Treatment of elbow stiffness

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Abstract

Elbow stiffness may develop due to various causes but most frequently it is secondary to a traumatic elbow lesion or heterotopic ossification common after head or spinal trauma. Both open and arthroscopic releases are effective. The arthroscopic release is reserved for intra-articular and capsular reasons, while open surgery can address either intra-articular or extra-articular causes. Different surgical approaches are used to treat elbow stiffness, depending on the exact anatomical location of the lesion that limits the range of movements. Complications are rare, the most frequent being incomplete resolution of stiffness. Nerve lesions are very rare. Most frequent is a partial ulnar nerve lesion, especially when nerve release or transposition is required. Conservative treatment with static or dynamic braces can be effective when there are no anatomical reasons for stiffness. Braces can be used as an adjunct to surgical treatment in the postoperative period in selected cases where no bony impingement is present.

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1 Introduction

Elbow is functionally an important joint; together with shoulder joint it allows a large range of motion. It provides freedom of movements required for everyday activities. Elbow stiffens more frequently than other joints due to its congruent shape and susceptibility of the joint capsule to trauma (1). Decreased motion may importantly weaken the arm function, therefore elbow stiffness is treated more frequently than that of other joints. The normal range of motion of the elbow is 0 °–145 ° (2). Some frequent activities such as the use of a mobile phone or keyboard require the flexion angle of up to 145 °.

The aim of this review paper is to present the management and types of treatment of elbow contracture, and is meant for family physicians, physiatrists, traumatologists, and orthopaedists.

2 Functional elbow anatomy

Elbow is a three-point hinge joint consisting of the ulnohumeral, radiohumeral, and proximal radioulnar articulation. The most important part is the ulnohumeral joint, consisting of trochlea of the humerus with a trochlear notch of the proximal ulna. It permits flexion and extension, and bears the greatest forces at these motions. Humeral capi-

tellum and fovea of the radial head form the radiohumeral joint without playing an important role in the joint strength, but together with ligaments it provides lateral stability. Together with the distal radioulnar joint the proximal radioulnar joint allows for rotation of the forearm. The coronoid process and olecranon on the distal ulna are the main stabilisers of the elbow in the sagittal plane. In this plane, the joint surface of the humerus bends for about 30 ° anteriorly, whereas in the frontal plane it bends for about 6 ° laterally into the valgus which is called the carrying angle.

On the medial side of the elbow there is the ulnar collateral ligament composed of the anterior, the posterior and the transverse bundle. The anterior bundle is the most important since it provides the valgus stability of the elbow. The lateral collateral ligament is located on the side of the radius. One bundle links the distal humerus with the lateral part of the proximal ulna, whereas the anterior bundle continues into the annular ligament which is the main stabiliser of the proximal radioulnar joint.

Functionally, the elbow is significantly weakened when the flexion falls below 120 °, when the range of forearm rotation is less than 45 ° or when the complete extension is decreased by over 30 °. Functionally, flexion is more important than extension. Everyday activities require the motion range of 30 °–130 °. Decreased flexion and rotation in the elbow significantly reduce everyday activities such as precise manual tasks, hand contact with the face and personal hygiene. The loss of elbow extension is often unpleasant since personal hygiene cannot be properly managed. Complete loss of supination is worse than pronation deficit as this can be substituted by the motion of the shoulder joint.

3 Pathogenesis of contracture

The causes of elbow stiffness are variable. In up to 20 % of cases it occurs as a complication of trauma (2), mainly after dislocation and fracture, as well as after head and/or spinal cord injury (3), in massive burns (4), and after elbow surgery (5). Simultaneous injury of the head and elbow leads to the development of heterotopic ossifications in 80 % of patients (6). Further important causes of contracture are arthrosis, systemic inflammatory diseases, congenital malformations, diseases of the synovial membrane, tendons and muscles, and long-term immobilisation.

