Arthroscopic Techniques in the Elbow

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Contents

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Abstract

In the last 15 years arthroscopic techniques of the elbow joint have been developed for the treatment of osteochondritis dissecans, impingement, limitation of motion, lateral epicondylitis, instability, trauma and post-traumatic deformities. Diagnosis and management of all these indications for elbow arthroscopy are described in detail. One of the major benefits of arthroscopic management over open surgical procedures is that post-operative rehabilitation will start earlier and can be more aggressive. To avoid complications the surgeon should have thorough knowledge of elbow anatomy and indications versus contra-indications for specific elbow disorders.

Keywords

Anatomy • Complications • Elbow arthroscopy • Fracture treatment • Indications and treatable pathologies • Rehabilitation • Techniques and portals

General Introduction

The elbow is less generally accepted as a joint manageable by arthroscopic techniques compared with the knee, shoulder, hip and ankle. Arthroscopy of the elbow was first described by Burman in 1932. However, for a long time, the indications for elbow arthroscopy were limited to diagnostic assistance and removal of loose bodies. As technology and techniques improved

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during the last decades, Orthopaedic surgeons have considered arthroscopy more frequently in the treatment of various elbow disorders. In the last 15 years arthroscopic techniques have been developed for the treatment of osteochondritis dissecans, impingement, limitation of motion, lateral epicondylitis, instability, trauma and post-traumatic deformities. Because of the proximity of neurovascular structures in the elbow and the complex anatomy of the joint the arthroscopic management of these disorders depends largely on the expertise of the surgeon.

Anatomy and Pathology

The elbow plays a major role in the flexion and extension of the arm and supination/pronation of the forearm. There is also a slight medial and lateral mobility (abduction and adduction in frontal plane) and medial and lateral rotation (about the ulna in the transverse plane). The elbow is formed by three bones: the humerus, the ulna and the radius. Three joints are involved in the elbow; the humero-radial joint; the humero-ulnar joint; and the proximal radio-ulnar joint.

The elbow is supported by strong medial and lateral collateral ligaments. The anterior and posterior ligaments are mainly thickened sections in the capsule. The medial or ulnar complex consists of an anterior medial collateral ligament, posterior medial collateral ligament and a transverse band. The lateral or radial ulno-humeral ligament complex has three components: the radial collateral ligament, lateral ulnar collateral ligament and the annular ligament.

Four groups of muscles cover the elbow joint:

1. Anterior, the elbow flexors supplied by the musculocutaneous nerve;
2. Posterior, the elbow extensors supplied by the radial nerve;
3. Medial, the flexor-pronator group of muscles supplied by the median and ulnar nerves;
4. Lateral, the extensor-supinators supplied by the radial and posterior interosseous nerves.

The median, radial and ulnar nerves are relevant in applied surgical anatomy. The median nerve crosses the front of the joint on its medial side in the cubital fossa. The radial nerve crosses the front of the elbow joint in the interval between the brachialis and brachioradialis muscles. The ulnar nerve crosses the joint in the groove on the back of the medial epicondyle (Fig. 1).

Three arteries cross the elbow joint. The brachial artery joins the medial nerve on its lateral side, lying on the brachialis muscle. At the level of the elbow, the brachial artery separates into the radial and ulnar arteries. The radial artery passes medial to the biceps tendon. The ulnar artery passes deep by the deep head of the pronator teres. Deep veins run along with the artery. The superficial veins are the cephalic vein and the basilic vein [1].

In the normal elbow joint, stability is maintained by the combination of joint congruity, capsuloligamentous integrity and well-balanced intact muscles. The olecranon and olecranon fossa joint provide primary stability at less than 20° or more than 120° of elbow flexion. Inbetween stability is provided primarily by the two distinct ligamentous complexes. The capsule along with muscle groups may act as secondary static and dynamic stabilizers of the elbow. The volume of the capsule averages 23 cm^3 (Fig. 2).

Normal range of motion is from full extension of 0–145° of flexion. Some hyperextension can be considered physiological in patients with more generalized laxity of the joints. Pronation and supination are 85° and 80°, respectively. However, the full range of elbow motion is not necessary to function well in most activities of daily living. A flexion-extension (30–130°) and pronation-supination (50–50° each) arc of 100° is sufficient. Flexion is restricted by soft tissues. Extension is blocked by osseous structures. Following trauma, intra-articular fluid can also restrict motion. With the elbow in extension, axial load is transferred from forearm to humerus via two elbow joints. The radiocapitellar joint processes takes 57 % of the load, the ulno-humeral joint is responsible for 43 % of the forces. These percentages are changing during movement as the axis of the elbow changes from valgus to varus during flexion and extension [2].

In most sports with overhead movement the elbow is subjected to high loads, and this occurs

