The stiff elbow

How I do it

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Contracture of the elbow is a common complication of fractures, dislocations, burns, etc., around the elbow. The stiff or contracted elbow is defined as an elbow with a reduction in extension greater than 30 degrees, and/or a flexion less than 120 degrees. Although supination and pronation are often reduced as well, this will not be considered further as contracture of the elbow is not related to forearm rotation. Stiffness of the elbow impairs hand function, because this is highly dependent on elbow extension and flexion and forearm rotation. A 50% reduction of elbow motion can reduce the upper extremity function by almost 80%.

Surgery of the posttraumatic stiff elbow is a challenging and demanding procedure. During recent years a more aggressive approach to the treatment of chronic contractures around the elbow joint in combination with more specific surgical techniques and an advanced postoperative rehabilitation have improved the final outcome.

The purpose of my article is to define a reasonable and specific approach for the clinician in the surgical management of the posttraumatic stiff elbow, based on a review of the literature and my personal experience.

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Mechanics

As in other joints, adequate elbow function requires a stable, pain-free joint with sufficient strength and range of motion.

Morrey et al. (1981) investigated the functional range of elbow motion in healthy volunteers. They studied 15 activities of daily living and concluded that about 90% of these activities could be carried out in an arc of motion between 30 and 130 degrees of extension and flexion. Furthermore, supination and pronation of 50 degrees each was required. However, it must be emphasized that none of the functions studied included sports or work activities.

Loss of terminal extension is less disabling than loss of the same degree of terminal flexion. In clinical practice, most patients can tolerate a flexion loss of about 30 degrees and an extension loss of 45 degrees, but if the decrease in motion reduces the overall range of motion to less than 100 degrees, most patients will complain of loss of function.

The stability of the elbow joint dependes on the soft tissues around the joint and the articular geometry. Knowledge of the stabilizers of the elbow is necessary to obtain good results after surgery for contracture.

The medial collateral ligament consists of two well defined bands, one anterior and one posterior. In vitro studies have shown the anterior part of the ligament to be the prime stabilizer in valgus and internal rotation (Søjbjerg et al. 1987a).

The lateral collateral ligaments, gathered in a complex, consist of the lateral collateral ligament, the annular ligament and the lateral ulnar collateral ligament (Søjbjerg et al. 1987b, Olsen et al. 1996a, b). In a recent study, O'Driscoll et al. (1991) stressed the importance of this ligament complex, stabilizing the joint in varus and external rotation. Their study suggested that reconstruction of the ligament complex restored the stability of the elbow.

The elbow joint is a congruent joint because of its osseous geometry and therefore by nature it is rather constrained. This is due to the olecranon and coronoid process articulating tightly to the humerus, thereby stabilizing the joint in extension as well as in flexion (An et al. 1986). Even minor exostosis at the tip of the olecranon or at the coronoid may increase the constraint of the joint, thereby reducing its mobility.

Incidence and etiology

The true incidence of elbow contracture after trauma is unknown, but it seems to be rather common, affecting approximately 5% of the elbows. Stiffness after a fracture is caused by soft-tissue injuries and/or dam-

Figure 1. Intrinsic pathology of the elbow in a 19-year-old woman, 2 years after a comminuted intraarticular condylar fracture, followed by ankylosis of the elbow. Treatment with extensive release and excision of the radial head resulted in a motion of 70 (30–100) degrees, but with moderate pain.

Figure 2. Extrinsic pathology causing fixed contracture of the right elbow in 80 degrees, in a 43-year-old man 1 year after a severe combined thermal and head injury. 2 years after excision of the posterior bony bridging of the joint and release of the collateral ligaments and anterior capsule, the patient had a painless elbow with a motion of 115 (20–135) degrees.

age of the joint surfaces. Mohan (1972) studied 200 cases of posttraumatic stiffness and reported that 20% were related to supracondylar, T-condylar or condyle fractures, 20% to an elbow dislocation, and 38% to fracture-dislocation of the joint. Radial head fractures accounted for 10% of the cases.

