

# ELBOW STIFFNESS AND ITS MANAGEMENT

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## ABSTRACT

The elbow is a complex synovial joint consisting of hinge and pivot components. In addition to the humero-ulnar shape, the medial and lateral collateral ligaments, with the anterior and posterior capsule provide static stability; the elbow flexors and extensors are the dynamic stabilizers. Flexion restricted to less than 120 degrees and loss of extension of over 30 degrees constitutes stiffness of the elbow, which maybe caused by traumatic and atraumatic conditions. Elbow stiffness maybe extrinsic, or intrinsic. The management includes nonoperative, followed by operative measures, including arthroscopic release, open arthrolisis, arthroplasty (interposition, distraction, total joint replacement) and excision of heterotopic ossification. The management of elbow stiffness is very difficult and challenging and so its prevention is very important.

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## INTRODUCTION

Elbow is a complex synovial joint formed by the articular surfaces of the distal humerus and proximal ulna and radius. It comprises the humero-ulnar, humero-radial and proximal radio-ulnar joints. Humero-ulnar joint is a highly congruous articular surface providing static stability along with the strong lateral and medial collateral ligaments with contributions from anterior and posterior capsule. The elbow flexors and extensor muscles provide dynamic stability to the joint. Flexion and extension movements predominantly occur at humero-ulnar joint which is a hinge joint while pronation and supination are the features of the humero-radial and proximal radio-ulnar joint which are pivoting joints.<sup>1,2</sup>

Elbow movement helps to move the hand in a sphere with the help of shoulder movements. The length of the arm and forearm bones form the radius of the sphere and any deficit in the elbow ROM affects the volume of the sphere. Morrey *et al.* in 1981 described the functional range of elbow motion required for activities of daily living. Flexion extension range

of motion (ROM) from 30° to 130° and forearm rotation between 50° supination and pronation is enough to perform most of the tasks.<sup>3</sup> A stiff elbow is defined as the one with flexion less than 120° and loss of extension over 30°.

## ETIOLOGY, CLASSIFICATION AND PATHOGENESIS

The etiology of elbow stiffness can be broadly divided into traumatic and atraumatic. Elbow flexion contracture is a common complication after elbow trauma and elbow surgery. Fracture and or dislocations of the elbow could lead to a stiff elbow and posttraumatic arthritis (Fig 1a and 1b). Prolonged immobilization, soft tissue trauma, heterotopic ossification, head injury, spinal cord injury and burns are recognised causes of elbow contractures.<sup>4</sup> Atraumatic conditions like osteoarthritis and inflammatory arthritis can lead to elbow stiffness. The other causes include post septic arthritis sequelae, hemophilia, congenital conditions like arthrogryposis and congenital radial head dislocation.



Morrey *et al.*<sup>5</sup> has classified elbow stiffness into extrinsic, intrinsic and mixed. In extrinsic type, the stiffness is caused by factors outside the joint, while in intrinsic it is caused by intra-articular factors. In mixed, it affects both locations. Extrinsic stiffness is caused by the tightness of capsule, ligaments, muscles, heterotopic ossification, severe burns and extra articular malunions or non-unions. Intrinsic causes include intra articular fractures leading to malunion/nonunion, chondral damage, osteophytes, loose bodies, and finally adhesions between articular surfaces.

Lack of elbow extension due to elbow flexion contracture is the commonest type of elbow stiffness. This is most commonly due to the contracture of the anterior capsule. Injury to the elbow leads to anterior capsule thickening and contracture. This could happen within days after the elbow injury and the other factors that contribute include severity of trauma, intra articular injury and duration of immobilization.<sup>4</sup> Contraction of brachialis muscle in an injured elbow, as a response to pain, causes limitation of elbow extension and this leads to the healing of injured anterior capsule in a shortened position.<sup>6</sup> This shortened and thickened anterior capsule 'tether' prevents extension and blocks flexion.<sup>7</sup> The collateral ligaments are slack between 70–110° and this further encourages elbow flexion contracture.<sup>8</sup> Osteophytes or loose bodies in the olecranon fossa can also block elbow extension. Loss of flexion is the other problem in a stiff elbow. This may be due to the tightness of posterior and postero-lateral joint capsule. Osteophyte formation on the coronoid process and coronoid fossa can cause mechanical block to flexion of the elbow joint. As mentioned earlier, the thickening of anterior capsule as such and the heterotopic calcification in the anterior muscles of the elbow joint also restrict elbow flexion.

## EVALUATION

Patients presenting with elbow stiffness should undergo a thorough clinical evaluation and appropriate investigations. Complete history on onset, duration and progression of the symptoms and also information about the associated illness should be obtained. The presenting complaint would be loss of flexion and extension and there may be associated pain as well. Pain could be at the extreme of the motion, which may be of impingement type. In inflammatory and degenerative joint diseases there can be history of recurrent flare ups which causes generalized pain with effusion. Patients may also complain of recurrent locking episodes which suggests loose bodies in the joint.

Clinical examination should follow the general pattern of 'look, feel, move' as well as assessment



(a)



(b)

**FIGURE 1.** AP and lateral radiographs showing posttraumatic arthritis.

of function. Thorough neurovascular evaluation, especially of ulnar nerve, should be performed and documented. It is recommended to use DASH and Oxford elbow scores, as it would help in assessing clinical evaluation and outcome of surgery.