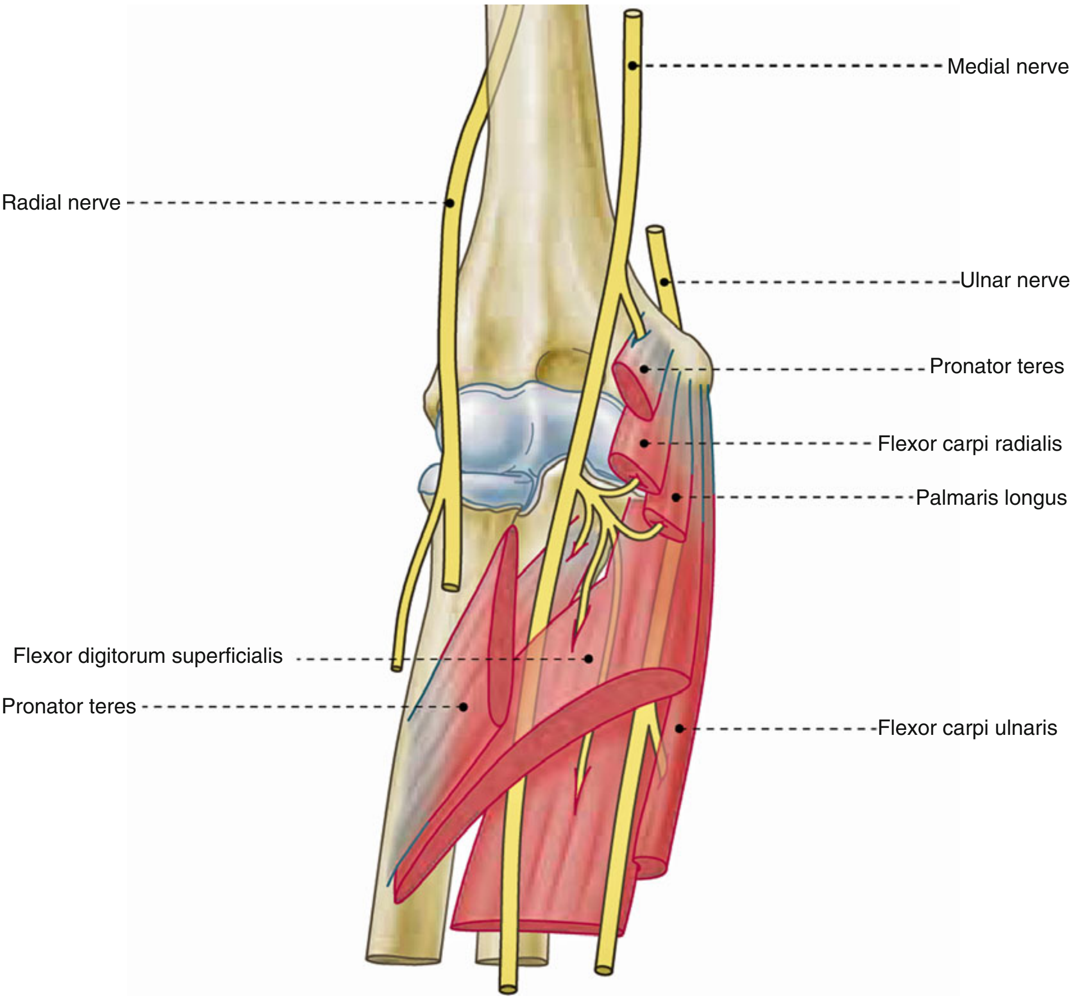

Fig. 1 Anatomy of the radial, medial and ulnar nerve at the elbow

in repetitive movements at very high speeds with very high forces. Common injuries encountered include Medial Collateral Ligament (MCL) tears, flexor-pronator muscle tendinitis or tears, ulnar neuritis, posterior impingement, osteochondritis dissecans of the capitellum and extensor tendinopathy [3].

Diagnosis

Diagnosing elbow pathology starts as always with taking a careful history. Ask for pain, stiffness, swelling, locking symptoms, traumatic moments, repetitive micro-trauma, instability and ulnar nerve symptoms. Next, a thorough clinical examination is performed. Inspection for varus or valgus deformity and swelling is important. Synovitis and swelling of the joint is best established at the posterolateral part of the joint. The ulnar nerve can be palpated behind the medial epicondyle. Flexion, extension, pronation and supination are determined and compared to the un-injured side. Stability is assessed with the moving valgus tests (shoulder in external rotation, gentle valgus stress at the wrist while stabilizing the elbow at the lateral epicondyle), “milking manoeuvre” (elbow is extended from the fully flexed position while the examinator exerts a valgus moment by

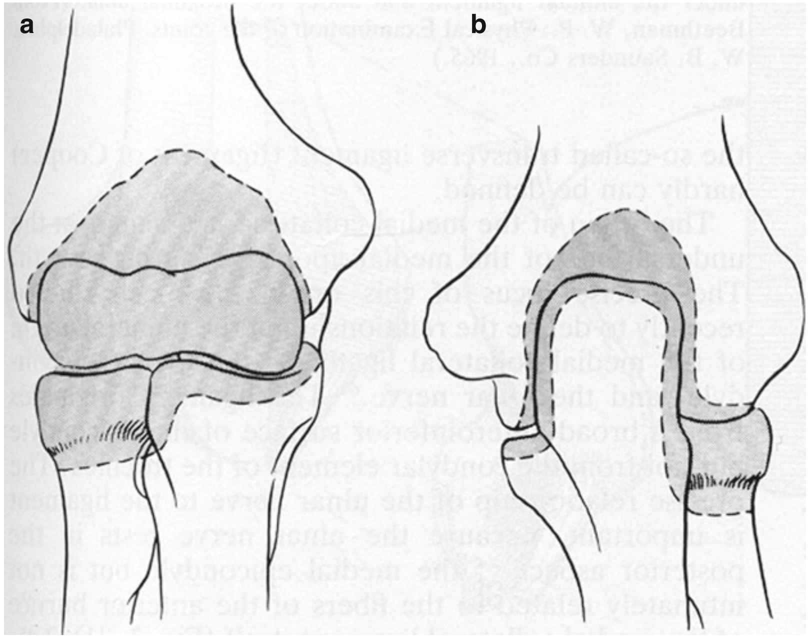

Fig. 2 Attachments of the elbow capsule

grasping the thump and resisting extension), "pivot-shift" test (on the supine patient, the forearm is fully supinated and the examiner grasps the wrist and slowly extends the elbow while applying valgus and supination movements and an axial compressive force) and "table-top" test. After examination of the elbow it is important to review the neck, shoulder and hand as well.

Standard x-rays of the elbow should be evaluated for loose bodies, degeneration, post-traumatic deformities and joint effusion. Evaluation of soft tissues can be done using ultrasound. The ultrasound however is observer-dependent. When better delineation of soft tissue is necessary, Magnetic Resonance Imaging (MRI) is the next step to take. Computed Topography (CT) scanning will be of help in detecting the extent of a fracture and intra-articular calcifications or deformities [2].