Cooney (1993) stated that the development of posttraumatic stiffness of the elbow was directly related to the severity of the initial trauma. The degree of an intraarticular involvement is most important, but the amount of periosteal stripping and the length of immobilization were also pointed out as risk factors.

Another group of contractures consists of nontraumatic cases as seen in hemophiliacs, after joint infection or in rheumatoid arthritis. These etiologies, however, are not the topic of my article, as they are seldom candidates for operative release. Finally, a contracture can be congenital. Common conditions are arthrogryposis or congenital dislocation of the radial head. Many of these patients have a severe neuromuscular condition causing secondary involvement of the elbow joint and they therefore need a different treatment.

Classification

An adequate classification of the elbow contracture is important for planning the treatment and postoperative rehabilitation. A simple descriptive classification related to the position of the contracture in extension or flexion is insufficient for the choice of treatment.

The most convenient and important classification of the posttraumatic stiff elbow is based on the pathologies responsible for the loss of motion and these can be divided into intraarticular and extraarticular causes. The intrinsic or intraarticular causes are due either to intraarticular adhesions or to a deformity secondary to an intraarticular fracture, which mechanically limits the elbow motion (Figure 1).

A common cause of extrinsic or extraarticular contracture is contracture of the capsule, collateral ligaments or the muscles following a severe trauma or just a simple posterior dislocation. Another kind of extrinsic contracture is a bony bridging of the joint. It is well known that patients with brain injury are at risk and the formation of heterotopic bone (Figure 2) after a severe burn is well documented also.

In reality, most cases present with both intrinsic and extrinsic causes, and therefore are mixed. Many elbow contractures due to extrinsic pathologies will present with some degree of secondary intraarticular adhesions and many intrinsic cases have scarring of the soft tissues, but they should be classified according to the major pathology.

Preoperative evaluation

An adqeuate clinical examination, including the history of the patient is, of course, necessary. The elbow should be passively forced into extension and flexion and very often it is possible to determine whether the restriction of motion is plastic and due to a soft tissue

contracture or blocked and due to bony exostosis located posterior or anterior to the joint. In a similar way, the elbow is tested during forearm rotation.

Plain radiographs form the next step in the investigation and in most cases the lateral radiographs provide sufficient information concerning the articular surfaces of the ulno-humeral joint and the existence of posterior or anterior osteophytes.

We also often use a CT scan in the preoperative planning. A three-dimensional reconstruction of the elbow precisely locates heterotopic bone formations and furthermore gives accurate information about the status of the articular surfaces. In our experience MRI scanning adds no further information for the diagnosis or preoperative planning.

Diagnostic arthroscopy has no place in the routine preoperative evaluation. It is difficult or even impossible to enter the joint and, because of a very limited intraarticular volume of the elbow, it may be impossible to obtain an adquate intraoperative distension of the joint and this increases the risk of damage to the neurovascular structures during insertion of the arthroscope (Gallay et al. 1993). However, in some cases with a limited contracture, arthroscopy may be used to treat the contracture.

Treatment

The aim of treating the stiff elbow is to give the patient a pain-free, functional and stable elbow. Several authors have reported good results after closed treatment of the stiff elbow. These nonoperative treatments include physiotherapy, manipulation, and static and dynamic splinting (Green and McCoy 1979, Morrey 1990, Cooney 1993).

Several different surgical procedures can be applied to the stiff elbow (Urbaniak et al. 1985, Itoh et al. 1989, Morrey 1990, Gates et al.1992, Redden and Stanley 1993, Søjbjerg et al. 1995). An adequate patient selection based on the preoperative assessment and classification is necessary. The patient should be informed of the expected goal of surgery and the demanding postoperative period.

