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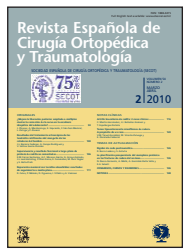

REVIEW ARTICLE

Elbow stiffness

R. Barco Laakso* and S. Antuña

Shoulder and Elbow Unit, Hospital La Paz, Madrid, Spain

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KEYWORDS
Elbow;
Stiffness;
Treatment;
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Abstract
Purpose: Loss of elbow mobility can result in a severe functional limitation. Its causes remain unclear and the degree of functional limitation may be variable. The advent of new therapeutic strategies and the introduction of arthroscopic techniques have rekindled interest in this pathology.
Materials and methods: A review of the literature is carried out in order to assist the reader in making decisions concerning this complicated disorder.
Conclusions: Arthroscopic techniques have heralded a reliable method for treating moderate elbow stiffness, a disorder that could entail a potential risk to local neovascular structures. Open capsulectomy has obtained good results and is capable of achieving ROM gains of 50 degrees in the majority of cases. Cases with an injured joint may be treated with interpositional arthroplasty or with an elbow prosthesis, depending on the patient's age and the severity of the damage.

PALABRAS CLAVE
Codo;
Rigidez;
Tratamiento;
Cirugía

Rigidez de codo postraumática

Resumen
Objetivo: La pérdida de movilidad del codo puede producir una grave limitación funcional. Las causas todavía no están claras y el grado de limitación funcional puede ser variable. La llegada de nuevas estrategias terapéuticas y la introducción de las técnicas artroscópicas han renovado el interés por esta afección.
Material y método: Se realiza una discusión de la bibliografía médica para guiar la toma de decisiones de este difícil problema.
Conclusiones: Las técnicas artroscópicas han introducido un método fiable para el tratamiento de la rigidez de codo moderada con el coste de un riesgo potencial de lesión de

*Corresponding author.
E-mail: raulbarcolaakso@gmail.com (R. Barco Laakso).

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las estructuras neurovasculares locales. La capsulectomía abierta ha demostrado buenos resultados y es capaz de conseguir una ganancia de 50° en la mayor parte de los casos. Los casos con lesión articular se pueden tratar con una artroplastia de interposición o con una prótesis de codo, dependiendo de la edad y del grado de daño articular.

Stiffness is a well-defined sequela following elbow trauma. The causes of this predisposition are unknown, and the functional limitation that results is variable, but the existence of effective surgical procedures has increased the ability of specialists to deal with this problem. The advent of arthroscopy has made progress in the treatment of these patients, although the potential for neurovascular complications and the learning curve have limited its expansion. Open capsulectomy provides good results and achieves a recuperation of over 50° mobility in the majority of cases. Patients with articular damage can be treated with interposition arthroplasty or with an elbow prosthesis, in accordance with the age of the patient and severity of the case.

Definition

Elbow stiffness is defined as a loss of arc of movement of the elbow following a trauma, degenerative changes, brain trauma, burns, or neuromuscular problems. Classically, these alterations produce 2 types of stiffness: extrinsic predominance and intrinsic predominance. In practice, cases of mixed stiffness are the most common (with extrinsic predominance).[1]

Stiffness with extrinsic predominance includes all those structures that can limit elbow mobility (joint capsule, heterotopic ossification, skin contractures, and marginal osteophytes) with integrity of the joint surface. Treatment will vary according to the cause of the patient's problem, which makes an understanding of all of the factors implicated a critical step for planning a given surgical procedure.

Based on a series of patient interviews, the arc of functional mobility was defined as between 30–130°. With this arc of mobility, patients were able to perform 90% of all their activities.[2] Normal elbow mobility, as defined by the American Academy of Orthopaedic Surgeons, ranges between 0 and 145°. A 50% reduction in elbow mobility can cause an 80% reduction in the functionality of the upper limb.[3] Each patient's individual needs must be evaluated before surgery, since some occupations have specific requirements (above all for complete extension).

Aetiopathogenesis

The reasons for predisposition to elbow stiffness are unknown, but several causes have been postulated, such as a highly congruent joint, the existence of 3 continuous joints within the same synovial joint cavity, and anatomical proximity to ligaments in the joint capsule and surrounding muscles. The nature of the joint capsule has been studied, showing a predisposition to biochemical and structural changes, even after minor trauma, that produces a thickening and loss of elasticity in the tissues that leads to a loss of movement in the elbow (fig. 1). In the joint capsules with stiffness, increases in collagen crosslinks and decreases in proteoglycan content and total water content have been shown.[4]

In the treatment of intra-articular fractures, the goal is to achieve a congruent joint and stable osteosynthesis that allows proceeding with an early mobility protocol. Non-adherence to these treatment principles can lead to an increase in the incidence of post-traumatic elbow stiffness. A prolonged immobilization period is another isolated aetiopathogenic factor that must be avoided when possible.

