17 Elbow Arthroscopy: From Basic to Advance (ICL 20)

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17.1 Elbow Arthroscopy: Setup and Portals

A. Van Tongel

Elbow arthroscopy is becoming more and more popular. Compared to open elbow procedure, this surgical technique has several advantages: able to see better, improved access, magnification (a microscope of the elbow), minimal "collateral damage," less scarring, decreased risk of infection, and less postoperative pain. But it also includes some risks that are more common compared to an open procedure like compartment syndrome and transient or permanent nerve injuries.

A perfect knowledge of the elbow anatomy with a specific focus on the several nerve tracts (ulnar nerve, radial nerve, median nerve, lateral and medial cutaneus antebrachii nerve) is very important before starting with this procedure.

The patient can be positioned supine, prone, or lateral decubitus. Supine can give a good medial and lateral access but a more difficult posterior access. During the procedure, the intra-articular anatomy is more intuitive. The prone position is less used because of the difficulties to position and due to the fact that the anesthetist will have difficulty accessing the airway. The most common used position is lateral decubitus. It eliminates traction and the surgeon can mobilize the elbow through its full range. An important disadvantage of this position is the fact that when standing behind the

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patient and working in the anterior compartment the camera on the screen shows a mirror effect.

After insufflation of the tourniquet, the joint should be distended with normal saline (around 20 cc). This can be done through the lateral soft spot or into the olecranon fossa. During insufflation, the flexed elbow will go into slight extension. Concerning fluid management intraoperatively, gravity-fed fluid inflow or pressure insufflation via a pump can be used (±30 mmHg).

The choice, the order, and the number of portals depend on the surgeon preference and the indication of surgery. It is important to remember that more distal portals are more prone to nerve lesions. Most commonly two to four portals are used for the anterior compartment, two for the posterior compartment and two for the posterolateral compartment. Perioperatively, it is important to have a very low threshold to use an extra portal for retraction. Also the use of the switching stick to switch portals is mandatory to work efficiently.

17.2 Lateral Painful Syndrome

Paolo Arrigoni

The presence of intra-articular findings that may complement extra-articular pathology in lateral epicondylitis has been suggested, but a role for microinstability of the elbow as part of the causative process of this disease has rarely been considered. This study was designed to describe the intra-articular findings in a specific population of patients suffering of lateral elbow pain.

Twenty-eight patients suffering from atraumatic lateral elbow pain unresponsive to conservative treatment and positive to posterior radiocapitellar joint pain and radial head supination pain tests were prospectively enrolled. The presence of capitellar ballottement with annular drive-through sign, synovial plicae, radial head chondropathies, capitellar chondropathies, anterior anteromedial synovitis, anterolateral capsular tears, and laxity of the radial component of the lateral collateral ligament was documented during arthroscopy, and the incidence of the reported findings was calculated.

92.9 % of patients presented at least one intra-articular finding, 82.1 % at least two, 46.4 % at least three. Synovitis was the most common finding (81.1 %), followed by radial head ballottement (42.9 %) and capitellar chondropathy (39.3 %).

The cumulative presence of several intra-articular findings sustains the existence of a pathology of the lateral aspect of the joint based on a minor instability pattern.

17.3 Arthroscopic Management of Epicondylitis of the Elbow

Marc R. Safran

Epicondylitis of the elbow is one of the most common maladies in orthopedic surgery. Lateral epicondylitis, also known as tennis elbow, is much more common that medial epicondylitis, also known as golfer's elbow. Interestingly, in high-level tennis players, medial epicondylitis is more common than lateral. Epicondylitis is a misnomer, because inflammation is not part of the pathology – it is a degenerative process, looking very much like scar tissue, with angiofibroblastic proliferation and neovascularization. Currently, the term tendinopathy and tendinosis are the accepted terms. Lateral epicondylosis involves the extensor carpi radialis brevis (ECRB) and the deeper extensor muscles at the elbow. Medial epicondylosis generally involves the pronator teres and flexor carpi radialis (FCR).

The ECRB may be accessed from within the joint by making a capsulotomy from within the joint proximolaterally. Unfortunately, the pronator teres and FCR, though deep, are not well accessed from within the joint, and with the proximity of the ulnar collateral ligament adherent and beneath those muscles, as well as the ulnar nerve next to the medial capsule and joint, most surgeons will not attempt to arthroscopically or endoscopically address medial epicondylosis. As such, this paper and presentation will focus on the arthroscopic management of lateral epicondylosis.