The causes of decreased elbow motion can be intra-articular or intrinsic, extra-articular or extrinsic and mixed. Intrinsic causes include effusion, osteophytes, loose bodies, adhesions, non-congruent articular surface, and inflammatory granulomas in rheumatic diseases. Intrinsic contracture is most often secondary to adhesion formation within the joint, cartilage loss or stripping from non-vascularised particles after a comminuted fracture and post-traumatic joint deformation.

Extrinsic causes include ectopic ossifications, compression, or impingement due to incorrectly healed fractures, pseudoarthrosis, congenital deformations, contractures of the soft tissues, and contractures due to nerve compression, mainly the ulnar nerve.

Contractures of collateral ligaments and the capsule may be pathophysiologically explained by accelerated myofibroblast formation around the joint (7,8), scarring and fibrosis of the articular capsule. Histologically, the contracted tissue differs from the normal one (9). Contractures of collateral ligaments are clinically common because they may

Figure 1: Proximal radioulnar synostosis with fixed contraction of pronation and supination and limited flexion extension after injury.

ossify after trauma, but they may also occur after excessive passive stretching of the elbow or after long-term immobilisation of the joint in the retracted position (5,10).

Heterotopic ossification is a pathological formation; small amount of bone develops within the soft tissue at the site where the bone tissue is usually not present. Recently it has been found that after head trauma, peripheral nerves secrete cytokines that stimulate a new bone formation, most frequently in the muscles, which explains the common occurrence of heterotopic ossifications around the elbow (11).

4 Diagnosis

The decision on surgical or conservative treatment of elbow stiffness is based on patient history and clinical examination. The examination should involve also neighbouring joints, cervical backbone, and neurologic status of the upper extremity. Special care should be taken of a potential entrapment of the ulnar nerve. In addition to the passive and active range of motion, joint stability should be verified. Firm and painless endpoints indicate a bony obstacle (Figure 1), whereas elastic endpoints indicate the cause for contracture to be in the soft tissue. It is important to evaluate the skin condition if a systemic disease is suspected. Beside the standard anterior, posterior, and lateral x-ray scans the main diagnostic examination is computed tomography with 3-D reconstructed images (CT 3D) to obtain a precise display of mechanical obstacles and simulate joint motion. Magnetic resonance imaging (MRI) can be performed for better soft tissue visualisation, if needed. In cases with high suspicion of intraarticular bodies, arthrography is mandatory.

4.1 Classifications

Various classifications of elbow stiffness are used, the most frequently used being that of Kay ranking the stiffness by the cause; more comprehensive is Morrey's classification based on anatomical involvement and the cause of stiffness which can be intrinsic, extrinsic or mixed (12).

5 Treatment

Many patients suffer from elbow stiffness, but only a few have range of motion outside the functional range. In these few, a demanding treatment can

Type 1	Contracture of soft tissues
Type 2	Contracture of soft tissues with ossifications
Type 3	Undisplaced articular fracture with soft tissue contracture
Type 4	Displaced intra-articular fracture and soft tissue contracture
Type 5	Post-traumatic ossification

Table 1: Kay's classification of elbow stiffness by the cause of limited motion.

significantly increase the elbow activity. The decision on surgery is easier when it is accompanied by pain and/or signs of the entrapment of the ulnar nerve or motor branch of the radial nerve. As elbow stiffness requires up to one year after injury to improve, it is reasonable to wait with surgery for a while in these cases (7,13-15). Prolonged waiting, however, will substantially decrease a successful outcome of surgery (12).

5.1 Conservative treatment

Elbow braces can be used independently in post-surgical rehabilitation, or when the cause of contracture is not in the bones (13). The use of braces after surgery may increase preoperative range of motion for more than 45 °. Without surgery, using with braces only, we can expect to gain up to 30–40 ° at most (10).

There are static and dynamic braces. With static braces the allowed range of motion is being gradually increased, whereas dynamic braces constantly gently extend the contracted tissues. Both types of braces are equally efficient as they can increase the range of motion for 30–40 ° (10). Physical therapy with intense passive extension is not recommended as it may cause inflammation of the capsule or, sometimes, ossification of the lateral collateral ligaments which in response decreases the range of motion. Conservative treatment requires a close collaboration of the physiatrist with the surgeon.