Splinting

For moderate extension or flexion deficiencies, provided the contracture is caused by the soft tissues, and is less than 1 year's duration in adults, and in children, independently of the duration of the contracture, we first use a dynamic splinting treatment (Dynasplint, Sports Enterprises A/S, Rungsted, Denmark). This

Figure 3. The dynamic splint.

splint has an adjustable spring tension between a few kilos and 10 kilos of torque (Figure 3). The treatment is started when the elbow is reasonably free of pain and in most cases we use the splint only at night. It is important to increase the load of the spring only so much that the elbow can be kept free of pain, otherwise the patient will not tolerate the splint. It is often necessary to give nonsteroid-antiinflammatory drugs to prevent joint inflammation. Green and McCoy (1979) reported good results with a static adjustable splint, the turnbuckle splint, but this device seems to be more demanding on the patient than a dynamic splint.

Arthroscopic release

Some patients resistant to closed treatment present with an intrinsic limitation of extension or flexion of the elbow mainly due to osteophytes at the tip of the olecranon or at the coronoid process. Although in our practice it seems that the role of osteophytic impingement is overestimated, we have successfully treated several patients with arthroscopic removal of the osteophytes. Redden and Stanley (1993) published promising results using a transhumeral approach to debride the anterior compartment of the elbow joint. However, in patients with a concomitant extrinsic pathology, the arthroscopic treatment seems inferior to open release.

Posterolateral release

Relatively many patients have an extrinsic extension deficiency greater than 45 degrees. The loss of motion is due primarily to contracture of the anterior capsule and thickening of the lateral collateral ligament complex, and the joint surfaces in nearly all cases are well preserved. Urbaniak et al. (1985) described an anteri-

or capsular release in these cases, but we prefer a limited release through a posterolateral approach.

With the patient in the lateral decubitus position, the elbow is approached through a posterolateral skin incision. The anconeus muscle is released from the ulna and the incision is brought proximal, opening the posterior compartment of the olecranon fossa. The extensor muscles together with the humeral insertion of the lateral collateral ligament complex is released from the humerus and the anterior capsule can be visualized and released. In nearly all cases, this is enough to extend the elbow fully and after a careful reinsertion of the lateral collateral ligament complex the wound is closed. The postoperative management is identical with that observed after the standard extensive release (see below).

Extensive release

By far, most of the patients present with severe combined flexion and extension contractures. They are classified as either extrinsic or intrinsic pathologies. The operative release is performed with the patient in the lateral position. A tourniquet is used and a prophylactic antibiotic is given. The elbow is reached through a triceps splitting posterior approach. The ulnar nerve is released but is not transferred anteriorly. The ulnar and lateral ligament complexes are released from their humeral and ulnar insertions, and heterotopic bone and bony exostosis abolishing the elbow motion are removed. The range of movement is checked and, if a contracture is still present, the joint can be widely opened during forced flexion and external rotation and release of the capsule from the coronoid process. Thus one can approach the anterior capsule and release it from its insertion on the anterior humerus. After a complete release of the elbow, the collateral ligaments are reinserted during 90 degrees of elbow flexion and a triceps lengthening is performed as a V-Y plasty.

I reviewed the outcome after extensive release of 30 stiff elbows with both flexion and extension contractures (Søjbjerg et al. 1995). The mean age at surgery was 36 (16–61) years and the patients were followed for at least 2 years. 16 patients had a major extrinsic pathology and 14 patients suffered a major intrinsic cause. The interval from trauma to operation was 0.5–46 years.

The preoperative range of motion in extension and flexion averaged 52 (0–110) degrees, with a mean extension loss of 46 degrees and a mean flexion of 98 degrees. 10 patients had no preoperative pain, 17 had slight or moderate pain and 3 patients complained of severe pain. 13 elbows had heterotopic bone formation anterior or posterior to the joint.

Immediate postoperative rehabilitation was undertaken with a continuous passive motion (CPM) machine. Early passive motion with CPM seems to improve the final outcome (Gates et al. 1992) but the beneficial effect of CPM is documented primarily in animal studies. Only limited clinical research supports the use of CPM devices, and the reports nearly all deal with knee surgery. The appropriate frequency and the duration of the treatment are unkown.

In our study, the patients were treated nearly 24 hours a day and the range of motion was gradually increased daily until maximum motion was reached, usually on the fifth day, and the treatment was continued for a mean of 1 week.