Nearly one-third of patients with lateral epicondylosis have a tear or rent in the capsule laterally before treatment, making the thought of performing a capsulotomy to treat tennis elbow inconsequential. My indications for performing arthroscopic tennis elbow surgery are those with inability to return to usual activities after 6 months of good rehabilitation and one to three injections with corticosteroids. The arthroscopic technique allows for reliable, direct visualization of the pathology, without violating the normal, healthy musculotendinous tendinous overlying the ECRB, and allows for treatment of coexistent pathology that may be seen up to 69 % of the time. Further, as a less invasive procedure, there is better cosmesis, less pain, and more often, quicker rehabilitation. The downside of the arthroscopic approach is there is more of a chance to perform an incomplete debridement, there is a longer learning curve, and there is the risk of iatrogenic injury to the lateral collateral ligament injury (which may also occur with the open technique) and risk of nerve injury. However, staying on the anterior half of the lateral epicondyle and anterior to the midplane of the radial head will help reduce the risk of injury to the lateral collateral ligament.

Several authors have demonstrated excellent results. Grewal et al. found that the outcomes are worse in heavy laborers, those involved with repetitive activity, and patients with worker's compensation claims [5]. Additionally, Oki found that functional recovery may improve for 3 months after surgery and more than 6 months for activity-related pain to be less than 10 [6]. Comparative studies are few. Szabo [7] and Lo [8] found no difference in outcomes when comparing technique for tennis elbow surgery. More recently, Othman found that arthroscopic surgery for lateral epicondylosis had better outcomes when compared to percutaneous technique [9]. A large study of sequential comparison groups found that patients undergoing arthroscopic treatment for tennis elbow had a larger percentage of elbows with excellent outcomes (78 %) as compared with the open technique (67 %), but similar failure rate [10].

There is question as to decorticate the lateral epicondyle as part of this procedure, and recently, Kim et al. found that decortication resulted in increased pain post-op and did not improve outcomes [11].

Arthroscopic management of tennis elbow appears to have several advantages over other techniques and can be performed safely and reliably [12].

17.4 Stiff Elbow

Denise Eygendaal

The elbow can move from 0 to 145° of flexion. Some hyperextension is normal. Pronation and supination range from 85 to 80°. The range of forearm rotation is comparable between both sides, but it is higher in women than in men and inversely correlated with age.

In clinical setting, the contralateral side serves for comparison of flexion, extension, and rotation as the range of motion can vary dependent from age, gender, and constitutional variances [1].

In professional athletes, an extension deficit of up to 10° of the dominant elbow in comparison to the nondominant hand can be noticed.

It has been stated that an elbow needs a minimal range of motion (ROM) of 100° flexion/extension and 100° of pronation/supination to function adequately in daily life.

However in specific groups of patients, as professional athletes, even a slight extension deficit of 10° can result in a dysfunction of the elbow.

Generally the patient notices loss of extension earlier than loss in flexion or rotation. A supination deficit will be earlier noticed by the patient than a limitation of pronation.

Interference, for instance, with daily living activities as eating or hygiene activities is more disabling with limited supination since it may not be compensated sufficiently, whereas the lack of pronation can easily be compensated by abduction of the shoulder and flexion of the elbow [1].

In conclusion the definition of stiff elbow is dependent on the patient, his demands, and the ability to cope with stiff elbow.

In adults, nontraumatic elbow contractures are usually caused by an inflammatory process as osteoarthritis, rheumatoid arthritis, acute or chronic septic arthritis, and periarticular ossifications after head injury.

The elbow is affected more frequently than any other joint by posttraumatic stiffness; the complex anatomy and proximity of tendons, muscles, ligaments, and overlying skin play an important role.

Posttraumatic contractures can be classified into extrinsic (extra-articular) or intrinsic (intra-articular) pathology. The extrinsic contracture involves the skin (skin burns, posttraumatic contracture wounds, or hypertrophic scars), the posterior and anterior capsule, the medial and lateral collateral ligaments, muscles surrounding the joint, and periarticular ossifications. The intrinsic or articular components consist of intra-articular adhesions, cartilage damage, or abnormal anatomy of the articular surface. This is in most patients the result of a trauma resulting in a posttraumatic osseous anatomy.

In most cases, there is a mixture of extrinsic and intrinsic factors as an intrinsic contracture will always result in secondary contracture of extrinsic structures. Extrinsic contracture can possibly lead to intra-articular adhesions or secondary osteoarthritis of the joint.

The exact etiology of the extrinsic of posttraumatic contractures is poorly understood; immobilization resulting in adhesions seems to play a role [3]. Another study has shown an increase of myofibroblasts in the capsule of a posttraumatic elbow [4].