5.2 Surgical treatment

Elbow surgery is always a technically demanding procedure because of numerous surrounding nerves and blood vessels. Topography of the elbow joint is diverse, therefore even a minimal bony deformity can importantly reduce the range of motion. Before surgery it should be clarified whether the impaired range of motion is due to bony or soft tissue reasons. Precise morphologic analysis of obstacles is required to plan the appropriate surgical approach that enables the visibility of the area where the cause of the limited elbow motion is located (Figure 2). When the signs and symptoms of the ulnar nerve irritation are present or if preoperative flexion is less than 100 °, the nerve should be released intraoperatively. If not, in 15 % of cases the nerve function can deteriorate due to acute entrapment in the elbow tunnel in (16).

5.2.1 Arthroscopic treatment

Arthroscopy of the elbow resolves elbow contracture in many cases. The advantages are in minimal invasiveness of the procedure, minimal blood loss, less pain after surgery and quicker rehabilitation. The surgery is technically demanding, its main danger lies in nerve damage which is more frequent than in open surgery. The main disadvantage of arthroscopy is a limited access to extrinsic structures. The indications for arthroscopic surgery of the elbow are intrinsic or capsular causes of stiffness. Heterotopic ossification, contractures with extrinsic joint adhesions, limited pronation and supination as well as severe arthrosis are contraindications for arthroscopy.

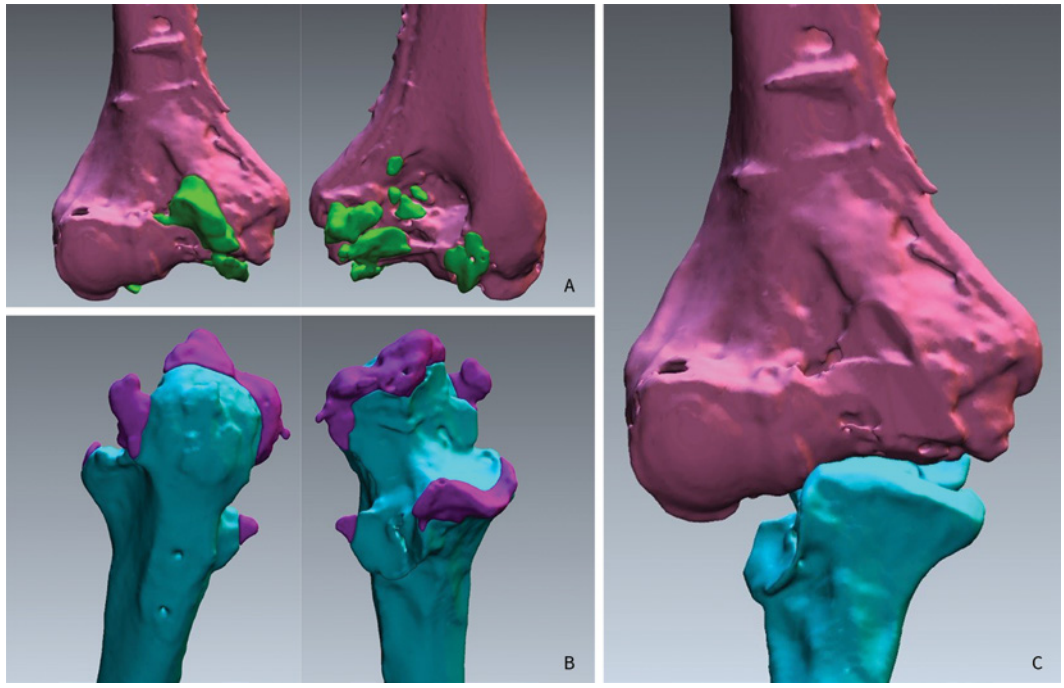

Figure 2: Preoperative planning. Computed analysis of topography of elbow stiffness. After simulation of flexion and extension, areas with osseous obstacles limiting the range of motion are marked. A – anterior and posterior surface of the distal humerus, osseous obstacles are marked green. B – anterior and posterior surface of the proximal ulna, osseous obstacles to the range of motion are marked violet. C – condition after virtual removal of osseous obstacles to motion.