Experience over the last has shown that elbow arthroscopy has evolved to be a very useful tool in diagnosis and evaluation of elbow pathology, especially in assessment of instability and the treatment of acute trauma. Diagnostic arthroscopy of these disorders are described below.

Indications for Arthroscopic Surgery

Osteochondritis Dissecans

OsteoChondritis Dissecans (OCD) is a localised condition in which a segment of articular cartilage and bone separates from the subchondral bone. The most common site of OCD in the elbow is the capitellum. It is an uncommon disorder in the general population and usually seen in patients that overuse their elbow in specific sporting activities. In children, OCD has been reported between the ages of 11 and 23 years, mostly provoked by "throwing" sporting activities. The aetiology of the condition is unknown. The most hypothesised cause is the combination of repeated valgus stress at the elbow and a inadequate blood supply to the capitellum. OCD seems to evolve through three stages. In the first stage the bone is hyperaemic and there is oedematous peri-articular soft tissue. The second stage consist of deformation of the epiphysis and sometimes with fragmentation. In stage three necrotic bone is replaced by granulation tissue. The articular surface may be unchanged as the bone heals, flattens and partially separates, breaks away and forms a loose body. Symptoms correlate with the degree of loss of articular surface [2].

OCD lesions can be graded according to the arthroscopic classification [4]:

Grade 1, smooth but soft, ballotable articular cartilage;
Grade 2, fibrillation or fissuring of the cartilage;
Grade 3, exposed bone with a fixed osteochondral fragment;
Grade 4, a loose but undisplaced fragment;
Grade 5, a displaced fragment with resultant loose body.

Management depends on the integrity of the cartilage and whether the involved segment is stable, unstable but attached or detached and loose. Stable lesions are primarily managed conservatively. If conservative management (rest, physical therapy, NSAID's) is unsuccessful, surgical treatment is an option. Other indications for surgery are loose bodies or evidence of instability.

Arthroscopic treatment consists of re-fixation in the case of large fragments. If re-fixation is not possible, debridement is an option, as it is in the case of smaller fragments. Arthroscopy is performed through 2 anterior and 2 posterior portals. Re-fixation of the fragments remain controversial. Several techniques has been described, including screw fixation, dynamic stapling, Kirschner wires and bio-absorbable implants. Yet none study has obviously demonstrated marked improvement over excision and debridement alone. Debridement is usually performed using a 3.5 mm shaver. All loose fragments and loose cartilage are removed until subchondral bone is seen. Loose bodies can also be removed using a grasper [5, 6].

Posterior Impingement

Posterior impingement of the elbow is an uncommon disorder in the general young population. It is usually seen in patients who overuse their elbow in sporting activities such as the football linesman, cricket fast bowlers, gymnasts,

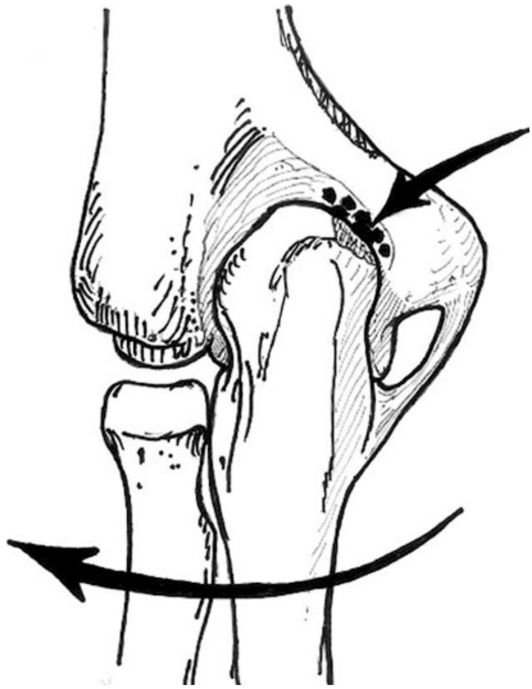

Fig. 3 The exact fit of the olecranon in the olecranon fossa of the humerus is critical for maximal extension and, therefore, for the function of the elbow. *Lower arrow*, valgus movement of the lower arm. *Upper arrow*, abutment of olecranon on the posteromedial border of the olecranon fossa, resulting in impingement

rodeo-riders, weight-lifters and fast-pitch softball pitchers. During the throwing motion there is a combination of valgus forces and rapid extension. This results in tensile forces along the medial side, compression on the lateral side of the elbow and shear forces in the posterior compartment. This combination is called the "valgus-extension-overload syndrome" and forms the basic pathological model of posterior impingement in the elbow. Thus, posterior impingement is the formation of bony or soft tissue in the posterior compartment, which results in mechanical abutment, leading to pain in the posterior compartment during extension (Fig. 3) The exact fit of the olecranon in the olecranon fossa of the humerus is critical for maximal extension. Consequently, the maximal extension, needed in most overhead sports is reduced in posterior impingement. A provocative examination upon forced hyperextension with the absence of laxity is the most suggestive physical finding. If posteromedial or posterolateral osteophytes are found at CT-scan, it should alert the surgeon to the possibility of co-existing valgus or varus laxity, respectively. When conservative management (physical therapy, rest, ice, NSAID's, steroid infiltration) is unsuccessful, arthroscopy of the elbow can be used effectively in these patients.

Arthroscopy for posterior impingement is performed through two anterior and two or three posterior portals. After standard arthroscopy of the elbow, debridement of the posterior fossa is performed using a 3.5 mm shaver. The shaver is used until there is no sign of impingement by any soft tissue and/or bony osteophytes visible. In some cases a high-speed burr is necessary to remove large osteophytes. Loose bodies can be removed with a grasper [7].

Stiff Elbow

Limitation of motion of the elbow is most frequently seen caused by primary capsular contracture or stiffness associated with osteoarthritis, OCD, synovitis and old trauma or fracture. Elbow contractures can be the result of intrinsic (intra-articular) or extrinsic (extra-articular) causes. In most post-traumatic contractures both intrinsic and extrinsic causes play a role. The exact aetiology of post-traumatic contractures is poorly understood. Immobilization resulting in adhesions seem to play a role.

