

REFERENCES


Figure legends:

**Figure 1:** Sub-brachialis space is visualized after initial dissection with an obturator. The anterior capsule is seen as a smooth white structure in contrast to the muscular fibres of brachialis. A shaver is used to gently dissect out the proximal and distal adhesions along the central sub-brachialis safe zone (left image). (C: capsule, B: brachialis). Localization of radiocapitellar joint is performed by probing with a blunt obturator in anteromedial portal (AM) and a switching stick (RH) is passed through the radial head portal to penetrate the capsule (right image). The capsule (C) proximal to this level can be safely resected.

**Figure 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 radial head portal (right image).

**Figure 3:** A shaver is used via anterolateral portal and is redirected for intraarticular 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]

**Figure 4:** The medial capsule (C) and brachialis are visualized via the anterolateral portal and the medial musculo-capsular 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)

**Figure 5**: Medial capsulotomy is continue using a shaver (left image) and coronoid process (CO) and trochlea (TR) are exposed. Capsule is finally released from the coronoid undersurface and the radioulnar joint is exposed.

**Figure 6**: A panoramic view of the medial (left image) and lateral (right image) capsulotomy is shown.
Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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