Heterotopic ossification can be a sequel of a traumatic event in which organized bone is formed in the surrounding tissues of the elbow joint. The exact etiology is still unclear; proliferation of mesenchymal cells into the cartilage or osteoblasts after trauma, in the presence of bone morphogenic protein, may play a role [5].

Contractures due to imbalanced muscles as in spastic flexion deformity of the elbow after a cerebral vascular accident or in spastic, hemiplegic children must be carefully assessed by a specialized team consisting of a neurologist, an orthopedic surgeon, and a specialized team for rehabilitation.

History taking is of utmost importance in the work-up of stiff elbow. The details about any traumatic lesion, trauma mechanism, the nonsurgical treatment, or surgical treatment in the past should be known.

The next questions have to be answered before starting an assessment and treatment plan.

- What is the dominant arm?
- What is the occupation of the patient and what are his or her limitations, due to the stiff elbow in daily life, occupation, and sports.
- Is the elbow also painful or is it just a decrease in range of motion that limits the patients in daily functioning?
- Which decrease of movement of the elbow is the most disabling in this particular case?
- Has the loss in range of motion been progressive or stable over the last year?

At physical examination, evaluation must be performed of:

- The skin around the elbow
- Previous surgical or posttraumatic scars
- Neurological evaluation
- Evaluation of muscle strength and voluntary control of muscles
- The bony alignment
- Stability of the elbow joint
- Wrist function especially of the function of the distal radioulnar joint
- Passive and active range of motion in comparison to the uninjured side

Preferably the abovementioned items are registrated in a validated rating system as the Mayo Elbow performance score or the EFA (elbow functional assessment) test [2, 5]. Preoperative imaging consists of standard radiographs of both elbows and wrists.

In intrinsic contractures, CT scan is mandatory in every case, preferably including a three-dimensional reconstruction.

To evaluate the activity of periarticular ossifications, bone scintigraphy can be performed. MRI is in most cases not necessary.

Nonsurgical treatment consists of an appropriate rehabilitation program using (turnbuckle) splints under the supervision of a specialized physiotherapist.

In order to preserve the gain in range of motion after active and passive exercises, splinting can be used. In the past, dynamic splints that apply a constant tension to the soft tissues over long periods of time (i.e., 12–23 h/day) were popular. However patient-adjusted static braces appear to be more effective although further studies have to be done.

These braces, which use the principle of passive, progressive stretch, are applied for much shorter periods of time and are better tolerated by patients.

Manipulation under anesthesia is, in general, not advised because of possible complications as periarticular fractures, ulnar nerve injury, periarticular ossifications, and elbow instability.

Surgical release is indicated in stiff elbows when nonoperative treatment has failed and function is severely impaired.

The type of surgery depends of the osseous integrity and preoperative range of motion.

If it is mainly a contracture of the capsule, muscles, and ligament, an arthroscopic or open limited approach can be performed. If heterotopic ossification (HO) plays a role, arthroscopic surgery is not indicated and excision of the HO is mandatory in combination with an extended approach.

Different surgical approaches have been described; the choice of type of approach is based on many factors as the site of any previous incision, the presence of neuropathy, and location of periarticular ossifications and intra-articular deformities. The lateral column procedure was first described by Mansat in 1998. The advantage of this approach is the ability to see and treat both the anterior and posterior ulnohumeral and radiocapitellar joint through one incision with preservation of the collateral ligaments. A disadvantage is that patients with an ulnar neuropathy or calcifications in the medial collateral ligament cannot be treated using one single incision; in those cases, a medial approach is preferred. The disadvantage of a medial approach is the risk of injury of the ulnar nerve [7].

Previous reports of the results of surgical release have shown an overall improvement in ROM [8–13].

Mansat and Morrey treated 38 elbows using a limited lateral approach to the anterior and posterior aspects of the capsule. The mean preoperative arc of flexion was 49°. At mean of 3 years postoperatively, the mean arc of flexion was 94°. The mean total gain was 45°. Marti et al. performed a capsulectomy using a lateral approach on 43 elbows, and an additional medial approach was used on 24 elbows to excise ulnar adhesions and perform a more extensive capsulectomy. They achieved an improvement in ROM from 45 to 99°. The rehabilitation program we used in was rather aggressive in comparison to other studies; some mention continuous passive motion and dynamic splinting as risk factors for the development of periarticular ossifications [12]. In our series, using a minimal invasive lateral approach, two patients had minimal periarticular ossifications, in both cases not symptomatic. The ROM was similar at 3-, 12-, and 24 months. Prolongation of physical therapy after 3 months did not improve the functional outcome and probably can be reduced after 3 months [13].