Therapy starts with physical therapy and static-progressive splinting for a minimum of 6–12 months. If conservative management is unsuccessful, patients who are motivated to comply with a strict post-operative rehabilitation program are candidates for surgical release. Recently, there has been progress in elbow arthroscopy for limitation of motion and advantages over open release include: smaller scars, improved joint visualisation, reduced pain, accelerated rehabilitation and shorter hospital stay. However, arthroscopic release is technically demanding because of the close proximity of neurovascular structures to portals and the restricted working space afforded by the congruity of the joint and non-compliant capsule. The learning curve shows a significant decrease in operative time after an initial 15 patients [8]. Currently, the results after open and arthroscopic surgery are more or less the same.

Arthroscopy for a stiff elbow is performed through three posterior portals and two anterior portals. The surgical procedure depends on intra-articular findings. In the anterior compartment extensive scarring and hypertrophic synovium can be debrided. Bony impingement by osteophytes, the coronoid process or distal humerus can be removed using an oval burr. Loose bodies can be removed using a grasper. A contracted anterior capsule can be released at the proximal one-third level of the capsule from medial to lateral until the posterior fibres of the brachialis muscle are visible proximally, using a punch. A complete capsulectomy will require careful separation of the capsule from the posterior interosseous nerve. However, often a small part of the capsule is left in order to protect this posterior interosseous nerve. Nevertheless the capsule must be divided to the level of the collateral ligaments on both sides for a complete release. In the posterior compartment, extensive scarring around the olecranon fossa and posterior capsule is removed. Bony impingement by osteophytes on the olecranon or the posterior olecranon fossa are relieved using an oscillating shaver and an oval burr. Release the capsule carefully in the medial and lateral gutter [9, 10].

Lateral Epicondylitis

The "tennis elbow," or lateral elbow pain affects 1–3 % of the population. In contrast to what is widely thought, tennis contributes in only 5–10 % of all cases of tennis elbow. The aetiology seems to be overuse or repetitive stress on the common extensor tendon, especially the Extensor Carpi Radialis Brevis (ECRB) portion. Alternatively, the annular ligament, lateral capsule, radial nerve and several bands of the extensor digitorum communis have been associated with lateral elbow pain as well. However, the highest level of evidence is for failure of reparative response in the ECRB tendon. The diagnosis can be made clinically, based on the patient history and physical examination. Palpation may reveal point tenderness directly on the lateral epicondyle or slightly anterior and distal to it. Resisted wrist extension or passive stretching with the elbow extended by flexing the wrist can reproduce the pain. Grip strength is commonly diminished. Imaging studies are rarely required for diagnosis, but should be obtained to rule out other co-existing pathologies. Generally, MRI findings correlate well with surgical and histological findings, and therefore can be used as a decision-making tool in the surgical treatment of lateral epicondylitis. Still, treatment starts with conservative measures such as NSAID's, physical therapy, bracing and infiltration with corticosteroids, platelet-rich plasma or autologous blood. Ninety per cent of patients respond to conservative treatment and recover within 1 year. Patients in which non-operative treatment for lateral epicondylitis fails are candidates for arthroscopic release. The reported success rate of operative intervention is approximately 80 %, regardless of surgical method [2].

Arthroscopy for lateral epicondylitis is performed through an proximal anteromedial portal and a direct lateral portal. After an initial intra-articular inspection, a partial capsulectomy is performed with a shaver. After the capsule is debrided, the ECRB tendon insertion should become visible. The ECRB is distinguished from the extensor carpi radialis longus as the latter appears more red or pink and has fewer fascial fibres. The ECRB insertion is carefully debrided, from medial to lateral. Care is taken to avoid damage to the lateral collateral ligaments. Subsequently, the shaver is used to debride the damaged part of the ECRB until only healthy tendon remains. Pathological tendons fibres can st be easily distinguished from healthy fibres since tendinitis is easily debrided giving the appearance of snowflakes, while healthy tendon is much harder to debride with the shaver. Just the degenerative ECRB tendons should be debrided and not routinely the whole tendon insertion. If visualization is difficult because of excessive synovitis for instance, an intra-articular retractor is easy to establish with or without the addition of an extra portal. At last the anterior part of the lateral epicondyle can be abraded. At last, arthroscopy facilitates the evaluation of associated intra-articular pathology which has been described in up to 30 % of all lateral epicondylitis cases [11, 12].

Instability of the Elbow

Instability is often described as a non-physiological motion and is usually symptomatic. Elbow instability can be classified in the direction of forces displacing the elbow. Simple patterns of instability include varus and valgus motion at which the lateral and medial ligamentous complexes are assessed, respectively.

The Lateral Collateral Ligament (LCL) is the primary ligamentous stabilizer of the elbow for varus and external rotation. The lateral collateral ligament is the most important soft tissue constraint to posterolateral and posterior dislocation of the elbow joint. Posterolateral dislocation is the most common pattern of elbow dislocations. More than 95 % of dislocations occur in a posterolateral direction. Posterolateral instability usually results from a fall on the outstretched hand with abduction of the shoulder. The elbow undergoes an axial compression force as it is flexed and the body approaches the ground. A combination of supination and valgus forces leads to posterolateral instability. Especially the ulnar part of the LCL is damaged in posterolateral instability and dislocation. Simple elbow dislocations are managed by functional treatment or short-term plaster immobilisation. Posterolateral instability is diagnosed by the lateral "pivot-shift" test of the elbow. During this test, the symptomatic elbow produces pain and/or apprehension on axial compression, valgus stress and supination. The diagnosis of chronic elbow joint instability can be difficult since the symptoms and the clinical presentation can be subtle. Comparison with the un-involved elbow should always be performed to differentiate between physiological and pathological laxity. The degree of laxity is often under-estimated in the conscious patient. In chronic symptomatic LCL complex deficiency there is no role for conservative treatment. Operative re-insertion or reconstruction is mandatory. This reconstruction may be open or arthroscopic [2].