Studies have shown great efficacy of arthroscopic surgical treatment. Analysing a big cohort group, Pederzini (17) found the range of motion in posttraumatic stiffness to be increased by 33 ° and in stiffness due to degeneration by 13 °. Wu has reported a mean increase in the range of motion by 65.9 ° in 34 patients (18). There are several other studies reporting similar results with the mean increase in the range of motion by 40 °. In most cases the motion regained by surgery does not decrease with time (19), however, a greater range of motion is achieved in the patients with smaller range of motion prior to surgery (20).

We perform about 10 arthroscopic surgeries of the elbow yearly in our institution.

5.2.2 Open surgical treatment

Open surgical treatment is usually associated with an additional procedure such as a decompression or transposition of ulnar nerve, interpositional arthroplasty or transposition of the anconeus muscle. The most important is the release and removal of the anterior and posterior capsule, tenotomy of the brachialis muscle or its release from the distal third of the humerus, removal of all osteophytes, and intrinsic or extrinsic osteotomy and removal of bony particles to improve joint congruency in some cases after poorly healed fractures. When the range of motion of the elbow is less than 100 °, it is necessary to release the posterior bundle of the medial collateral ligament (16), which is the main stabiliser in flexion and gradually shrinks in extension. It is located at the bottom of

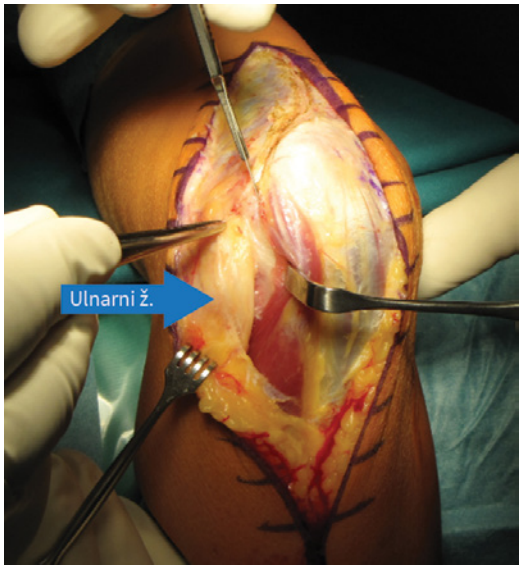

Figure 3: Universal posterior approach allows access at 270 ° of the elbow range.

the elbow canal under the ulnar nerve, which should in this case be released. In surgeries aiming at gaining maximum flexion the release of the triceps from the distal part of the humerus is also important.

Different surgical approaches can be used depending on the location of the obstacles. To maintain elbow stability it is of most importance that the lateral collateral ligament and the anterior bundle of the medial collateral ligament are preserved. Universal posterior approach permits best visibility as it allows access to the medial and lateral side of the elbow (Figure 3). Lateral and medial approaches are used when the pathology is located on the lateral and/or medial side of the elbow. Medial approach is best for the procedures on the coronoid process. Anterior or Henry's approach is rarely used, mostly when it is necessary to also release the radial nerve or its branches, and with the changes in proximal radioulnar joint. For surgical procedures around the radial head, the lateral approach in the Kocher interval between the anconeus muscle and the extensor carpi ulnaris is used. This approach also permits the transposition of the anconeus muscle, if needed, (Figure 4) or the exchange of the radial head with the prosthesis. When deciding on the type of surgical approach it is always necessary to consider potential adhesions from previous procedures. Open surgery is most effective in removal of extrinsic ossifications (10,21) that only rarely reoccur after surgery.

The most frequently used open surgical approach for improvement of elbow stiffness is the lateral approach to the joint with preservation of the lateral collateral ligaments and with release of the anterior and posterior joint capsule, the so-called column procedure (22,23). This approach is developed between the humerus and the extensor carpis radialis longus up to the joint capsule where it continues distally between the short and the long wrist extensor. Posteriorly it runs between the lateral head of the triceps and the humerus, and continues distally in front of the anconeus muscle.

