

POST-TRAUMATIC STIFFNESS OF THE ELBOW

Geraldo Motta Filho¹, Marcus Vinícius Galvão²

ABSTRACT

Elbow stiffness is a common problem after joint trauma, causing functional impairment of the upper limb. The severity of the dysfunction depends on the nature of the initial trauma and the treatment used. Appropriate clinical evaluation and complementary examinations are essential for therapeutic planning. Several surgical techniques are now available and the recommendation must be made in accordance with patient characteristics, degree of joint limitation and the surgeon's skill. Joint incongruence and degeneration have negative effects on the prognosis, but heterotrophic ossification alone has been correlated with a favorable surgical prognosis.

Keywords – Elbow/injuries; Elbow/surgery; Wounds and injuries

INTRODUCTION

Elbow stiffness is a common problem after joint trauma and can cause substantial impairment of upper limb function⁽¹⁾. A variety of clinical situations can lead to loss of elbow movement. Success in treating this depends on adequate clinical evaluation to determine the anatomical changes involved in the pathological process, thus allowing the surgeon to intervene appropriately⁽²⁾.

Etiology

The propensity of the elbow joint to develop stiffness after trauma is recognized by orthopedists, and can occur even after mild trauma. The main factors that expose the elbow joint to this complication are the high degree of congruence, the complexity of the joint surfaces and the high tissue sensitivity to trauma, especially in the joint capsule. In addition to the direct relationship between elbow joint stiffness and trauma, poor rehabilitation and unnecessary prolonged immobilization, there are also factors relating to loss of range of motion in which orthopedists can have a direct influence.

Patient involvement in the treatment has also been cited as a causal factor in elbow stiffness, although many authors have taken the view that this is not a cause of great relevance.

Other causes that have been described include burns and heterotopic ossification, frequently consequent to cranial trauma⁽³⁾.

Pathology

Experimental laboratory-based studies have investigated the biochemical and biological alterations that occur in periarticular tissues in response to trauma. Cohen *et al*⁽⁴⁾ reported that stiff elbows presented a thin capsule with a disorganized collagen matrix, increased inflammatory cytokine levels and fibroblastic infiltration, thus characterizing a fibrotic and inflammatory condition. Other authors have documented increases in the formation of cross-linked collagen, associated with decreased proteoglycan content and water in joints presenting contracture, along with changes to the regulation of growth factor beta 1 (TGFβ). Another important concept that has emerged from more recent investigations suggests that the response to trauma of the same intensity is individualized^(5,6).

1 – Director-General of the National Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro.

2 – Physician at the Surgical Center for Shoulders and Elbows, National Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro.

Work performed at the National Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro.

Rua Washington Luís 61, Centro, 20232-070 Rio de Janeiro, RJ.

Correspondence: Marcus Vinícius Galvão, Av. Afrânio de Melo Franco 141, sala 511, Leblon, 22430-060 Rio de Janeiro, RJ. E-mail: mvgambaral@terra.com.br

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Clinical condition

The loss of range of motion depends on the nature of the lesion and its treatment. Loss of extension is more common, but loss of flexion is not uncommon and neither is loss of forearm rotation⁽¹⁾. The combination of loss of extension associated with loss of forearm supination represents a severe limitation on certain activities of daily living⁽²⁾.

In patients who present simple dislocation of the elbow, the loss of movement is purely intrinsic and related to the capsule-ligament contracture and muscle damage. Patients with fractures or dislocation present limitation of elbow movements either because of the nature of the injury or because of the postoperative rehabilitation. In some cases, joint instability, joint incongruence or subluxation, particularly humerus-ulnar subluxation, may be associated with limitation of the range of motion^(1,7).

Symptoms of pain are not usually present, except in cases of joint degeneration or with extreme movements. On the other hand, pain while at rest may suggest the presence of infection, especially in individuals who have already undergone previous surgery⁽¹⁾. In these cases, assays on C-reactive protein concentration and erythrocyte sedimentation rate will be required.

One of the most important clinical parameters for indicating surgical treatment is the presence of symptoms relating to the ulnar nerve. Signs of neuropathy indicate that there is a need for neurolysis and anterior transposition. The neuropathic symptoms may sometimes be subclinical and, in such cases, the examiner should seek to identify them by means of provocative tests⁽¹⁻³⁾.

Examinations under anesthesia are a controversial matter, with regard to their indications and efficacy. Morrey recommended such procedures for patients who, during the postoperative period, did not respond to rehabilitation, even with the use of joint immobilizers, physiotherapy or continuous joint mobilization apparatus (Amac)⁽¹⁾ (Figure 1).

