Arthroscopic Technique

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2.1 Anesthesia

Regional or general anesthesia can be used for arthroscopy of the elbow and each has advantages and disadvantages. Regional anesthesia most commonly involves the use of a brachial plexus block, which has the advantage of providing excellent post-operative pain control while minimizing use of narcotics. Regional anesthesia is also preferred for patients with co-morbidities that preclude the use of general anesthesia. The most significant disadvantage of using a regional block is that it prevents accurate neurologic assessment of the extremity post-operatively. Patients may also become apprehensive or uncomfortable during surgery, either from the procedure or the positioning required for surgery, and conversion to general anesthesia may become necessary. The overall complication rate for interscalene brachial plexus blocks has been estimated at 1.1 % [3]. Although relatively rare, serious and disabling complications include central nervous system, respiratory, and cardiovascular compromise, as well as permanent nerve deficit [3]. A Bier Block may also be used for regional anesthesia during elbow arthroscopy, but is less desirable because tourniquet pressure can cause significant patient discomfort and there is a small risk of systemic toxicity if the tourniquet is suddenly deflated after introduction of the intravenous anesthetic.

Many surgeons prefer general anesthesia because it allows improved patient comfort and total muscle relaxation, which prevents patient movement during surgery, and avoids complications associated with a regional block. The disadvantages of general anesthesia include longer post-operative recovery and potentially greater pain in the immediate post-operative period.

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2.2 Positioning

For arthroscopic elbow surgery, the patient may be positioned supine, lateral decubitus, or prone depending on surgeon preference and location of the pathology. Several important principles should be followed during positioning. All bony prominences should be well padded, and the surgeon should have circumferential access to the elbow region. Positioning should allow unimpeded elbow flexion for safe portal placement, complete evaluation of intra-articular anatomy, and maximal distension of the joint capsule [7]. The use of a sterile tourniquet allows greater access to the elbow and provides excellent visualization, allowing a safe and efficient procedure.

2.2.1 Supine

The supine position was originally described by Andrews and Carson in 1985 [2]. The patient is placed supine with the shoulder at the lateral edge of the operating table in 90° of abduction, and the elbow flexed to 90°. The forearm is secured in a prefabricated wrist gauntlet or finger traps, and traction is applied with a pulley system to allow joint distraction (Fig. 2.1). Positioning a patient supine has several advantages. Firstly, the elbow is maintained in the normal anatomic position relative to the surgeon, allowing improved orientation. Secondly, it allows a relatively quick set up and provides the anesthesiologist with direct access to the patient's airway. Additionally, if an open procedure is indicated, traction can be easily released and the arm can be placed on an arm board. The disadvantages are that arthroscopically accessing the posterior compartment of the elbow from this position is difficult and anatomic orientation posteriorly can be more challenging. Additionally, the traction set up may risk the sterility of the field, add cost to the procedure, and may not provide enough stability to the arm during instrumentation, necessitating an additional assistant to hold the arm.

2.2.2 Lateral Decubitus

The lateral decubitus position was first utilized by O'Driscoll and Morrey [6] because it offers increased stability and access to the arm and unrestricted elbow motion, compared to the supine position. The lateral decubitus position also allows easy access to the patient's airway by the anesthesiologist. In this position, the patient is placed on the operating table with the operative extremity upward and the torso/pelvis stabilized with a beanbag or hip positioners. An axillary role is then placed, and the patient is secured to the table with straps or tape. The operative arm is supported by an appropriately padded bolster, with the shoulder flexed and internally rotated 90° and the elbow in 90° of flexion (Fig. 2.2). The bolster should be placed proximal to the antecubital fossa and high enough to

Fig. 2.1 The supine position. The arm is held upright with finger traps and a traction system. A counter weight can be added to the arm to provide additional joint distraction