Radial head can be replaced with prosthesis after severe trauma, deformation, or radiohumeral arthrosis (24). If the elbow is stable without radial head removal, the disorder can be treated with the anconeus muscle transposition (Figure 4). Radial head replacement with prosthesis is justified only in unstable elbow with severe disorder of the anterior bundle of the medial collateral ligament and valgus instability.

Open surgeries of the elbow are very efficient. Most studies report a substantial improvement in the range of motion and joint function (26) with general increase from 20 ° to 90 ° (25-27); additional interventions further increase the range of motion (26). It should be noted that in severely stiff elbow, the entire deficit cannot be restored with only one surgical procedure. Severe stiffness

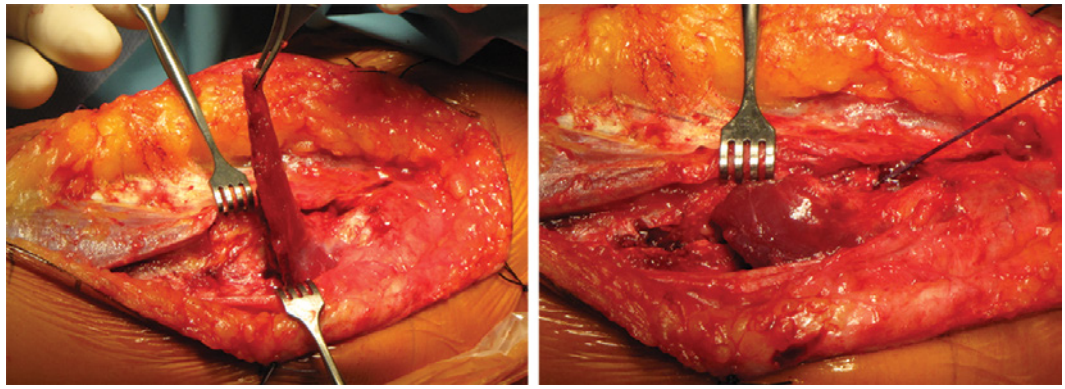

Figure 4: Preparation of the anconeus muscle and its transposition into the radiocapitelar compartment.

always requires several contracture release surgeries to provide long-term efficacy (27,28). In posttraumatic stiffness the outcome of treatment is better if surgery is performed not later than within a year after the injury (14).

External fixator is only rarely used. It is important, however, in surgeries in which the release of contractures and reconstruction of collateral ligaments are done simultaneously. It allows postoperative rehabilitation without tension on the reconstructed ligaments or bones. It also plays an important role after surgical release of contractures when stretching is required, and in patients after interpositional arthroplasty to permit motion while the ligaments are still healing (29).

In our institution 10–20 open arthrolysis are performed yearly.

5.3 Complications

The most frequent complication of surgical treatment of elbow stiffness is it recurrence. Morrey found this to be the case in 26 % of patients – in these an additional arthrolysis had to be performed (12). A similar proportion has been reported in other studies (15,18). Nerve injuries are rare. The surgeon should consider the fact that after the release of contractures the ulnar nerve can be entrapped in the ulnar canal with flexion, especially if it is surrounded by an ectopic bone, since the flexion diminishes the canal diameter. If the preoperative flexion is less than 90 °, it is necessary to first release or even relocate the ulnar nerve before starting the final arthrolysis (30). Up to 10 % of patients experience a mildly injured nerve after surgery, but in most cases the symptoms are transitory (31).

6 Conclusion

Elbow stiffness is frequent even after minor injuries. A full range of motion is absolutely needed for everyday activities. The outcomes of surgical treatment are good with few complications. When there are no mechanical bony obstacles, conservative treatment may be applied. Surgery is necessary when limited motion significantly hinders common daily activities. In severe elbow stiffness it is recommend to first release the ulnar nerve and then proceed with releasing other parts to avoid nerve compression with the newly acquired flexion.

In Slovenia, the above-mentioned surgical procedures are performed by

orthopaedists and traumatologists in tertiary centres, and by orthopaedists in specialised orthopaedic centres where patients are referred for subsequent management.

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