CLASSIFICATION

Morrey⁽¹⁾ classified joint stiffness into two main groups based on etiology and anatomical location of the contracture. Extrinsic stiffness was limited to soft tissues or extra-articular processes. Intrinsic stiffness related to joint processes such as defective consolidation and degenerative joint diseases. Intrinsic contracture often presents an associated extrinsic component and is thus considered to be mixed contracture⁽²⁾.



Figure 1 – Patient using articulated immobilizer with a device providing passive gains of range of motion (flexion)

Kay⁽⁸⁾ described another classification for elbow stiffness, based on the components involved in the process. In type I, there would only be isolated contracture of soft tissues. In type II, there would be contracture of soft tissues associated with heterotopic ossification. In type III, there would be contracture of soft tissues associated with a consolidated joint fracture, without dislocation. In type IV, the contracture of soft tissues would be associated with defective consolidation of the joint fracture. In type V, a cross-joint bone bar would be present.

Complementary examinations

In most cases, simple radiographs of the elbow in anteroposterior and lateral views are sufficient. In cases of contracture greater than 30°, the anteroposterior image presents distortions and, in these cases, oblique images are the appropriate choice. In addition to assessing joint deformities, the joint space, quality of the joint cartilage, joint congruence, presence of heterotopic ossifications and location of osteosynthesis material should be evaluated⁽³⁾.

Computed tomography should be requested whenever there is associated joint impairment, which is more severe when the humerus-ulnar joint is affected^(2,3) (Figure 2).

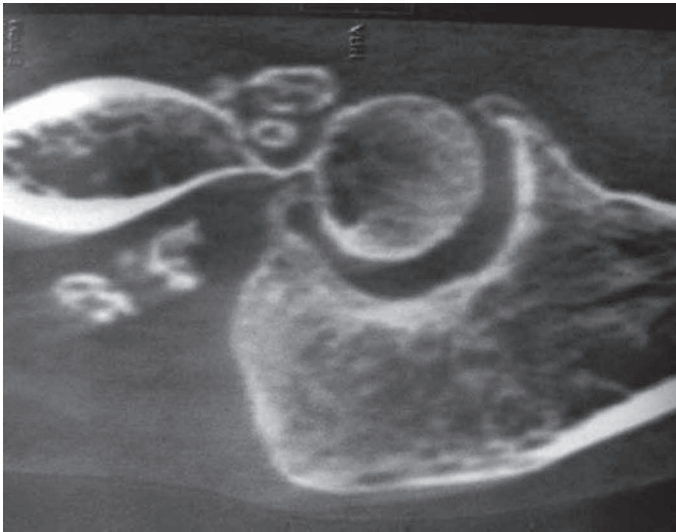


Figure 2 – Computed tomography image of sagittal section through an elbow, showing the presence of intra-articular free bodies with ulnar-humeral joint degeneration

Electroneuromyography is necessary when there is a clinical suspicion of neuropathy of the ulnar nerve⁽³⁾.

On the other hand, magnetic resonance imaging would be unusual for the propaedeutics of this pathological condition⁽⁹⁾.

Surgical indications

The functional arc of the elbow is defined as a range of flexion-extension motion of 30° to 130° and pronosupination of 50° to -50°⁽¹⁰⁾. On the other hand, loss of 50% of the mobility of the elbow represents a functional loss of 80% of limb function. Likewise, contracture of flexion greater than 45° gives rise to severe dysfunction regarding the capacity to position the hand in space.

In summary, surgical intervention will be indicated for patients who present elbow range of motion of less than 100° of flexion-extension or 50° to -50° of pronosupination. However, the indication needs to be individualized, according to each patient's functional needs and the surgeon's skills.

Patients with elbow joint stiffness, independent of etiology, who present clinical signs of neuropathy of the ulnar nerve, should be treated surgically with neurolysis and nerve transposition, together with elbow joint release. Motor impairment is an absolute surgical indication^(1,2).

The degree of joint impairment is the most important prognostic factor and is the variable that guides the therapeutic method and results, which will go from joint release to interposition arthroplasty⁽¹⁾.

TREATMENT

The choice of technique to be used depends on the etiology of the joint stiffness and the surgeon's experience. Several treatment methods have been described in the specialized literature, but with inconsistent results.