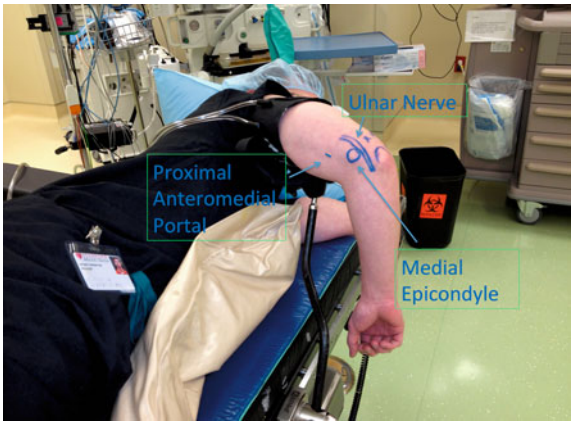

Fig. 2.2 The lateral decubitus position. The patient is held in this position with a beanbag and the operative extremity is rested over a padded bolster

prevent compression of the anterior neurovascular structures, allow maximal distention of the joint capsule, and allow unrestricted elbow motion. The contralateral shoulder and elbow should be placed on an arm board with enough flexion to not interfere with elbow flexion of the operative extremity. This position of the elbow, with the olecranon up, is similar to the position of the knee for knee

arthroscopy, making it familiar to arthroscopic knee surgeons. The main disadvantage of the lateral position is that repositioning may be required for access to the anterior compartment or for open anterior procedures.

2.2.3 Prone

The prone position was popularized by Poehling et al. [8] in 1989. After undergoing general anesthesia, the patient is placed prone near the edge of the table on chest rolls. The shoulder is abducted to 90° and the upper arm is supported with an arm board or holder, allowing elbow flexion and gravity distraction of the joint (Fig. 2.3a and b). The elbow should undergo a full range of motion to make sure there are no blocks to flexion or extension. The prone position offers the similar advantages and disadvantages compared to the lateral decubitus position; however, patient positioning can be more cumbersome, and access to the airway is limited.

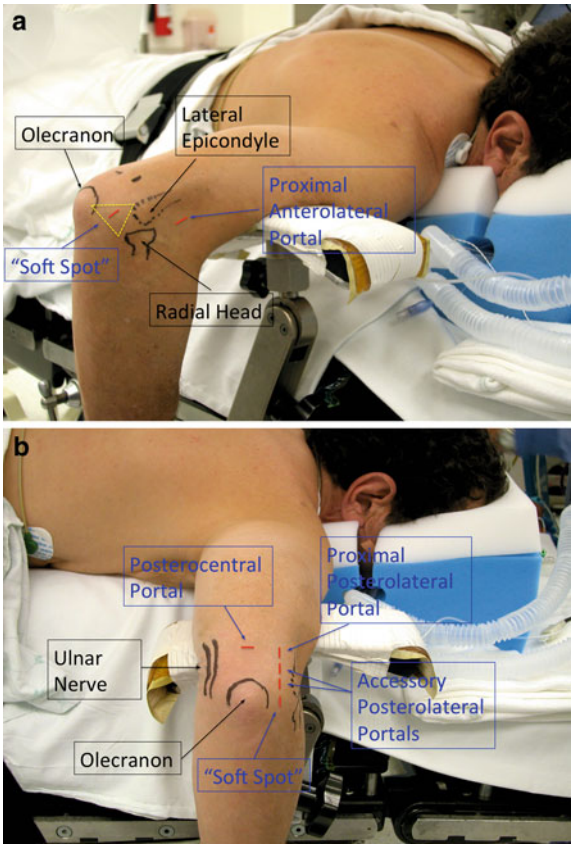

Fig. 2.3 The prone position. The patient is placed on chest rolls and the operative extremity is rested over a padded bolster. **a** Demonstrates the "soft spot" and proximal anterolateral portals. **b** Demonstrates the posterocentral, proximal posterolateral, accessory posterolateral, and "soft spot" portals

2.3 Set-Up and Instrumentation

The general set-up places the arthroscopic tower, pump, and mechanical shaver system on the opposite side of the table from the surgeon and operative extremity (Fig. 2.4). After positioning the patient, the skin of the operative extremity is prepared with a chlorahexidine disinfectant solution and draped with enough room to allow placement of the sterile tourniquet (Fig. 2.5). An elastic wrap is placed