Kelberine published a comparative study between open and arthroscopic arthrolysis of the elbow; the results are almost similar with a significant higher improvement in flexion (7°) in the open group.

17.5 Arthroscopic Treatment of OCD

L.A. Pederzini, E. Tripoli, and A. Cheli

17.5.1 Introduction

OCD is represented by an osteochondral focal lesion that generally involves the capitulum humeri or the radial head with a greatest incidence between 10 and 15 years.

Treatment for stable, early-stage OCD lesions is to avoid repetitive stress on the elbow and observation. If the lesion has not resolved in 6 months, then consideration of surgical management is made [13, 15, 17].

Surgical procedure is indicated for lesions that do not improve with appropriate nonoperative treatment, the presence of loose bodies with mechanical symptoms, or the presence of an unstable lesion. There are different operative procedures that have been described for treating OCD, including fragment removal with or without curettage or drilling of the residual defect, fragment fixation by a variety of methods, drilling of the lesion, closing-wedge osteotomy of the lateral condyle, reconstruction with osteochondral autograft, and autologous chondrocyte implantation.

The surgical method is generally planned preoperatively using radiography and MRI, but the surgical procedure is finally decided according to arthroscopic findings and/or direct confirmation of the lesion during operation.

Arthroscopic surgery has become the standard procedure for the treatment of capitulum OCD [18–21]. It offers the advantage of assessing the extent of the disease inside the joint and the ability to treat the lesion and remove loose fragments at the same time.

This minimally invasive approach reduces the risk of operative morbidity from a surgical incision and allows the patient to start regaining range of motion early after surgery. Studies on arthroscopic treatment for OCD of the elbow have shown encouraging results with intermediate follow-up. However, long-term results still need to be evaluated [17, 18, 21].

In small or stables or in chronic lesions when refixation is impossible or larger osteochondral defects exceeding 1 cm^2 impossible for refixation or in larger osteochondral defects exceeding 1 cm^2 drilling and debridement represent good surgical options [17–19, 21].

17.5.2 Surgical Technique

The anesthetist identifies nerve trunks by applying electrostimulation and places a catheter without injecting the anesthetic. Patients then undergo general anesthesia. When they wake up, only after a neurological evaluation, peripheral block is performed. After the induction of anesthesia, ROM is carefully assessed and a complete ligamentous balancing is carried out. A well-padded tourniquet is placed proximally around the arm. The limb is exsanguinated and the tourniquet insufflated to approximately 250 mmHg.

The patient is then placed in lateral decubitus but can also be placed in the prone position depending on the surgeon's preference and experience, with the shoulder abducted 90°, the elbow flexed to 90°, and the arm held up by an arm holder secured to the operating table.

Sterile field is set up and elbow joint landmarks are drawn by a dermographic pen (medial and lateral epicondyle, ulnar nerve, radial head, posterior soft spot). Soft spot posterior portals and supero-anteromedial and supero-anterolateral portals are marked.

An 18-gauge needle is inserted in the elbow through the "soft spot" in the middle of the triangular area delimited by the epicondyle, the radial head, and the olecranon, while the joint is distended by injecting 20–25 mL of normal saline through the lateral soft spot. Joint distention displaces the volar neurovascular structures more anteriorly to help protect against iatrogenic injury during portal creation and instrumentation.

Five portals, three posterior and two anterior, are always used. After the incision is made, soft tissues are retracted by using a fine hemostat.

Posterior compartment arthroscopy is firstly performed by introducing a 4-mm 30° arthroscope or a 2.7-mm arthroscope (this may be required for the smaller adolescent patient) through the posterolateral portal (soft spot). Then a second portal is established, 1.5 cm proximal to the latter. These two portals allow to use the scope and the shaver at the same level of the posterior portion of the radial head.

Joint distension is achieved by a pump set at 35–50 mmHg. Once we get a good and complete view of the proximal radioulnar joint (posteriorly), a third posterior portal is placed in the olecranon fossa, close to the triceps medial border and oriented 2–3 cm proximal to the olecranon tip. When we have a good view of the joint, we can perform many different operative procedures including drilling of the lesion, fragment removal with or without curettage of the residual defect, or fragment fixation by a variety of methods.