Non-surgical treatment

The non-surgical methods for managing post-traumatic elbow stiffness consist of using joint immobilizers and physiotherapy. Conservative treatment up to the fourth month is not unusual, particularly in cases of stiffness that are not associated with joint deformity or heterotopic ossification. Although some authors have presented extension gains of up to 30° through this type of treatment, these results have not been reproduced by most authors and thus are exceptional. Manipulation under anesthesia in cases of chronic contracture not only does not present good results but also predisposes towards the formation of hematoma, pain, additional stiffness and heterotopic ossification^(10,11).

Surgical treatment

Surgical treatment for stable stiff elbows can be carried out as an open procedure or by means of a videoarthroscopic technique. Open surgery is preferable in cases in which there is a high degree of soft-tissue retraction, since arthroscopic surgery is technically difficult in such cases, and when there is an indication for resection of heterotopic ossification, joint reconstruction or interposition arthroplasty. In the presence of post-traumatic joint deformity, corrective osteotomy in association with arthrolysis will be indicated. Total elbow arthroplasty is an option for elderly individuals who place low demand on the joint and present functional limitation and joint degeneration⁽¹⁾.

The current orthopedic literature records similar functional results in groups undergoing open and arthroscopic joint release, but there are no comparative studies between the techniques, probably because of the difficulty in identifying homogenous groups that would make it possible to conduct this type of evaluation⁽¹²⁻¹⁴⁾.

Most series have not recommended performing arthrolysis on children and adolescents (either as open or as arthroscopic procedures), because of the quality of the results obtained among this group of patients⁽¹⁵⁾. However, from more recent series, it has been confirmed that the results from patients without incongruence or

joint degeneration are similar to the results from the adult population⁽¹⁶⁾.

Thus, independent of the technique, for the surgical treatment to be efficient, the cause of the stiffness needs to be correctly identified, which will enable specific and sequential surgical planning.

Open surgical procedure

Care in dealing with the periarticular soft tissues should be the main concern when using the open surgical technique, especially among patients who have undergone previous surgery, because of the risk of postoperative complications.

The complication rate in open surgical release procedures is around 10 to 30%, depending on the nature of existing abnormalities and the treatment used. The complications that have been described include, in order of frequency, complications of the skin, infections, neuropathy of the ulnar nerve, heterotopic ossification and pain^(1,2,12).

In the following, the various options for surgical access that are used for treating post-traumatic elbow stiffness are discussed.

Anterior access

Urbaniak *et al*⁽¹⁷⁾ popularized the anterior access to the elbow, especially for treating loss of elbow extension. They proposed only to perform transverse anterior capsulotomy, in patients with contracture under flexion alone. Other authors performed anterior capsulectomy in association with brachial tenotomy, through this access. The great limitation of this access is that it does not act on the limitation of flexion and requires identification and protection of the neurovascular structures. Nevertheless, this access route allows direct exposure of the anterior capsule and identification of heterotypical ossifications within this topography^(1,17).

Medial access

The main indication for medial access is in patients with signs of ulnar nerve impairment. This access route not only allows treatment of neurological abnormalities of the ulnar, but also makes it possible to approach the entire anterior capsule and posterior recess of the joint. This exposure is limited and inefficient when the disease affects the humerus-radial joint and the lateral structures. The anatomical repairs made through this access are to the medial epicondyle, ulnar nerve and medial intermuscular septum of the arm. The key to good exposure

is separation and elevation of the round pronator of the flexor mass, thereby enabling a full view of the anterior capsule. To approach the posterior face of the joint, the ulnar nerve is released and the medial portion of the triceps is detached, thus making it possible to identify the osteophytes^(1,2).

Limited lateral access: the columnar procedure

The columnar procedure described by Mansat and Morrey⁽¹⁸⁾ makes it possible to approach the joint anteriorly and posteriorly. The anterior region of the joint is identified in the space between the distal fibers of the brachioradial muscle and the long radial extensor of the carpus. In this manner, it is possible to resect the lateral two thirds of the anterior capsule and make an incision in the medial third. When the head of the radius is involved and there is an indication for its resection, a lateral access will be indicated. Osteophytes from the coronoid process and the anterior region of the distal extremity of the humerus can then be resected. Next, by means of elevation of the lateral portion of the triceps, the posterior capsule, posterior osteophytes, fibrous tissue filling the olecranon fossa and heterotopic bone are exposed, thus enabling adequate resection.