Indications

Those patients with a limited range of extension greater than 30° are candidates for surgery. Some patients with less than 30° extension and with pain upon stretching the elbow or that limits their professional or vocational activity can also be candidates for corrective surgery. The loss of flexion can limit daily hygienic activities and also must be considered as an indication for surgery. The treatment objective must be to reach a functional arc of movement free of pain.

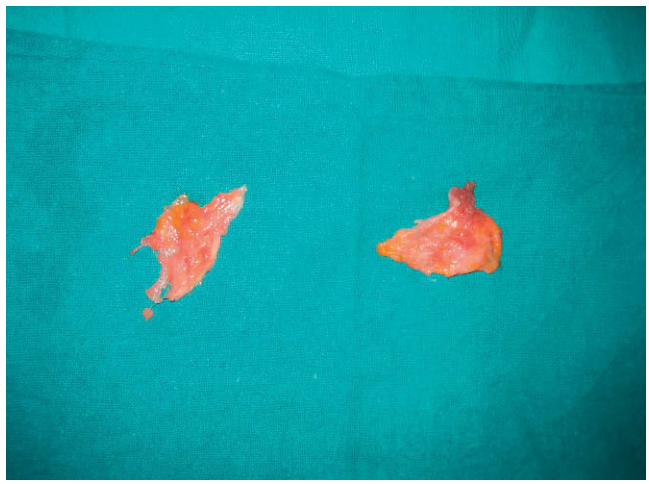

Figure 1 Anterior and posterior capsule following resection. Note the capsular thickening.

Table 1 Results of arthroscopic capsular release

Author (year)	No. patients	Procedure	Mean follow-up time (range)	Medial preoperative mobility (°)	Mean postoperative mobility (°)	Mean mobility improvement (°)	Results and complications
Byrd (1994)	5	Radiocapitellar debridement following radial head fractures	24 months (12–41)	41–124	30–138	44	Mobility and painful crepitus improved in all patients
Timmerman and Andrews (1994)	19	Debridement and manipulation	29 months (12–51)	29–123	11–134	29	80% of results were good or excellent 2 repeated arthroscopies
Kim et al (1995)	25	Removal of loose bodies, osteophyte excision, anterior capsulectomy, abrasion arthroplasty, and partial resection of the radial head	25 months (12–46)	21-113	14–130	24	92% satisfaction VAS improved from 2.8 to 4.6 Two transitory neuropraxias from the median nerve An instrumental break One reoperation for continued
Phillips and Strasburger (1998)	15	Removal of loose bodies, osteophyte excision, anterior capsulectomy (not in athletes –6 points) and posterior debridement stiffness		37.7–117.1 (80.1)	5.9–135.4 (130.2)		Pain improvement in all patients
Savoie et al (1999)	24	Debridement, partial olecranon and coronoid resection, and fenestration of the olecranon fossa	32 months (24–60)	40–90	8–139	81	Significant reduction of pain in all patients (VAS: 8.2-2.2) One heterotopic ossification One superficial infection
Kim and Shin (2000)	63	Removal of loose bodies, osteophyte excision, anterior capsulectomy, abrasion arthroplasty and posterior debridement	42.5 months	73	123	50	92% patient satisfaction. Symptom duration was less than one year and correlated with greater mobility improvement
Ball et al (2002)	14	Debridement, osteophyte resection, and anterior and posterior capsulectomy	One year minimum (12–29 months)	35–117	9–133	42	All patients were satisfied with results. Recuperation of extension is more predictable

Several possible surgical options exist for the treatment of these patients, including the use of less invasive therapeutic protocols, such as arthroscopy, as well as open surgical techniques. The choice of an arthroscopic technique or a conventional open surgery is based on individual aetiological factors and the experience of the surgeon. Independent of the surgical option used, achieving a congruent joint is a basic condition for determining the success of the procedure. Satisfactory results can be achieved with a simple capsulectomy for mild joint conditions, as long as the central articular axis is unscathed and the clinical evaluation shows acceptable joint congruency. When more advanced joint damage exists that is associated with stiffness, an interposition arthroplasty must be considered.