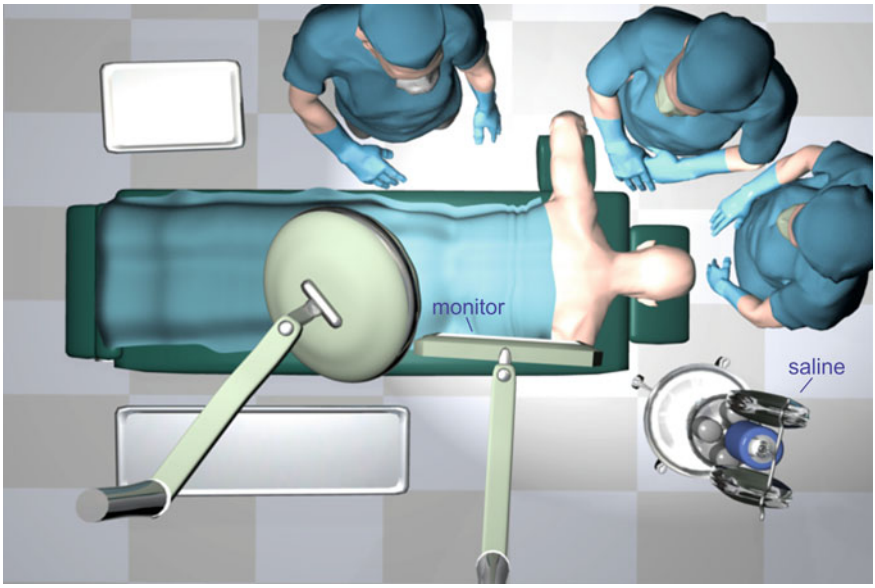

Fig. 2.4 General room set-up

Fig. 2.5 The operative extremity is prepped and draped high enough to allow a sterile tourniquet to be placed without interfering with portal placement and instrumentation

circumferentially around the hand and forearm to minimize fluid extravasation into the soft tissues.

Standard equipment necessary for shoulder and knee arthroscopy can be utilized for elbow arthroscopy. A 4 mm arthroscope with a 30° lens is most commonly used and allows a wide field of view and adequate fluid flow. A 4 mm 70° and 2.7 mm arthroscope should be available if viewing becomes difficult through the standard equipment or for smaller patients. An interchangeable cannula system can be used to minimize tissue damage and fluid extravasation when changing the viewing portal or switching arthroscopes. Because of the close proximity of the intra-articular pathology and joint capsule, the cannula should be non-vented to prevent fluid extravasation that could occur when the camera lens is operating at the margin of the capsule. A low-pressure arthroscopic pump or gravity inflow may be used to for joint distension. If an mechanical pump is used, pressures should be kept at <30 mm Hg to prevent joint capsule rupture [7]. Other necessary instruments include a standard mechanical shaver, switching stick, Wissinger rod, blunt trocar, probe, grasping and biting instruments, straight blunt hemostat, 18 gauge spinal needle, and a 30 cc syringe. The use of specialized equipment may be necessary and is dependent on the requirements of the procedure to be performed.

2.4 Diagnostic Arthroscopy

Before beginning, a marker is used to outline the bony anatomy (epicondyles, olecranon tip, and radial head), arthroscopic portals, and location of the ulnar nerve. The ulnar nerve should be palpated during elbow flexion and extension, and if subluxation is detected the nerve should be protected during medial sided portal placement. For surgeons with less experience, it is helpful to remember the radial head is always on the cephalad side of the elbow for orientation purposes.