After evaluating the posterior compartment, anterior compartment inspection is carried out in order to have a good view of the entire joint and to treat associate pathologies. The proximal medial portal is created approximately 2 cm proximal and 1 cm anterior to the palpable medial epicondyle. After the skin is incised, a straight hemostat is usually used to spread the subcutaneous tissues to help prevent injury to the crossing sensory nerves. A blunt trocar is inserted through the proximal medial portal aiming toward the center of the joint while maintaining contact with the anterior humeral border. The anterior compartment of the elbow is evaluated while viewing from the proximal medial portal. A proximal lateral portal is created using an in-out. This portal is approximately 1–2 cm proximal to the lateral epicondyle along the anterior humeral surface. Any associated synovitis is removed with a small, motorized shaver. If present, loose bodies are retrieved with a grasper. The anterior radiocapitellar joint is inspected, with evaluation for any potential cartilage softening or fragmentation. Lesions present on the anterior capitellum are probed. If a large lesion is present with attached bone, fixation can be performed with fluoroscopic assistance. Smaller fragments and purely chondral lesions are debrided with a small full-radius shaver. All affected and unstable cartilage is removed. Next, the arthroscope is placed in the proximal lateral portal to complete the full evaluation of the anterior compartment [17, 18, 21].

Thorough inspection of the capitellum is achieved through the posterior lateral, the direct lateral, and an accessory direct lateral portal. The second direct lateral portal is created under direct visualization after needle localization. In a cadaveric study, Davis et al. [16] reported that 78 % of the entire capitellar surface area was accessible through the dual direct lateral portals. Both portals remained safely proximal and posterior to the lateral ligamentous complex.

All unstable cartilage of the lesion is removed with a combination of a grasper and shaver to a stable bed. A ringed curette assists in creating a stable, perpendicular rim of healthy surrounding cartilage. After the calcified cartilage layer of the lesion bed has been removed, we create microfractures in the lesion bed. Using arthroscopic awls, the subchondral plate is usually penetrated to a depth of 2–4 mm approximately 3 mm apart, beginning at the periphery of the lesion. The inflow is then turned off to verify the efflux of blood and marrow elements from each microfracture hole.

Reports of arthroscopic treatment of OCD of the capitellum with removal of loose bodies, debridement, and abrasion chondroplasty describe overall improvements in pain and range of motions with variable return to pre-injury level of sporting activity [14, 17].

More recently some authors [17, 21] are preferring to use an arthroscopic mosaicplasty (from lateral knee trochlea to capitulum humeri) in order to completely restore the joint surface possibly avoiding a later osteoarthritis.

The patient is then placed in lateral decubitus extrarotating the hip, with the shoulder abducted 90°, the elbow flexed to 90°, and the arm held up by an arm holder secured to the operating table.

We performed an arthroscopic mosaicplasty taking the graft from the homolateral knee, performing knee arthroscopy. The patient is placed in a lateral decubitus position and hip extrarotation in order to approach arthroscopically the homolateral knee to remove the osteochondral cylinder of the lateral femoral trochlea. Two posterior lateral portals in the posterior soft spot of the elbow allow the identification of the OCD and its preparation in accordance with the technique to insert the osteochondral cylinder.

The 6.5-mm cylinder graft taken from the lateral knee trochlea was inserted in the elbow lesioned area carefully checking the angle of the drilling and of the insertion of the bony-cartilaginous cylinder. Arthroscopically the perpendicular insertion of the cylinder allows a complete coverage of the OCD area. The cylinder press fit makes the graft stable.

At 4 months later MRI shows a nice bone incorporation of the graft. Postoperatively the cpm started in day 2 and passive exercises in day 4 post-op. Patients were back to normal activity in 4 months [17].

17.6 Elbow Joint Instability

L.A. Pederzini, E. Tripoli and A. Cheli

Elbow joint is composed from endings of three long bones: the distal humerus, proximal radius, and ulna. The elbow is one of the most congruent and stable joints of the human body. The main reasons for that are almost parallel bony components of joint surfaces and very solid soft tissue stabilizers – lateral and medial collateral ligaments and anterior capsule.

Lateral collateral ligament and anterior bundle of medial collateral ligament start from the endpoints of axis of rotation of the elbow joint.

Medial collateral ligament has two components: the anterior bundle taut in extension but its posterior bundle is taut in flexion. The lateral collateral ligament showes rather constant tension during all activities and functions with or without the radial head; the central part of it called the lateral collateral ulnar ligament attaches to the ulna, thus stabilizing the ulnohumeral joint and, together with posterior and anterior capsule, controlling the pivot shift maneuver.