Contraindications

The patient must be compliant and dedicated, since the postoperative treatment and rehabilitation are essential for optimal results. Any patient that does not comply with these requirements should not be a candidate for surgery, since this is one of the factors implicated in obtaining inferior results in younger patients.[5]

Alternatives to surgical treatment-prevention

A central objective for elbow traumas is to reduce inflammation and oedema. In order to achieve this, the use of anti-inflammatory drugs, local application of cold, compressive bandages, and active exercises can be beneficial. It is necessary to go through a controlled physical therapy programme so that the patient learns to avoid episodes of muscular antagonism that limit mobility and induce pain. The use of splints has been the point of much debate in the treatment of these patients. Basically, two types of splints exist: static and dynamic splints. Currently, the preference of the majority of surgeons is for static splints, in which the patient controls the stretching of the tissues. In any case, it is important to prevent capsular damage (haemorrhages or partial tears) with the use of this type of treatment.[1,3]

Surgical treatment: capsulectomy

Arthroscopic treatment

Arthroscopic techniques have entailed a major advance in treatment of an important group of patients with post-traumatic and degenerative elbow stiffness. Most neurovascular complications that are produced during elbow arthroscopy are associated with techniques that include anterior arthroscopic capsulectomy, for which only those surgeons that are highly familiarized with arthroscopic elbow anatomy should perform this procedure. Nevertheless, existing results (table 1) confirm the efficacy of this technique.[6-12]

Surgical technique

The patient is placed in lateral lying position with the arm on a specially designed support for elbow arthroscopy. It is preferable to use general anaesthesia because it provides an adequate control of pain, a complete muscular relaxation during the procedure, and immediate postoperative exploration of the neurovascular state of the patient. A 4mm arthroscope with a 30° angle of vision is used with gravity-fed serum and low pump pressure (30–40 mmHg). Ischaemia is employed systematically, avoiding its prolonged use for more than 90 min. Otherwise, the ischaemia sleeve is lowered and replaced following a period of reperfusion. The joint must be distended with serum before inserting the arthroscope. The volume received in these cases can be less than 10 cc (normal: between 20–30 cc), since the distance from bones and neurovascular structures is lower than in other procedures and, as such, increases the risk of complications.

Control of the ulnar nerve during the procedure is essential, and in those cases with previous transposition of the ulnar nerve, an open surgery is required or, at the least, the approach must be over the ulnar nerve, identifying it before proceeding with the elbow arthroscopy. When preoperative flexion is at 100-110°, a transposition or decompression of the ulnar nerve is recommended. In any case, if the ulnar nerve is unstable following release or in cases where subjacent damage can compromise the integrity of the nerve, it must be transposed. A diagnostic arthroscopy is performed through the proximal anterior portals (anteromedial and anterolateral). The use of separators, as described by O'Driscoll,[13] facilitates intra-articular procedures and can significantly reduce the number of complications. Debridement of the intra-articular adherences and a synovectomy is performed in both joints (radiocapitellar and ulnohumeral) through these two portals. If an associated bone procedure is required, this must be done before starting the capsulectomy. The

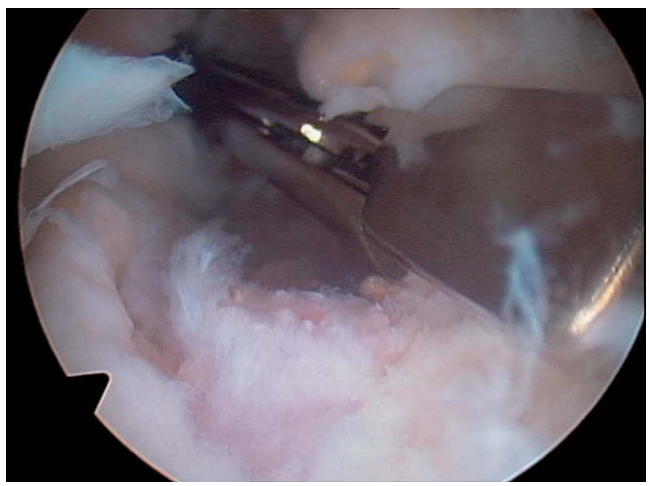

Figure 2 Arthroscopic image of an anterior capsulectomy with a basket clamp. Fibres of the brachialis muscle can be observed behind the capsule (view from the anterolateral portal).

capsulectomy is commenced with the optics in the anterolateral portal and the basket clamp at the anteromedial portal, progressing into the radiocapitellar region, where the position of the instruments must be inverted. In this zone, the radial nerve is in close contact with the capsule, necessitating a meticulous and careful dissection in order to avoid iatrogenic complications. Once the capsulectomy has been performed, the procedure is completed with a motorized resector without suction (fig. 2).