After inflation of the tourniquet to 250 mm Hg, the joint is then injected with 25 ml of physiologic saline to allow full distension of the capsule [7] and shift the neurovascular structures away from the joint [5]. This puncture is administered through the "soft spot" located between the tip of the olecranon, radial head, and lateral epicondyle (Fig. 2.3a and b). Intra-articular placement of the saline is confirmed by slight extension and supination of the arm that occurs with capsular inflation. Removing the syringe from the needle will demonstrate fluid backflow from the needle, also confirming intra-articular fluid placement. After introduction of fluid into the joint, arthroscopic portals can be placed in a systematic manner. Flexing the elbow relaxes the anterior neurovascular structures and places them at less risk of damage during anterior portal placement [5]. All incisions should be through the skin only to avoid damage to cutaneous nerves, followed by a blunt straight hemostat or trocar for joint penetration.

The elbow can be viewed as having three separate compartments: anterior, posterior, and posterolateral, and during a diagnostic arthroscopy each compartment should undergo evaluation. There is still controversy regarding which portal to create first and is dependent on surgeon preference, location of pathology, and location of portals relative to neurovascular structures. The senior author prefers to start with the proximal anteromedial portal, followed by the proximal anterolateral portal. After the anterior compartment arthroscopy using the two aforementioned portals, posterior compartment arthroscopy is performed using proximal posterolateral and posterocentral portals made at the same time. When necessary, the direct lateral (soft spot) portal is then made.

2.4.1 Anterior Compartment

We begin the diagnostic arthroscopy in the anterior compartment with the *proximal anteromedial portal* because cadaveric studies have shown it to be further from major neurovascular structures relative to other starting portals [4, 11]. The starting point for this portal is located 2 cm proximal to the medial humeral epicondyle and anterior to the intermuscular septum, which usually can be palpated (Fig. 2.2) [8]. After making the skin incision, a blunt trocar inside an arthroscopic cannula is used to palpate and stay anterior on the shaft of the distal humerus. The trocar is directed to the center of the ventral surface of the joint and driven trough the capsule. Intra-articular placement is confirmed with fluid backflow upon removal of the trocar from the sheath. If the patient has a history of ulnar nerve transposition or medial sided elbow surgery, identification of the location of the nerve should be determined before placing the cannula. If the location of the nerve cannot be established, a 2–3 cm skin incision should be used to dissect directly down to the capsule, allowing safe portal placement [10].

After the portal is placed and the trochar is removed from the cannula, the arthroscope is introduced and the anterior compartment is systematically examined. The radial head serves as an important landmark and the articular surface should be evaluated with pronation-supination of the forearm. The annular ligament is evaluated along the radial neck. The arthroscope is next directed anterosuperiorly to evaluate the capitellum and radial fossa (Fig. 2.6a). Advancing the scope from here allows inspection of the lateral gutter, lateral capsule, and origin of extensor muscles to the lateral epicondyle. The anterior portions of the capsule are examined as the camera is withdrawn medially. The arthroscope is then used to inspect the proximal radio-ulnar joint, coronoid process, coronoid fossa, and trochlea (Fig. 2.6b).

After evaluation of the anterior compartment, a *proximal anterolateral portal* is established 2 cm proximal and 1 cm anterior to the lateral epicondyle (Fig. 2.3a) [11]. This portal is made using an "outside in" technique by directing an 18 gauge needle towards the central portion of the joint. Once the appropriate placement and trajectory of the needle is established, the skin only is incised and either a blunt

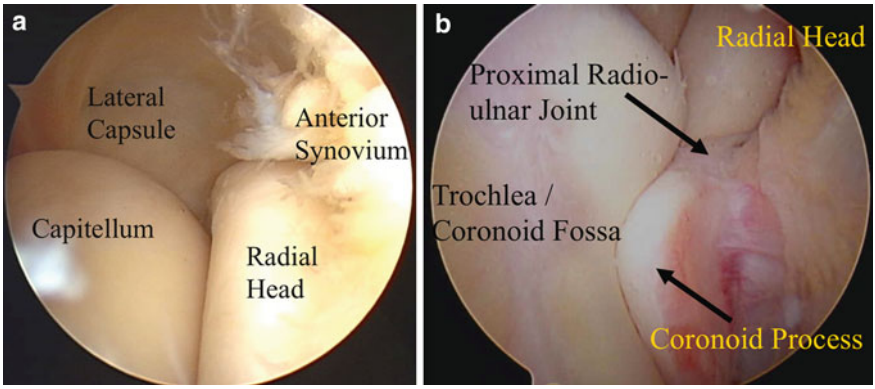

Fig. 2.6 Arthroscopic anatomy of the anterolateral (**a**) and anterior (**b**) elbow viewed from the proximal anteromedial portal