Muscles crossing the elbow joint also play an important role in dynamic stability. The muscular forces across the elbow compress the irregular but congruous joint surfaces against each other.

The elbow, after the shoulder, is the second most commonly dislocated major joint in adults and the most common among the children. Dislocation may occur as a result of a single event such as a fall from the bike on an outstretched hand, or it may be a summary of repetitive stresses resulting in laxity as a consequence of repeated valgus force, such as with throwing in the overhead athlete.

There are three main mechanisms of injury to the elbow: valgus, posterior translation, and posterolateral rotatory mechanisms. The valgus stress mechanism is the most common and high-incident injury. Injury to the elbow medial collateral ligament (MCL) from valgus repetitive forces was first described in 1946 by Waris in a javelin thrower [22].

Josefsson and Nilsson analyzing 178 acute elbow dislocation demonstrated a peak incidence in the 10–20-year-old age group with approximately ten dislocations per 100,000 and in the 50–60-year-old age group an incidence of 4 per 100,000 [23].

Elbow dislocations might be classified by their direction, presence of associated, fractures, and the timing (acute, chronic, or recurrent).

If elbow dislocation occurs without fracture, it is referred to as a “simple dislocation.” It is a surprisingly rare condition, because when meticulous diagnostic studies are performed, minor avulsion fractures of several millimeters from the medial and lateral epicondyle regions or of the coronoid tip occur. When acute dislocations are associated with significant fractures, they are classified as “complex dislocations.”

Complex elbow instability consists of a dislocation of the ulnohumeral joint with a significant fracture of one, or several, of the bony stabilizers of the elbow. These include the radial head, proximal ulna, coronoid process, or distal humerus. Following this type of dislocation, there is frequently a tendency to chronic instability and an increased incidence of posttraumatic arthrosis.

X-ray of both elbows is mandatory; in a case of any doubts – CT or MRI are advocated, because even minor fracture, for instance, of the coronoid might be the only sign of posteromedial rotatory instability. In children – both elbows should be investigated, to distinguish the epicondyle epiphysiolysis.

In acute settings, dislocations without important associated injuries might be treated by simple reduction and the arm cast or hinged brace, in majority of cases in pronation.

In delayed cases, more than 10 days – an open approach is preferred.

Long-standing, chronic cases of an open reduction and ligament reattachment or reconstruction are advocated. Special attention is paid to ulnar nerve free gliding.

Associated injuries have to be treated as well at the same time and conditions for early protected motion created.

Complex instability of the elbow is defined as an injury that destabilizes the elbow because of damage to the articular surface.

The clinical investigation should be performed in patient relaxed, in supine position, for valgus and varus instabilities – with the elbow extended, for posterolateral rotatory instability using lateral pivot-shift as described by O'Driscoll should be performed. Sometimes it needs general anesthesia. In symptomatic cases – an operative treatment is advocated.

17.7 Nerve Compression Around the Elbow

A. Mehmet Demirtaş and M. Derviş Güner

The elbow joint is under repetitive muscle activity and subjected to multidirectional forces. These forces may cause joint instability. Longitudinal stresses and fascial restraints make nerve compression more likely. The athletes and manual workers who perform heavy and repetitive actions have higher risk of nerve compression.

Ulnar, median, and radial nerve crosses the elbow joint, and they are vulnerable to trauma as the muscle and subcutaneous fat is not bulky enough to absorb the energy. Increased pressure around the nerve due to inflammation or vascular aberrations, abnormal fascial bands, boney prominences, and muscular variations may cause nerve compression.

Pain, sensory loss intermittent at the early stages, and weakness are the symptoms. The prognosis is usually excellent if proper treatment decompression has been performed before irreversible damage has occurred.

17.8 Ulnar Nerve Compression at the Elbow

17.8.1 Cubital Tunnel Syndrome

Cubital tunnel syndrome is the most common entrapment condition of the ulnar nerve. Following carpal tunnel syndrome, cubital tunnel syndrome is the second most common compressive neuropathology of the upper extremities.

Ulnar nerve entrapment results from both pathologic and physiologic responses to repetitive trauma. Mechanical factors include compression, traction, and irritation of the nerve. Compression of the ulnar nerve proximal to the cubital tunnel may be due to a tight structure (arcade of Struthers or intermuscular septum) or to hypertrophy of an adjacent muscle (anconeus epitrochlearis or medial head of the triceps). Compression at the level of the cubital tunnel may result from osteophytes, loose bodies, synovitis, or a thickened retinaculum (Osborne lesion). Compression can also occur distal to the cubital tunnel at the FCU aponeurosis or at the deep flexor-pronator aponeurosis after the ulnar nerve passes between the two heads of the FCU. Occupational related causes account for 30 % of cases. Careful neurologic evaluation of the upper extremity is mandatory to rule out more proximal causes of neuropathy. Percussion along the ulnar nerve may elicit Tinel's sign. Diagnosis of cubital tunnel syndrome is based on a combination of clinical findings and electrodiagnostic test findings.