The posterior part of the arthroscopy is performed through the posterior and posterolateral portals. The posteromedial region, where the ulnar nerve is located, must be protected throughout the procedure. The synovectomy is completed, along with resections of the olecranon osteophytes and fossa. The posterolateral gutter debridement is performed with vision in the central portal and the resector in the posterolateral portal, although a mediolateral portal may also be necessary (soft point) for resection of scar tissue in the posterior area of the radiocapitellar joint. Postoperative treatment is similar to the procedure used for open surgery since the technical objective is the same even though the surgical technique used is different.

Open capsulectomy

Open arthrolysis includes resection of the capsule and osteophytes through a lateral approach (column procedure[14]) or through a medial approach (over the top[15]). The anterior approach is currently little used.[16] The results from these open surgery techniques are summarized in table 2.

Lateral approach

This approach is used in most cases through a longitudinal posterior incision. This incision also allows access to the medial side through the same cutaneous approach. The disadvantage is that the subcutaneous dissection is larger and could produce problems for wound healing. The advantages of the use of a lateral column approach include the possibility of access to the 3 elbow joints, simplicity in the surgical approach, the use of an internervous muscular plane, and the absence of morbidity arising from the disinsertion of the flexopronator muscular mass.[17] The use of a posterior cutaneous incision permits rapid access for release of the ulnar nerve and resection of the posterior fascicule of the collateral medial ligament.[18]

The lateral approach described by Mansat[14] requires disinsertion of the extensor mass, and the dissection can be distally extended through a Kocher approach while maintaining the integrity of the ulnar lateral collateral ligament. The triceps and anconeus muscles are retracted posteriorly (posterior column procedure) and the extensor mass is retracted anteriorly (anterior column procedure). All muscle dissections are made before performing the capsulotomy and capsulectomy in order to facilitate the procedure. The anterior dissection must be very meticulous, since the anterior neurovascular structures (radial and median nerves) are contiguous with the plane of dissection. The separation of the anterior brachialis exposes the capsular plane for resection of a capsular triangle from the lateral base towards the medial section of the joint. The terminal extension is performed through a controlled manipulation or by cutting the medial capsule. In cases of technical difficulties, a medial approach can be used to finalize the medial capsulectomy. In the posterior plane, once the dissection between the triceps and capsular plane has been made, the capsulectomy can proceed. Once the anterior and posterior capsulectomies have been performed, the arc of mobility is tested along with the presence of bone impingement. In this case, the use of a bur, chisel, or osteotome can facilitate whatever osteophyte resections are deemed necessary (figs. 3,4, 5, 6, 7 and 8).

Medial approach[15]

When this approach is used through a medial incision in the skin, the medial antebrachial cutaneous nerve crosses the anterior part of the cut, and must be protected. Once the dissection of the ulnar nerve has been performed, this is protected and an incision follows that goes along the length of the supracondyle crest separating the triceps posteriorly in an analogous way to the previously described technique. The intermuscular septum must be identified and partially resected in the next step in order to perform an anterior transpositioning of the nerve and facilitate identification of the capsular plane. In order to perform the anterior capsulectomy, the dissection is continued from the supracondyle crest towards the inferior third of the flexopronator mass in order to respect the medial collateral ligament that lies beneath this muscle layer. The flexors are retracted along with the anterior brachialis and, once the capsule is in view, the resection commences. Next, the ulnar nerve is subcutaneously transposed to an anterior position.

Although some authors use an external fixator as an adjuvant for surgical treatment of severe stiffness, no significant differences have been found when comparing groups of patients with and without external fixators, except in those cases in which the elbow is unstable following the capsulectomy.[1,20]

Postoperative plan

In both approaches, the layers are closed over one or two deep drainages and the arm is placed in extension with the help of a padded anterior splint in order to limit articular haemorrhage during the first 24–48 hrs. Once the splint is removed, the patient is placed in a continuous passive motion machine for 3–5 days until the patient can actively collaborate in rehabilitation. The use of an interscalenic or axillary catheter helps to control postoperative pain and improves the fulfilment of the rehabilitation plan.