During arthroscopy the radial head can be seen to subluxate posteriorly while varus stress is applied. The arthroscope is placed in the proximal anteromedial portal from where failure of the stabilizing aspects of the lateral ligaments can be noted. Shifting of the radial head can also be visualized from this view. Chronic instability may lead to secondary changes such as plica formation, loose body formation and chondromalacia, all of which can be treated arthroscopically. The more advanced arthroscopist can perform an arthroscopic plication technique for this instability. Multiple sutures are passed using a spinal needle retriever technique medial to the LCL complex. These sutures are retrieved posterior to the humerus and used to plicate the LCL complex. Next, these sutures may be tied over or under the anconeus muscle and then sutured back to the humerus using an anchor [13].

The medial collateral ligament (MCL) is the most important soft tissue constraint to valgus instability of the elbow. The anterior medial collateral ligament is the strongest and most stiff of the collateral ligaments. The three most common causes of MCL injury are elbow dislocation, chronic attenuation in athletes and acute valgus injury. Complete dislocation and MCL injury, usually occur in association with a small coronoid fracture. Treatment of these MCL injuries after dislocation depends on the size of the coronoid fragment and is in general surgical. The diagnosis of medial ulnar instability is based on a history of medial pain associated with the acceleration phase of throwing. At physical examination one should assess the degree of extension loss. The joint must be tested for valgus instability in 30° and 90° of flexion. Comparison with the uninvolved elbow should always be performed to differentiate between physiological and pathological laxity. In patients with MCL insufficiency a typically painful arc can be produced using the “milking manoeuvre” and/or the modified moving valgus test. The elbow is extended from the fully flexed position while the examiner exerts a valgus moment by grasping the thump and resisting extension. The above mentioned instability test can be hard to perform without anaesthesia, however most patients with MCL insufficiency will report an apprehension. The assessment of elbow instability is often difficult, even for experienced clinicians, since even in the presence of a complete tear of the anterior oblique ligament of the MCL, valgus opening only occurs to a small extent.

Arthroscopy of the elbow with examination under anaesthesia can be very useful in selected cases to diagnose the type and degree of instability. The MCL cannot be consistently visualised by arthroscopy. However, arthroscopy can provide effective indirect evidence of MCL insufficiency. This can be accomplished by “the arthroscopic valgus instability test.” In this test one visualise the most medial aspect of the ulnohumeral articulation, opening of the ulnohumeral joint space of as little of 2 mm at valgus stress, represents a complete tear of the anterior oblique bundle of the MCL. Next, no opening is seen until complete disruption of the ligament [14].

Conservative management of acute isolated MCL injuries consist of a short period of immobilisation. Subsequently an intensive exercise program is started. Persistent symptomatic instability after a period of 3–6 months of non-operative management is an indication for operative reconstruction. Since the contemporary reconstructions options are extra-articular, there is no place for primary ligament reconstruction by arthroscopic techniques. However, when an open reconstruction is performed, many surgeons complete an arthroscopy for the evaluation and management of intra-articular damage caused by the medial instability [2].

Trauma and Post-Traumatic Deformities

The elbow is prone to injury. Fractures results from a fall on the outstretched hand or occur due to a direct impact to the elbow. Fractures can range from simple fissures to severe open elbow dislocations. Ligamentous injuries and associated fractures can result in instability and long-term post-traumatic arthritis. Arthroscopy has proven itself to be useful not only in the diagnosis and management of acute elbow trauma, but also in treating the sequelae of these traumata. Arthroscopy can help in reduction and internal fixation of fractures. Since cannulated screws and Kirschner wires are effective in several elbow fractures, there is much potential for arthroscopic (assisted) fracture treatment.

Radial head fractures are the most common of all elbow fractures. They occur in 30 % of elbow fractures and up to 5 % of all fractures. Radial head fractures are classified according to the Mason classification.

Type 1 fractures are non-displaced;
Type 2 fractures have a displacement of >2 mm;
Type 3 fractures are comminuted with multiple displaced fragments.

Type 1 fractures are managed conservatively. Type 3 fractures require radial head excision with or without placement of a prosthesis. Type two fractures should be treated operatively in most cases. This fracture type of the radial head can be fixed arthroscopically. However there is no scientific evidence in favour of arthroscopic treatment over open surgery of radial head fractures. With arthroscopy the radial head is best visualized from the proximal anteromedial portal. Fragment size, articular congruity, and chondral damage should be assessed. Next the joint and fracture should be cleared of debris and haematoma. Using the straight lateral or anterolateral portal, a Kirschner wire can be used as a joystick while an assistant rotates the forearm to aid in reduction. The posterolateral portal is used typically for fracture fixation instruments, such as cannulated screws or reduction guides. In patients with continued pain after a conservative fracture of the radial head, arthroscopic evaluation and management of articular cartilage irregularities and loose bodies can be effectively performed [14].

A fracture of the olecranon process is another common injury of the elbow. The force of the triceps tendon essentially avulses the olecranon from the proximal ulna. The olecranon can also fracture because of an direct impact. Olecranon fractures usually require surgical treatment with Kirschner wires and tension-band wiring. This technique is not amenable for arthroscopy. However, in patients with on-going pain and loss of motion after a healed olecranon fracture, arthroscopy is perfect to evaluate secondary post-traumatic changes in the elbow joint. Debridement and "adhesiolysis" can improve elbow function and pain.

Coronoid fractures are amenable for arthroscopic fixation, depending on size and comminution. Coronoid fractures are classified into three types according to the Regan and Morrey classification:

Type 1, involves just the tip of the coronoid;
Type 2, fragment involving <50 % of the process;
Type 3, fragment involving >50 % of the process.