straight hemostat or blunt trocar/arthroscopic cannula is advanced through the brachioradialis into the anterior compartment of the elbow. This portal can be used for instrumentation when viewing from the proximal anteromedial portal and for viewing the ventral and medial aspect of the joint. Anatomic structures that can be viewed are similar to what can be seen through medial portals; however, the proximal anterolateral portal allows improved visualization of the medial capsule and anterior bundle of the medial collateral ligament but a lesser view of the radiocapitellar and medial ulnohumeral joints [1]. Of note, the anterolateral portal is close to the radial nerve, particularly the posterior interosseous nerve. The more proximal the lateral portal is, the greater the distance from the radial nerve, increasing the margin of safety.

Procedures that can be performed in the anterior compartment of the elbow from the proximal anteromedial and anterolateral portals include diagnosis of ulnar collateral ligament insufficiency, removal of ventral loose bodies and osteophytes, synovectomy for rheumatoid arthritis or synovial proliferative disorders, debridement and microfracture of osteochondral lesions, capsular release for arthrofibrosis, arthroscopically assisted internal fixation of radial head fractures, radial head excision, and debridement of the extensor carpi radialis brevis tendon for lateral epicondylitis. Ventral loose bodies often "hide" at the proximal radioulnar joint.

2.4.2 Posterior Compartments

Following completion of anterior joint arthroscopy, we routinely perform posterior compartment arthroscopy. A *posterocentral "trans-tricipital" portal* is useful for evaluating the proximal portions of posterior compartment. To make this portal a horizontal skin incision is made in-line with Langer's lines 3 cm above the tip of

the olecranon (Fig. 2.3b). Once the skin has been incised, the blade is turned 90° and the triceps tendon is punctured in-line with its fibers. The elbow is placed in 30–45° of flexion and a blunt trocar/cannula is advanced toward the olecranon fossa until the joint capsule is penetrated. Next, the *proximal posterolateral portal* is made lateral to the trans-tricipital portal on the lateral border of the triceps tendon (Fig. 2.3b) [2]. After making the skin incision, a blunt trochar and sheath are introduced into the olecranon fossa. If visualization is obscured after first entering the olecranon fossa, a mechanical shaver can be used through the trans-tricipital portal to debride any soft tissues occupying the field of view. This is safe if the instruments are in the olecranon fossa.

Both of these portals allow visualization of the posterior trochlea, tip of the olecranon, olecranon fossa, and the lateral and medial gutters/capsule (Fig. 2.7a, b, and c). The ulnar nerve is located superficial to the joint capsule and posterior bundle of the ulnar collateral ligament in the medial gutter; therefore, caution should be used when debriding this area to prevent nerve injury [8].