Upon discharge, the patient is instructed to perform terminal flexion and extension exercises with the help of an active elbow orthesis and to sleep with the arm alternately

Table 2 Results from open capsular release

Author (year)	No. patients	Procedure	Mean follow-up time (range)	Medial preoperative mobility (°)	Mean postoperative mobility (°)	Mean mobility improvement (°)	Results and complications
Cohen and Hastings (1998)	22	Lateral approach with ligamentous preservation	29 months (15–73)	74	129	55	Improvement of pronosupination from 135 to 159° (24°) Pain and function improved significantly
Tsuge et al (1998)	43	Lateral approach with z-section of the ulnar LCL and an approach from the posterior part of the LCM from the radial side	9.2 years (3–19 years)	35	94	59	88%had satisfactory results. Many cases required release of the collateral radial ligament. Seven cases included interpositioning with fasciae latae with mean improvement of 68
Mansat et al (1998)	38	Column procedure	43 months (24–74)	49	94	45	82%of patients satisfied 89%presented improvement in their last visit 11%lost 24° in accordance with their preoperative situation
Ring et al (2006)	46	Anterior capsulectomy	48 months		103	53	Nine patients with 2° and with the procedure achieved an additional 24° improvement

Table 3 Results of interposition arthroplasty in post- traumatic elbows

Author (year)	No. patients	Procedure	Mean follow-up	Medial time (range) mobility (°)	Mean preoperative mobility (°)	Results and complications postoperative
Morrey et al (1990)	6	Fascia	33 mo (22–49)	26.6 (65–91.6)	106.7 (28.3–135)	80%obtained good results. 88%had no pain. One patient with neurotrophic impairment 100%satisfaction.
Cheng et al (2000)	10	Fasciae latae	51.8 mo (10–121)	69.4 (38.5–107.9)	98.3 (42.5–140.9)	69%had no pain or mild. Four patients had unsatisfactory results. 8 complications (ulnar lesion, donor zone, pin infection). Instability was correlated with poorer results. At 31%, a TEP evaluation was performed.
Larson et al (2008)	27	Allograft from the Achilles tendon	6 to (2.9–10.5)	51 (49–100)	97 (28–125)	4 out of 5 patients with instability had poor results. 7 reinterventions were performed. At 16%, a TEP evaluation was performed.

TEP: Total elbow prosthesis

Figure 3 Clinical case of a 28-year-old patient with previous elbow trauma antecedents. These are the preoperative extension images.

Figure 4 Preoperative flexion.

in extension and flexion. The use of the orthesis is prolonged. In accordance with the evolution of the patient, it can be used anywhere from 6 to 12 weeks, and the home rehabilitation programme can be modified depending on the improvement obtained and the preoperative deficit. On occasion, the rehabilitation programme can last up to 6 months, and the patient must be notified of this in order to achieve the necessary therapeutic compliance. Indometacin is used at high doses for a minimum of 3 weeks in order to prevent heterotopic ossifications.

Interposition arthroplasty

The indication for interposition arthroplasty is based on the presence of articular damage.[21] When there is significant damage to the joint surface, interpositioning or prosthetic

Figure 5 Preoperative radiograph. Lateral view.

Figure 6 Preoperative radiograph. Anteroposterior view.

Figure 7 Clinical image with postoperative flexion.

Figure 8 Clinical image with postoperative extension. This patient will be immobilized in an extension glove for about 48 hrs duration.

substitution must be considered in accordance with the age of the patient.

An extended Kocher approach is usually employed, including a more intensive disinsertion of the anconeus and triceps. In these cases, a disinsertion of the ulnar bundle of the radial collateral ligament is often necessary, which permits access to the elbow joints. Occasionally, the medial side must be accessed and the medial collateral ligament released, attempting to respect the anterior part. The joint surface is then regularized and covered by the reconstruction material of choice. Results have been promising when using allografts from the Achilles tendon, although fascial tissues have also been used (table 3).[1,22] This material is fixed through a series of transosseous points with the aid of anchors. In the case of ligamentous deficit, 2 lateral bundles are reconstructed and preserved from the graft (one medial and the other lateral) for reconstruction of the ulnar lateral collateral and medial collateral ligaments. When a ligamentous reconstruction is required, the use of an external articulated fixator is recommended to permit immediate mobility with a low level of distraction.