There is a tendency for spontaneous recovery in patients with mild and/or intermittent symptoms if provocative causes can be avoided. Numerous surgical techniques have been described for the treatment of cubital tunnel syndrome, including simple in situ decompression of the cubital tunnel, anterior transposition of the ulnar nerve (subcutaneous, submuscular, or intramuscular), and medial humeral epicondylectomy with decompression of the ulnar nerve; however, there is a lack of consensus concerning which technique is superior. Endoscopic decompression [24–31] is as effective as open decompression and has the advantages of being less invasive, utilizing a smaller incision, producing less local symptoms, causing less vascular insult to the nerve, and resulting in faster recovery for the patient [32].

17.9 Median Nerve Compression at the Elbow

The median nerve is the least frequently entrapped nerve at the elbow. Compression might be caused by the ligament of Struthers, the lacertus fibrosus, the pronator muscle and its fibrous components, or the fibrous proximal margin of the flexor digitorum superficialis muscle. Median nerve compression at the elbow is called pronator syndrome and anterior interosseus nerve syndrome.

17.9.1 Pronator Syndrome

Pronator syndrome mimics the symptoms of carpal tunnel syndrome; it is often missed or confused. As the nerve compressed at a more proximal location, forearm tenderness and pain is the main symptom. The pain is aggravated by forceful use of the extremity, especially involving pronation. Hypoesthesia of the median dermatome, weakness, or clumsiness is often noted. These symptoms are similar to those seen in carpal tunnel syndrome. In pronator syndrome, night pain is unusual while carpal tunnel syndrome may awaken patients. Tinel's sign may be present. Weakness in thumb flexion and pinch strength and atrophy in the thenar muscles may be noted in advanced cases. Loss of sensation in the palmar cutaneous nerve distribution (mid-palm and thenar skin) suggests compression proximal to the carpal canal. Lacertus fibrosus provocation like hyperflexion of the elbow past 120° with resistant forearm supination may reproduce forearm symptoms if the nerve is compressed by this structure. Resisted forearm pronation with the elbow flexed followed by elbow extension that increases symptoms suggests the pronator teres as the site of median nerve compression. Radiographs are necessary to rule out supracondylar process in the distal humerus or any bone pathology. Electrodiagnostic studies (EMG/NCS) are rarely diagnostic. They may be helpful in excluding coexisting pathology and may implicate other causes of nerve compression.

17.9.2 Anterior Interosseus Nerve Syndrome

The anterior interosseus nerve is the branch of the median nerve 5 cm distal below the medial epicondyle and then passes posteriorly through the two heads of the flexor digitorum sublimis muscle. The anterior interosseus nerve has no sensory component; numbness is not associated with this syndrome. Anterior interosseus nerve innervates the flexor pollicis longus, pronator quadratus, and the flexor digitorum profundus of the index finger. This causes weakened index finger-thumb pinch. In contrast to pronator syndrome, pain may be elicited by resisted flexion of the flexor digitorum sublimis of the long finger and may also be present at rest and on local palpation of the nerve. EMG/NCS may be diagnostic in anterior interosseus nerve syndrome. The initial treatment for median nerve compression is conservative. Surgical release is performed either open or with endoscopic assisted methods. Full recovery may take as long as 6 months even after surgical decompression. If there is severe nerve damage, recovery may take longer and may be incomplete.

17.10 Radial Nerve Compression at the Elbow

Radial tunnel syndrome is often confused and thought to be tennis elbow (lateral epicondylitis). One of the more difficult diagnoses to make in the upper extremity is distinguishing between radial tunnel syndrome and lateral epicondylitis.

The radial tunnel syndrome results from dynamic compression of the posterior interosseus nerve in its course from the anterior capsule of the elbow joint proximally to the arcade of Frohse distally.