The commonest complication from this approach is paresthesia in the region of the ulnar nerve, either because of aggressively accessing the medial structures, or because of placement of retractors in this region, or because of the postoperative gain in movement, especially flexion, which exposes the nerve to greater tension and gives rise to a subclinical symptom of neuropathy^(18,19).

Extensive posterior access

This access route is indicated in severe cases, when medial and lateral exposure are needed, or in cases in which the joint surface is affected⁽¹⁾. A posterior access is made in the skin, and the ulnar nerve is the first structure to be identified and released from its bed. Next, a lateral skin flap is dissected and the extensor mass of the anterior capsule is raised, thus identifying and protecting the lateral ligament complex. Following this, a medial flap is detached and the previously identified ulnar nerve should be protected. In cases in which flexion limitations persist after lateral release, resection of the posterior band of the medial collateral ligament is indicated since this is an important restrictor on flexion from 110° onwards. Through this access, resection of

the medial capsule can also be performed under direct viewing, along with possible resection of heterotopic ossification⁽²⁰⁾ (Figure 3).

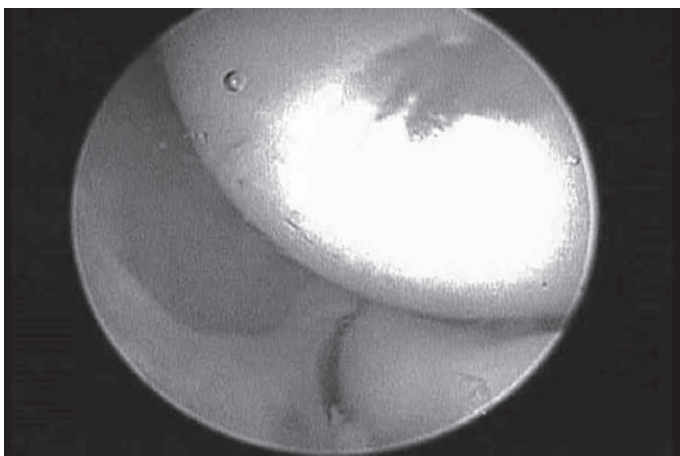


Figure 3 – Arthroscopic image of an elbow showing the posterolateral recess of the joint, thus enabling access to the head of the radius

Arthroscopic procedure

Surgery using the videoarthroscopic technique for treating post-traumatic stiff elbow has become current practice, with consistent results in the orthopedic literature. However, this is a technically complex procedure for surgeons. It should preferably be indicated in cases of less severe contracture, with loss of less than 15° of extension, and when free intra-articular bodies are present^(13,14,21,22).

What makes the procedure complex is the proximity of the neurovascular structures to the periarti-

cular tissues and arthroscopic ports, along with the reduced capsule volume, which may be by up to 6 cm³, which makes it difficult to achieve hydric distension of the joint, thereby increasing the risk of injuring prime structures⁽²³⁾.

In this technique, the initial step is to identify and resect all of the free bodies. Following this, the osteophytes and heterotopic bones are resected, while fully preserving the capsule structure. Morrey⁽¹⁾ preferentially viewed the site through the anteromedial port and carried out the bone resection through the anterolateral port. Capsule retractors, which were popularized by Kelly *et al*⁽²³⁾, are extremely useful at this moment. After carrying out the bone stage described above, the anterior capsule is released from proximal to distal, always laterally to the coronoid process, with viewing through the medial port. Aspiration should not be used: only gravitational outflow should be used. The radial nerve is at risk at this moment, since it is only one to two millimeters from the joint capsule. The risk of injury is minimized when humeral capsulectomy is performed, while avoiding working on the capsule tissue that is in the region of the head of the radius. Next, central posterior and posterolateral ports are constructed and the posterior approach is carried out in the same sequence⁽²¹⁻²³⁾.

Currently, several case series have presented satisfactory results with complication rates equivalent to the arthrolyses performed using the open technique^(13,14,23) (Figure 4, A, B, C and D).



Figure 4 – Anteroposterior (A) and lateral (B) radiographic views of a patient with joint ankylosis who underwent semi-constricted total elbow arthroplasty (C) and (D)

Interposition arthroplasty

Interposition arthroplasty in association with arthrolysis should be considered for young patients who present mixed contracture with radiographic signs of degeneration of the joint surfaces of more than 50%, or who require remodeling of joint surfaces because of defective consolidation. The fascia lata is the tissue most commonly used in this procedure, and it should be carefully sutured all around the joint surface that was compromised by the transosseous suture. An approach towards the lateral compartment of the elbow, with release of the lateral ligament complex, is possible through wide exposure of the joint: a fulcrum with lateral opening is made over the medial collateral ligament, which needs to be entire. Resection of the head of the radius should be avoided, since this increases the risk of postoperative instability. The use of an external articulated fixator for four to six weeks is recommended: this provides joint relaxation and stability, and allows early mobilization⁽²⁰⁾.