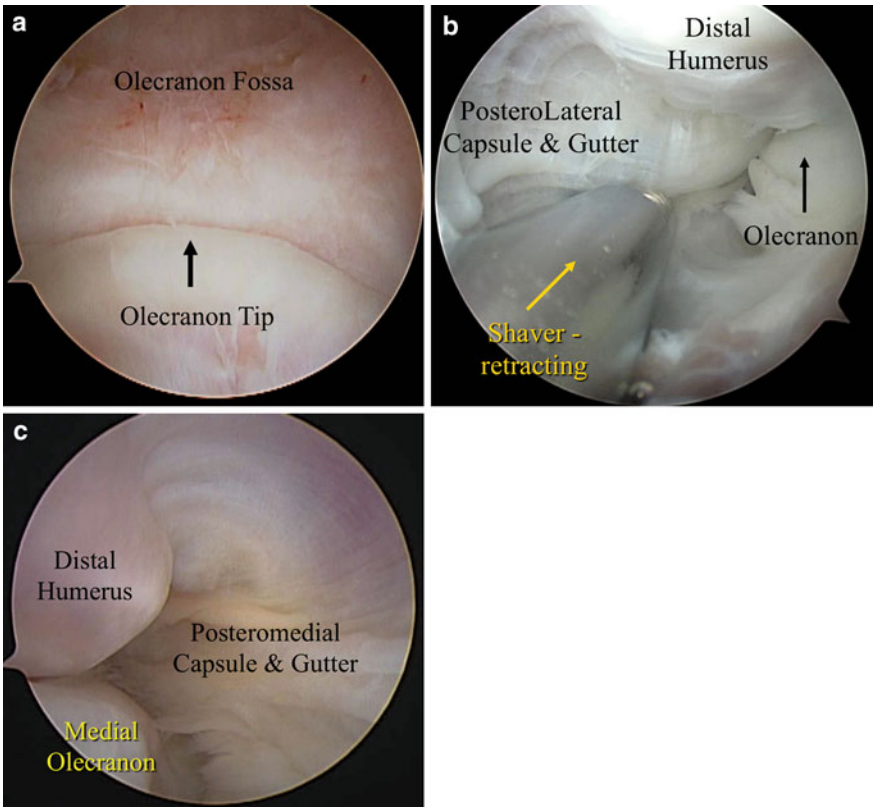

Fig. 2.7 Arthroscopic anatomy of the posterior elbow viewed from the posterocentral portal. Viewing centrally (**a**), laterally (**b**), and medially (**c**) with the 30° arthroscope

The proximal posterolateral and trans-tricipital portals can be used together as viewing and instrumentation portals for treating a variety of conditions including removal of loose bodies and osteophytes, posterior joint synovectomy, joint arthrolysis, and debridement of osteochondral and osteochondritis dissecans (OCD) lesions.

In cases of posterolateral plica or OCD of the capitellum, a *direct lateral* (*soft spot*) *portal* that was used to insufflate the joint can be made for visualization (Fig. 2.3a and b). From this portal, the posterior portions of the radiocapitellar joint, radial head, and dorsal capitellum are inspected. Again, the forearm can be pronated and supinated for identification of the radial head. The camera lens is then directed medially to evaluate the posterior radioulnar joint, followed by the ulnohumeral articulation and tip of the olecranon. A blunt trochar or Wissinger rod may be introduced from either of the posterior portals and placed between the ulna and distal humerus to open this articulation for visualization [9]. *Accessory posterolateral portals* can be created superiorly inline with the direct lateral portal to allow instrumentation for the treatment of OCD lesions of the capitellum and removal of loose bodies (Fig. 2.3b). When treating pathology in the posterolateral space one can also switch to the 2.7 mm arthroscope to prevent instrument crowding.

Through the aforementioned anterior and posterior portals combined, 90 % of the radiocapitellar joint and 75 % of the humeral articular surface is visible [1]. Without the joint jack maneuver, 25 % of the ulnar articular surface can be seen, but with the opening of the joint with the blunt instrument, more than half of the ulnohumeral articular surface can be visualized.

Following the completion of the arthroscopic procedure, some surgeons inject anesthetic into the elbow for postoperative pain relief; however, others prefer not to inject anesthetic to allow for neurovascular examination in the recovery room. After completion of the procedure, the elbow is usually dressed with a temporary bulky dressing for 2–4 days, followed by early active range of motion exercises, unless immobilization is required.

2.5 Summary

Although technically demanding, elbow arthroscopy has emerged as an effective method to diagnose and treat a wide variety of pathologic conditions about the elbow. Knowledge of arthroscopic anatomy and a systematic approach to set-up, positioning, portal placement, and diagnostic arthroscopy are important to a successful intervention and in avoiding complications.

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