Small type one coronoid fractures can be debrided arthroscopically in order to prevent a loose body in the joint and possible subsequent cartilage damage. As long as type 2 fractures are non-comminuted, they are amenable for arthroscopic reduction and fixation with one or two cannulated screws placed from a posterior direction in the fracture fragment [2].

Fractures of the distal humerus can result from high energy trauma, but also from simple falls in the osteoporotic patient. It is important to recognize the difference between intra-articular and extra-articular fractures. Conservative treatment is justifiable in non-displaced, stable fractures. Other fractures usually require operative management. In particular non-comminuted unicondylar distal humerus fractures are sometimes amenable to arthroscopic evaluation and arthoscopically assisted fracture fixation. These fractures are classified by Milch into two types:

Type 1: the lateral wall of the trochlea remains attached to the humerus.

Type 2: the lateral wall of the trochlea is attached to the fracture fragment.

Type 1 fractures are smaller and affect elbow stability much less than type 2 fractures. Consequently, type 1 distal humerus fractures are potential candidates for Arthroscopic Reduction and Internal Fixation (ARIF). Haematoma and debris at the fracture site can be removed. Next, a probe or K-wire joystick is used to reduce the fracture fragment. A cannulated guide-wire can be advanced after reduction of the fracture fragment and thereafter a cannulated screw can be percutaneously placed over the guide-wire. In conclusion ARIF can provide anatomic reduction, stable fixation and debridement while minimizing surgical trauma in type 1 distal humerus fractures [15].

The elbow can become inflamed following penetrating trauma. In case of septic arthritis, which is very rare, the arthroscope is an excellent tool to apply a proper lavage of the septic elbow joint. After lavage it allows for detailed joint assessment.

Dislocations of the elbow are described in the section of this chapter: *Instability of the Elbow*.

Operative Techniques

The elbow differs from other joints since it is tightly constrained, making manipulation difficult. On average the elbow has a capacity of 10–30 ml. Several portals are therefore required. The proximity of neurovascular structures makes arthroscopy of the elbow riskier than arthroscopy of other joints. Indications for elbow arthroscopy are determined by the experience of the arthroscopist.

Arthroscopic Technique

Arthroscopy begins with adequate positioning of the patient. For elbow arthroscopy the supine, prone and lateral decubitus positions are available (Fig. 4). The supine position allows for easy access to the anterior compartment and airway management is simplified for the anaesthetist. If the arthroscopy needs to be converted to an open procedure, the supine position is preferred. The prone and lateral decubitus positions provide better access to the posterior compartment. So positioning depends mainly on the surgeon's preference.

There are more than seven portals obtainable for elbow arthroscopy. Before placement of the portals, the surgeon should outline the important landmarks of the elbow (Fig. 5) and distend the joint. On the medial side lie the medial epicondyle and ulnar nerve. On the lateral side the radial head and the lateral epicondyle. On the posterior side the olecranon. Be aware of altered landmarks after trauma or previous ulnar nerve transposition.

The joint is distended with 10–30 ml of normal saline to displace the neurovascular structures, thereby making portal placement safer (Fig. 6). Distension is done in the posterior compartment of the elbow, via a needle placed in the centre of the triangle between lateral epicondyle, olecranon tip and radial head (Fig. 7). The elbow is in extension and in supination with maximal distension. For the anterior compartment are five common portals used. The proximal medial and proximal lateral portals are the safest. The anteromedial and anterolateral portals allow for more direct exposure to the joint but are at higher risk for causing neurovascular injury during placement. The direct lateral portal allows for joint distension and visualisation of the inferior radial head area. The posterior compartment is exposed by two common portals. The direct posterior and the posterolateral portals. The posterior compartment is normally relatively safe from the neurovascular structures.

Fig. 4 The lateral decubitus position

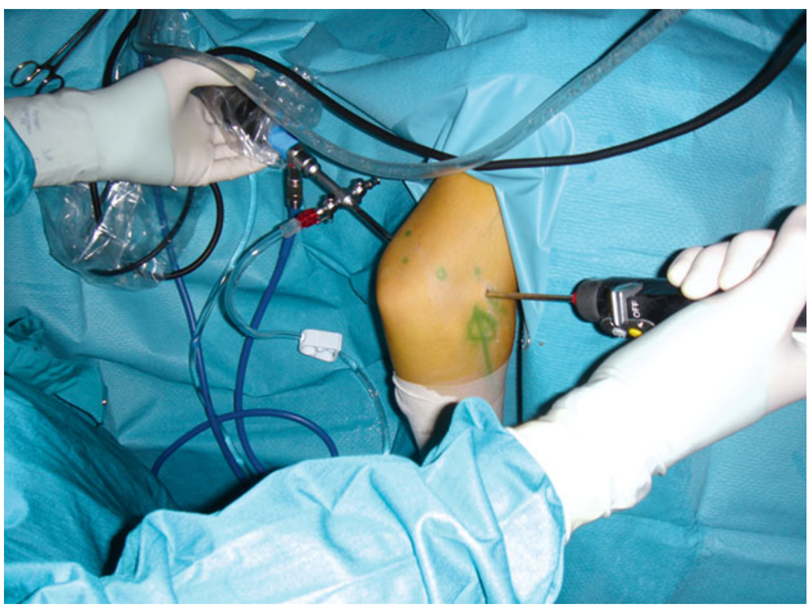

Fig. 5 Placement of instruments through portals according to pre-operative outlined landmarks. In the left hand, the arthroscope and in the right hand, a shaver

Placement of the above mentioned portals is as follows:

Proximal medial:	2 cm proximal to the medial epicondyle and 1 cm anterior to the medial epicondyle. This is just anterior to the medial intermuscular septum. It is approximately 6 mm from the medial antebrachial cutaneous nerve and 1 cm from the median nerve.
Proximal lateral:	2 cm proximal to the lateral epicondyle and 1 cm anterior to the lateral epicondyle. This is approximately 1 cm from the radial nerve.
Anteromedial:	2 cm distal to the medial epicondyle and 2 cm anterior to the medial epicondyle. This is 7–14 mm from the median nerve and 0–5 mm from the medial antebrachial cutaneous nerve.
Anterolateral:	3 cm distal to the lateral epicondyle and 2 cm anterior to the lateral epidcondyle. This is approximately 7 mm from the radial nerve.
Direct lateral:	In the centre of the triangle between lateral epicondyle, olecranon tip and radial head. Same position as the needle used for distension. It is 7 mm from the posterior branch of the lateral antebrachial cutaneous nerve.
Direct posterior:	3 cm proximal to the olecranon tip and in mid-line through the triceps tendon. This is approximately 2.5 cm from the posterior antebrachial cutaneous nerve and the ulnar nerve.
Posterolateral:	3 cm proximal to the olecranon tip and on the lateral edge of the triceps tendon. Usually 2 cm lateral to the position of the direct posterior portal. This is approximately 2.5 cm from the medial antebrachial cutaneous nerve, posterior antebrachial cutaneous nerve and the ulnar nerve.

The posterior portals should be placed with the elbow in 20–30° of flexion.

Normally a 4 mm arthroscope is used for visualisation of the elbow joint; however in small or stiff joints a 2.7 mm arthroscope can be preferred. Elbow arthroscopy is facilitated by the circulation of normal saline through the joint via tubes and a pump. There is a wide range of instruments developed to support the surgeon during arthroscopy. Probes and graspers are used to manipulate structures. Burrs and shavers are used for debridement and/or removal of tissues. Cautery devices are used for debridement and to control bleeding. Kirschner wires, guide-wires and cannulated screws can be used for fracture manipulation and fixation. For effective use of the instrumentation excellent visualisation is a necessity. Thus, most important, is to use the correct portals for every single activity during arthroscopy. Each of the seven portals has it own ideal properties:

Proximal medial:	A good starting portal because of safe access, minimal fluid extravasation and good visualisation of the entire anterior compartment, including anterior capsule, trochea, capitellum, coronoid process, radial head, medial and lateral gutters. Viewing the radiocapitellar joint. Anterior instrumentation.
Proximal lateral:	Also a good initial portal because safe access, minimal fluid extravasation and good visualisation of the anterior compartment, including anterior and lateral radial head, capitellum and lateral gutter. Anterior instrumentation.
Anteromedial:	Inflow portal. Visualization of the anterolateral structures. Anterior instrumentation.
Anterolateral:	Visualization of the coronoid process, trochlea, coronoid fossa and medial radial head. Anterior instrumentation for the medial joint.

Reversal of the anterior portals between medial and lateral, reverses visualization and instrument placement.

Direct lateral:	Initial joint distension. Visualization of the (inferior) radial head, capitellum and radio-ulnar joint. Instrumentation for the posterior capitellum and radio-ulnar joint.
Direct posterior:	Visualization of the entire posterior compartment. Instrumentation in the posterior compartment.
Posterolateral:	Visualization of the posterior compartment including the tip of the olecranon, olecranon fossa posteriorly, medial and lateral gutters.

At the end of the arthroscopic procedure, only the skin is stitched. No drain is left when the tourniquet is deflated. A pressure bandage and sling provide some comfort for the first post-operative hours. Immediately thereafter, the pulse in the radial and ulnar artery are monitored. When the patient is conscious the neurological status is assessed [16, 17].

Fig. 6 Distension of the elbow joint

Post-Operative Care and Rehabilitation

Post-operative care after elbow arthroscopy consists of standard procedures as after all surgical interventions. Assess the neurovascular status and range of motion of the joint and extremity. Check for adequate wound healing, signs of infection, oedema or thrombosis. A major difference between elbow arthroscopy and open surgical procedures is that rehabilitation will start either on the day of surgery or the day after, and will be more aggressive. Active range of motion exercises are started within 24 h following surgery. After 24 h the pressure bandage can be removed and range of motion is progressed as tolerated. Oedema and pain can be reduced with cold packs [16].

The anatomical structure and orientation of the elbow makes it highly prone to post-operative stiffness. Prolonged immobilization contributes to the development of joint contracture. Therefore early mobilization is most important in a successful rehabilitation program. Since arthroscopy causes minimal injury to the soft tissue structures of the elbow, stability is maintained and early exercises are safe. Both active and passive range of motion exercises

Fig. 7 Distension of the elbow capsule via a needle placed in the centre of the triangle between lateral epicondyle, olecranon tip and radial head

may be commenced under supervision of a physiotherapist. The use of Continuous Passive Motion (CPM) post-operatively is advocated by many authors. However, the benefits of CPM have never been proved in randomized controlled trails. CPM can be used for as long as it is necessary to achieve range of motion goals [18].

Restoration of range of motion is especially important after arthroscopic release of the stiff elbow. Rehabilitation in the post-operative period after capsular release can be subdivided into four phases: [9]

1. Acute phase. Goals: Limit pain and swelling, increase in ROM, isometric strengthening without pain.

   Rehabilitation program: Kinetic link exercises, scapula co-ordination and stabilization exercises, no sporting activities, passive range of motion, pain-free mobilization, cryotherapy, non steroid anti-inflammatory drugs (NSAIDS).
2. Intermediate phase. Goals: No pain at rest, no swelling, limited activity, increasing ROM.

   Rehabilitation program: See phase 1, and stretching of elbow musculature without free, cardiovascular conditioning programme.
3. Advanced strengthening. Goals: Full ROM, no pain and no limitation in daily activities, sport-specific exercises possible.

   Rehabilitation program: See phase 1 and 2, maximal passive and active pain-free mobilization, maximal muscular strengthening, start throwers 10 programme if applicable.
4. Return to sports activity. Goals: gradual return to sports activity, throwing motion. in competitive way.