Total elbow arthroplasty

This is indicated for elderly patients (over the age of 65 years) who present severe functional limitations of the elbow together with degeneration of the joint surfaces.

In the orthopedic literature, there is little information about this procedure. Mansat and Morrey⁽²⁴⁾ reported

that 76% of their results were satisfactory, although 50% presented complications, with two cases of deep infection. In addition, according to Mansat and Morrey⁽²⁴⁾ and Blaine *et al*⁽²⁵⁾, total elbow arthroplasty in patients who previously underwent interposition arthroplasty presented results and complication rates that were comparable to those from series of revision of total elbow arthroplasty (Figure 5, A, B and C).

Heterotopic ossification

Heterotopic ossification is one of the factors relating to post-traumatic elbow stiffness.

There is no scientific proof to show that non-hormonal inflammatory medication and radiotherapy are effective for preventing heterotopic ossification in the elbow⁽²⁶⁾.

There are also no controlled studies on the use of indomethacin combined with modern methods for postoperative elbow mobilization. It is believed to be likely that the use of Amac and external articulated fixators would diminish the incidence of heterotopic ossification.

In any event, surgeons who regularly treat stiff elbow use low radiation doses, or three to six weeks of indomethacin, 75 mg per day, divided into three doses.

Hastings and Graham⁽²⁷⁾ proposed a classification for heterotopic ossification, into three types relating to the extent of ectopic bone formation (Figure 6, A and B).



Figure 5 – Radiographic images showing different types of heterotopic ossification according to Hasting's classification. (A) Type I, with isolated heterotopic ossification in soft tissues; (B) type IIA, with the presence of an incomplete bone bar; and (C) type IIB, with joint ankylosis

Most patients who present heterotopic ossification are candidates for surgical intervention. The ideal moment for resection will be defined by the presence of radiographic signs of maturity of the ossification and a minimum evolution time of four to six months^(28,29).

Bone scintigraphy has limited value for evaluating the maturity of ossification and is little used in clinical practice.

Heterotopic ossification has been considered to be a poor prognostic factor in relation to elbow joint stiffness⁽²⁶⁾. Recently, some authors have suggested that there is clinical evidence to show that an association between elbow stiffness and heterotopic ossification would present better postoperative clinical results^(28,29).

Postoperative period

The postoperative treatment for stiff elbow depends on its etiology and the type of surgical procedure used.

In cases in which release of the lateral ligament complex was necessary, or in cases of interposition arthroplasty, external fixators are useful since they provide protection for ligament and joint reconstructions, thereby enabling early joint mobilization, particularly during the first three weeks⁽¹⁾.

Another option is the use of Amac, which is not widely available within the Brazilian environment but allows passive joint mobilization with good results, always in association with continuous blocking of the brachial plexus during the first days, thus making the joint pain-free and enabling adequate mobilization^(1,3,25).

One form of rehabilitation that is more accessible is the use of joint immobilizers. These can be used with continuous or intermittent mobilization. The latter form is reserved for cases in which it is desired to focus on one specific movement, which could be either extension or flexion⁽³⁰⁾.

The value of physiotherapy is questionable and a matter of controversy in the orthopedic literature, since the potential aggression to the joint during the sessions causes pain and increases the inflammatory process, thus impeding recovery of the range of motion. This should be reserved for situations in which there is effective interaction between the surgeon and the therapist, such that the therapist is informed about the procedure carried out, the results and the expected limitations⁽¹⁾.

It should be emphasized that each patient requires an individualized approach using one or more of the techniques described.

CONCLUSION

Over the last 20 years, dramatic changes in the approach towards post-traumatic elbow stiffness have been documented. Better understanding of pathological abnormalities and joint biomechanics has made it possible to develop more appropriate surgical techniques. Nevertheless, the postoperative results depend on the disease extent, treatment used and surgeon's experience. We believe that better diagnosis and treatment of acute traumatic elbow injuries is still the best way to prevent this type of complication.



Figure 6 – Postoperative view following extensive open arthrolysis, with early elbow mobilization on an outpatient basis using an articulated external fixator (A) and (B)

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