It is important to distinguish an elbow mainly suffering from stiffness from one with degenerative changes and pain but mobile, since results obtained will be significantly different. In a study of fascial interpositioning in 25 patients for intrinsic stiffness, 90% of them were satisfied with results at their 5 year follow-up, with a mean improvement in extension of 63 to 30° and in flexion of 93 to 126°.[1] In another study, 13 patients with painful osteoarthritis and limited range of movement due to pain were analysed, in which a triceps allograft was used. After the five-year follow

up period, the percentage of patients satisfied with the procedure was 77%. The presence of preoperative instability was correlated with a worse clinical result.[22] The use of an Achilles tendon allograft was analysed in a study of 69 patient subjects with inflammatory arthropathies and post-traumatic osteoarthritis. In the evaluation of 38 patients with survival of the allografts, mobility improvement averaged an increase from 51° preoperative to 97° postoperative, and an improvement on the Mayo Elbow Performance Score (41° preoperative-65° postoperative) and the Disabilities of the Arm, Shoulder, and Hand.[23,24] Patients with post-traumatic osteoarthritis obtained poorer results than those with inflammatory arthropathies. Nevertheless, 31 patients claimed to have had an improvement following the procedure. Those patients that presented with preoperative ligament instability showed poorer results in spite of the effort made for surgical reconstruction. As such, the authors advised not to perform this procedure in patients with preoperative instability. This procedure must be considered only as a salvage technique, especially indicated in young patients with inflammatory arthropathy or post-traumatic osteoarthritis with loss of movement as a central symptom. It does not eliminate pain entirely, or achieve a complete arc of movement, but it is a procedure that can gain time and function for the elbow in order to avoid a total arthroplasty of the elbow.[25]

Replacement arthroplasty

Very little has been published on the treatment of elbow stiffness using elbow arthroplasty. This procedure is probably only recommendable in older patients who have no possibility of an alternative treatment and who understand the restrictions that are implicated by the implantation of a total arthroplasty of the elbow. In a review of 13 patients with preoperative mobility less than 30° (including arthrodesis), an assembled implant was used.[26] Mobility improved from 7° preoperative to 67° postoperative. At the 63-month follow-up, 10 of the patients were satisfied with the procedure. Seven complications were recorded, including 2 deep infections. The authors acknowledge the difficulty of this procedure and recommend conserving the integrity of the extensor apparatus, the importance of balancing soft tissues and the use of an assembled implant.

The result of an assembled elbow arthroplasty following a previous interposition arthroplasty was analysed in a study of 12 patients.[27] The mean survival time of the interpositioning was 10 years. The mean patient age for implantation of the assembled prosthesis was 50 years. At the end of the follow-up, 10 of the 12 patients were satisfied with the procedure. The clinical improvement of the patients, according to the Mayo Elbow Performance Score, was 48 points. Two patients required a second operation due to loosening of the humeral component and wear of the polyethylene.

Complications

Complications can arise from the treatment of stiffness, related to soft tissue scarring, damage to neurovascular structures, or recurrence of stiffness or persistence of pain.

Problems in the wound are infrequent, although seromas have been described to appear when a posterior longitudinal incision is used to access the lateral or medial side in relation to the extensive subcutaneous dissection.

Neurovascular damage can be related to the surgical approach in both arthroscopic and open techniques. Fortunately, the majority of lesions that are produced are neuropraxias that recuperate spontaneously, although there are cases described of complete injuries to the radial and median nerves.[28,29] If a preoperative compromised ulnar nerve goes unnoticed or is not released following increased flexion mobility, this can produce failure due to pain or progressive loss of flexion following an apparently successful surgery.

Early recurrence of stiffness, especially in extension, can be resolved in some cases by a closed manipulation under anaesthesia within the first weeks after the intervention. A secondary reintervention achieves only mild improvements and must be counterweighed against the risks that are associated with a new operation.[19] A progressive decrease in mobility improvement should give suspicion of the presence of heterotopic ossifications. The use of indometacin in high doses for three weeks following surgery appears to be an efficient mode of prevention.

Conclusion

A greater understanding of the causes of stiffness, increased anatomical knowledge, and references for better treatment have generated an environment of trust and confidence among specialists for the treatment of this problem. The advent of new arthroscopic techniques has created new expectations for treatment of these injuries, and has been shown to be as successful as open surgery, although the potential for neurovascular complications and high level of surgical experience required limit their expanded use. In cases of articular damage, an interposition arthroplasty can be a palliative solution that is capable of extending basic usage of the elbow and does not impede a successful later intervention for a total elbow prosthesis.

It is critical that the patient comprehend the surgical procedure, the possible neurovascular complications, the tedious rehabilitation programme, and the possible functional limitation in cases of joint damage in order to obtain full collaboration from the patient for the purpose of maximizing results and achieving a satisfactory perception of the procedure.

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