Symptoms include deep, dull proximal dorsal forearm ache, often with distal radiation. The pain is often described as a cramp. Night pain is common. Sensory loss over the dorsoradial aspect of the second metacarpal head suggests radial sensory branch involvement. Motor findings are usually absent. Symptoms are aggravated by resisted supination and extension, resisted extension in the metacarpophalangeal joint of the long finger with the wrist extended, and repetitive forearm pronation with the wrist flexed. EMG/NCS is not helpful in confirming the diagnosis but may be useful in identifying coexisting pathology. Injections into the lateral epicondylar area can sometimes help differentiate radial tunnel syndrome from lateral epicondylitis. Conservative treatment is attempted in most cases. Efforts should be made to modify patient activity to avoid provocative positioning of the arm. Ergonomic evaluation should be completed to modify the offending task or job. Task that requires elbow extension, forearm pronation, and wrist flexion repetitively or for long periods of time contributes to the development of radial tunnel syndrome.

Initial treatment should include rest, stretching, and splinting. Surgical intervention may be considered if the symptoms are not relieved by rest, activity modification, nonsteroidal anti-inflammatory medication, or a corticosteroid injection. Before considering surgery, precise localization of the pain to the radial tunnel must be confirmed.

17.11 Future of Elbow Arthroscopy

Roger P. van Riet

Despite the obvious risk of complications, elbow arthroscopy has become a common procedure. It can be performed safely with low risk of complications [33–35]. However complications, such as permanent nerve injury, are probably underreported [36–40], as larger series have always been published by experts in the field. The proximity of neurovascular structures may limit the extent of what will be possible with elbow arthroscopy in the future.

Common indications include removal of loose bodies, debridement and drilling of OCD lesions, synovectomy, capsulectomy, removal of osteophytes, and the treatment of lateral epicondylitis [41].

Less common and sometimes challenging procedures include arthroscopy for the treatment of intra-articular fractures [42], ulnar nerve release [32, 43, 44], bursectomy [45], and ligament [46] and tendon repair [47]. Many of these have been described years ago, but should still be included in the future of elbow arthroscopy.

17.12 Biceps Endoscopy

Biceps endoscopy can be used for partial or full tendon ruptures. The greatest advantage lies in partial tendon ruptures as this technique allows for the biceps insertion to be evaluated atraumatically with an enlarged view, which is not possible with an open technique. The decision to debride, repair, or reconstruct can be made on the basis of the endoscopic view and can be performed safely at the same time, with the use of retractors. Care should always be taken to avoid injury to the anterior neurovascular structures of the antecubital space. A potential specific disadvantage is excessive swelling of the forearm, due to the irrigation fluid that is used.

17.13 Lateral Collateral Ligament Repair or Imbrication

A lateral collateral ligament reconstruction requires a large incision and complications, such as elbow stiffness, are not uncommon. In fact, most patients will loose some degree of their motion [48]. An arthroscopic technique will allow the surgeon to evaluate the entire intra-articular joint space and to address any other intra-articular pathology at the same time, without the need for a larger approach or additional incisions. The arthroscopic technique can be challenging due to difficulty in precisely locating the position of anchors or bone tunnels, but a simplified technique has been shown to have excellent results [49].

17.14 Trauma

Intra-articular fractures are amendable to arthroscopically assisted or all arthroscopic reduction and fixation. Arthroscopic treatment of radial head fractures [50], capitellar shear fractures, and trochlea fractures [42, 51, 52] have all been reported, but arthroscopy is particularly helpful in the treatment of coronoid fractures. Arthroscopic reduction and screw placement can be done very precisely, without the need for a medial incision, therefore decreasing the morbidity that is common with open reduction and internal fixation of coronoid fractures.

A thorough understanding of the anatomy of the elbow is essential in order to forward the field. Besides this, elbow arthroscopy requires a specific skill that will only be acquired with experience. Patients always need to be informed of the possible complications before surgery is performed. When a surgeon is at the beginning of the learning curve, the patients also need to be informed that arthroscopy is a means to an end and not a goal as such. Although this is hardly ever necessary, if arthroscopy cannot be performed safely, a conversion to an open procedure should be contemplated. Only if these circumstances are met, the surgeon will be able to perform more advanced procedures and decrease the chance of complications.

The future of elbow arthroscopy therefore lies in two fields. Firstly, common procedures need to be simplified and standardized, so that they can be done safely, even in less experienced hands. Simple tricks, such as positioning of the patient, portal placement, and pressure of the irrigation, are crucial. The use of specialized and specific instrumentation greatly helps the surgeon. A "distal outflow only" cannula and retractors are examples of instruments that should be more available than they are now.

Besides optimizing existing procedures, the future will also hold an increase in indications. Especially soft tissue procedures and arthroscopy in elbow trauma hold great promise. Some advantages and disadvantages will be discussed for selected procedures.

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