   Rehabilitation program: complete throwers program, increase strength, start both concentric and eccentric exercises at different speed.

During the rehabilitation progress, splinting may protects the healing joint from outside forces. It is, however, crucial that an immobilisation splint is only worn for a maximum of 2 weeks post-operatively. Its main use after arthroscopy should be for fracture management.

Complications

In the literature, complication rates for arthroscopy of the elbow are as high as 10 %. Most complications are minor and transient. However, permanent major injury to all of the nerves in the elbow has been described. Minor complications are transient and considered as common in arthroscopy. Examples are haematoma formation, swelling and persistent drainage from portals. Major complications involve permanent neurovascular injuries or complications requiring re-intervention or loss of function of the elbow. Nerve injuries are more common in patients with rheumatoid arthritis for several reasons. Because of bony erosive changes, the normal landmarks can be difficult to identify, and severe synovitis makes visualization at the commencement of the procedure often poor [18].

The incidence of complications can be reduced by standard procedures for every arthroscopy of the elbow. For instance, landmarks should be defined before distension. Before portal placement the joint should be distended. Portal placement can be located using a needle or the “inside-out technique” after the first portal is created. Only the skin is incised with a blade, thereafter blunt dissection is performed with a haemostat in a longitudinal direction. A blunt trocar is used to create the portal. Placement of portals in the anterior compartment should be done with the elbow in 90° of flexion. During the procedure knowledge of local anatomy most important to avoid injuries.

Last but not least, complications can be avoided by knowledge of the correct indications and contra-indications for elbow arthroscopy. Significant disruption of normal anatomy as a result of trauma or rheumatoid arthritis is a relative contra-indication for arthroscopy. Another contra-indication is an elbow with overlying local infection or cellulitis. A history of ulnar nerve transposition is a relative contra-indication depending on the position of the nerve and the simplicity of localising it. Perhaps the most important indication or contra-indication for elbow arthroscopy is the experience of the surgeon [19].

Summary

Arthroscopy of the elbow was first described by Burman in 1932. However, for a long time, the indications for elbow arthroscopy were limited to diagnostic assistance and removal of loose bodies. The elbow differs from other joints since it is tightly constrained, making manipulation difficult. On average the elbow has a capacity of 10–30 cm^3. Several portals are therefore required. The proximity of neurovascular structures makes arthroscopy of the elbow riskier than arthroscopy of other joints. Indications for elbow arthroscopy depend on the experience of the arthroscopist. The list of indications for arthroscopy includes osteochondritis dissecans, impingement, limitation of motion, lateral epicondylitis, instability and trauma. A major difference between elbow arthroscopy and open surgical procedures is that rehabilitation will start either on the day of surgery or the day after, and will be more aggressive. Complications can be avoided by knowledge of correct indications and contra-indications.

References

1. Hoppenfeld, deBoer, The anatomic approach. Surgical exposures in orthopaedics. 4th ed. Philadelphia: Lippincott Williams & WIlkins; 2009. 740 p.
2. Eygendaal D, editor. The elbow. 1st ed. Nieuwegein: Arko Sports Media; 2009.
3. Eygendaal D, Rahussen FT, Diercks RL. Biomechanics of the elbow joint in tennis players and relation to pathology. Br J Sports Med. 2007;41(11):820–3.
4. Baumgarten TE, Andrews JR, Satterwhite YE. The arthroscopic classification and treatment of osteochondritis dissecans of the capitellum. Am J Sports Med. 1998;26(4):520–3.
5. Levine Field and Savoie, Arthroscopic management of osteochondritis dissecans of the elbow. Oper Tech Sports Med. 2006;14:60–66.
6. Rahusen FT, Brinkman JM, Eygendaal D. Results of arthroscopic debridement for osteochondritis dissecans of the elbow. Br J Sports Med. 2006;40(12):966–9.
7. Rahusen FT, Brinkman JM, Eygendaal D. Arthroscopic treatment of posterior impingement of the elbow in athletes: a medium-term follow-up in sixteen cases. J Shoulder Elbow Surg. 2009;18(2):279–82.
8. Kim SJ, et al. Arthroscopic treatment for limitation of motion of the elbow: the learning curve. Knee Surg Sports Traumatol Arthrosc. 2011;19(6):1013–8.
9. Cefo I, Eygendaal D. Eygendaal Irma Cefo and Denise Eygendaal, Arthroscopic arthrolysis for posttraumatic elbow stiffness. J Shoulder Elbow Surg. 2011;20 (3):434–9.
10. Sahajpal D, Choi T, Wright TW. Arthroscopic release of the stiff elbow. J Hand Surg Am. 2009;34(3):540–4.
11. Merrell G, DaSilva MF. Arthroscopic treatment of lateral epicondylitis. J Hand Surg Am. 2009;34(6):1130–4.
12. Savoie FH, VanSice W, O'Brien MJ. Arthroscopic tennis elbow release. J Shoulder Elbow Surg. 2010;19(2 Suppl):31–36.
13. Savoie FH, Field LD, Ramsey JR. Posterolateral rotatory instability of the elbow: diagnosis and management. Oper Tech Sports Med. 2006;14:81–5.
14. Field LD, Savoie FH. The arthroscopic evaluation and management of elbow trauma and instability. Oper Tech Sports Med. 1998;6(1):22–8.
15. Holt MS, et al. Arthroscopic management of elbow trauma. Hand Clin. 2004;20(4):485–95.
16. Brach P, Goitz RJ. Elbow arthroscopy: surgical techniques and rehabilitation. J Hand Ther. 2006;19(2):228–36.
17. Brown DE, Neumann RD. Orthopaedic secrets. 3rd ed. Philadelphia: Hanly & Belfus; 2004.
18. Steinmann SP. Elbow arthroscopy: where are we now? Arthroscopy. 2007;23(11):1231–6.
19. Savoie 3rd FH. Guidelines to becoming an expert elbow arthroscopist. Arthroscopy. 2007;23(11):1237–40.