To prevent new bone formation, all patients in our series were treated with prophylactic indomethacin, 25 mg 3 times daily for 3 weeks. The effect of indomethacin after hip arthroplasty is well known, but no controlled studies concerning the role of indomethacin after excision have been published of heterotopic bone around the elbow (Kjærsgaard-Andersen et al. 1992).

At follow-up, only 3 elbows, all with heterotopic bone formation preoperatively, had grade-one bone formation and all were situated anteriorly.

At the follow-up at a minimum of 2 years postoperatively, the mean increments in extension and flexion were 60 (20–130) degrees, with a mean extension gain of 27 (5–60) degrees and a mean gain in flexion of 33 (0–75) degrees. 21 patients had a pain-free or only moderately painful range of motion greater than 100 degrees and 3 patients had pain-free motion between 80 and 100 degrees. 5 patients with moderate or severe preoperative pain had a poor result, primarily due to severe pain.

Complications included 1 patient who developed a deep infection and 4 patients with prolonged drainage. 2 patients were eventually reoperated with a total elbow arthroplasty due to persistent pain.

The outcome was better in patients with extrinsic contractures. 14 of 16 patients obtained a good functional result, compared to 8 of 14 patients with intrinsic contractures.

Distraction arthroplasty

Some patients with severe intrinsic pathology or instability can be treated with postoperative distraction of the joint (Deland et al. 1983, Regan and Reilly 1993). Morrey (1990) published a series about 26 young patients with a limitation in elbow motion

mainly due to intraarticular pathology and treated with release and postoperative hinged distraction. After operative release of the joint, the distraction device was applied.

The rationale for the distraction arthroplasty is based on the assumption that the center of rotation of the elbow constitutes a locus of less than a few millimeters. Therefore, when the diameter of a pin from the distraction device is greater than the locus of the center of rotation (about 4 millimeters) and is inserted through the center of rotation, the elbow joint can be moved uniformly through the full range of movement.

This device was applied for 4 weeks and the postoperative treatment after pin-removal included dynamic splinting of the elbow between 1 and 2 months. Motion at the follow-up was approximately 100 degrees which was the functional goal and complications occurred in 6 patients.

It seems that the main indication for distraction arthroplasty is a young patient having an intrinsic stiff elbow, with an unstable elbow after correct release and reinsertion of the collateral ligaments.

Furthermore, distraction may be of value in cases having an interposition arthroplasty, often by fascia lata transplants, but a long-term follow-up in these patients, who presumably suffer progressive elbow deterioration, is necessary before the exact indications for distraction arthroplasty can be given (Morrey 1993, Wright et al. 1993).

Total elbow replacement

Patients older than 60 years with a painful reduction of elbow movement due to intraarticular deterioration interfering with activities of daily living can be treated with a total elbow replacement (Morrey and Adams 1995). Figgie et al. (1989) used a hinged prosthesis in such cases and obtained good short-term results, concerning pain relief, whereas the motion obtained was less than that in other studies on patients with minor preoperative reduction of motion due to inflammatory arthritis.

Conclusions

Posttraumatic contracture of the elbow is rather common, having an incidence of about 5%. An adequate classification is necessary for choosing optimal treatment; extrinsic and intrinsic pathologies should be distinguished. A careful patient selection is necessary, taking into consideration the cooperation of the patient, especially in the postoperative period. Closed treatment, including dynamic splinting, can be applied in children and in adults, if the contracture is less than 6–12 months of duration. Arthroscopic release is of limited value, except for minor extension or flexion intrinsic contractures. A limited posterolateral release is indicated in extension deficiencies, but the postoperative treatment does not differ from the more extensive procedures. Distraction arthroplasty is useful in the severe intrinsic contractures, especially in the perioperative unstable elbow. Extensive release through a posterior approach to the joint may reestablish a functional range of motion in the pain-free contracted elbow. Finally, a total elbow replacement yields good results in older patients with a low functional demand on the elbow, suffering an intrinsic painful contracture of the elbow joint.

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