Antero-posterior and lateral radiographs of the elbow are the primary investigation. These may show bony abnormality in fractures and osteophyte formation at the tip of the coronoid and olecranon processes in patients with arthritis. Generalised joint space narrowing is more obvious in early stage of rheumatoid arthritis leading to subluxation or ankylosis of the joint at the later stages. Computerised tomography (CT) is useful to identify bony abnormality, loose body formation and sites of osteophyte impingement. MRI scan is useful in suspected chondral injury. Nerve

conduction and electromyographic studies may be used in patients with ulnar nerve symptoms.

## TREATMENT

Management of stiff elbow is a challenge and hence prevention is very important. Early mobilization is recommended after fractures and dislocation around the elbow provided elbow is stable. Splinting of elbow in extension<sup>9</sup> and continuous passive motion (CPM)<sup>10</sup> are recommended strategies to prevent elbow stiffness in the postoperative period.

## Non-Operative Treatment

The non-operative management of stiff elbow includes dynamic and static splinting, CPM, serial casting, manipulation and physiotherapy. Non-operative management is effective in early stages of stiffness when there is no bony block to the range of motion. Application of physical agents to provide local heat works on the principle of plastic elongation of the contracted soft tissue.<sup>11</sup> Heat application should be followed by passive ROM exercise, which would help to achieve progressive increase in ROM by stretching of the tissue rather than tearing. Both dynamic and static splinting of elbow can be used as a strategy for the treatment and also prevention of stiff elbow. Several authors have reported significant improvement in ROM with progressive splinting of the elbow.<sup>12,13</sup> Splinting is not helpful if the loss of motion is caused by intrinsic pathology and on the contrary it would lead to increasing pain. Closed manipulation of the stiff elbow under anaesthesia on its own<sup>14</sup> or along with surgical release<sup>15</sup> has reported success rate in improving ROM. However, this is not without complications like neuropathies, fracture, heterotopic ossification. Continuing active ROM progressing to strengthening exercise should follow any gain in the ROM achieved by the above strategies.

## Operative Treatment

Operative management may be considered for stiff elbows that are refractory to non-operative treatment. The surgical options ranges from arthroscopic approach to open surgery.

### Arthroscopic Release

This is becoming more popular among surgeons but is technically demanding and requires appropriate training. It requires good knowledge of elbow anatomy and in particular the location of the neurovascular structures. The technique is termed arthroscopic osteocapsular arthroplasty, as described by O'Driscoll.<sup>16</sup> The technique is useful for the removal of osteophytes, loose bodies, release of the capsule and radial head excision. The advantages of arthroscopic treatment over the more established open techniques are reduced

soft tissue trauma, smaller scars, faster rehabilitation and reduced length of hospital stay.

*I perform elbow arthroscopy in the lateral position with the patient under general anaesthesia, and with a high arm tourniquet. Having first identified and marked the surface anatomy of the elbow, the joint should be distended with saline via the posterolateral soft spot. Standard anterior and posterior arthroscopic portals are then created with additional portals as required. The anterior compartment is generally examined first using the anteromedial viewing portal and assessment of the articular surfaces is made. Loose bodies and osteophytes from the coronoid tip and the anterior humerus are removed using an arthroscopic burr, via a lateral portal. The posterior compartment is then entered and osteophytes from the olecranon tip and the fossa are similarly excised. If a capsular release is to be performed for loss of extension we preferentially start in the posterior compartment to avoid significant swelling developing after the anterior capsule has been excised. The thickened anterior capsule can be then excised taking care to avoid damage to the radial nerve as it lies anterior to the radial head. If the patient has loss of flexion, the anterior compartment is debrided and loose bodies removed after which the posterior compartment of the elbow is entered and the capsule excised from the posterior humerus. Arthroscopic soft tissue shaver or an arthroscopic punch may be used. Assessment of range of motion can be repeatedly checked to gauge the amount of excision / release that is required, and a gentle manipulation may provide some extra range of movement at the end of the procedure. The medial and lateral gutters are inspected, with particular care to avoid the ulnar nerve on the medial side, and again loose bodies are removed if present. If a significant increase in the range of elbow movement is anticipated release or anterior transposition of the ulnar nerve is mandatory as without it ulnar nerve symptoms are likely to occur postoperatively. Post-operative analgesia is achieved with a regional block. A bulky dressing is applied and, if there have been significant increases in range of motion achieved, continuous passive motion may be employed. The majority of patients however are allowed to freely mobilise the elbow. The bulky dressing is discarded at five days to facilitate range of motion.*

Arthroscopic debridement of elbow joint has shown encouraging results in terms of pain relief and improvement of range of motion in patients with elbow arthritis.<sup>17,18</sup> The technique allows removal of loose bodies, excision of osteophytes and resection of the thickened olecranon fossa membrane. The results showed reduction in pain, though no significant improvement in range of motion was noted. Adding anterior and posterior capsular releases has been advocated to improve range of motion.<sup>19</sup> The outcome of arthroscopic release is comparable to open surgery with significant increase in flexion and extension with low complications even in high demand patients and those with complex problems.<sup>20-22</sup> The most



**FIGURE 2.** Lateral arthrotomy for column procedure.

common complication of arthroscopic elbow surgery is nerve palsy, which is most often transient but can on occasions be permanent.

#### **Open Elbow Arthrolysis**

Open surgical release/arthrolysis has been the classical surgical approach to a stiff elbow secondary to post trauma or degenerative arthritis.<sup>5,23-25</sup> Mansat and Morrey introduced a limited approach to open release surgery, termed 'column approach' (25). It is normally performed via a lateral approach (lateral column) but a medial column procedure can also be undertaken particularly if the ulnar nerve requires decompression or transposition. Patients with restriction of elbow flexion have significant thickening and contracture of the posterior bundle of medial collateral ligament and medial joint capsule, and these structures require resection at the time of surgery. Hotchkiss *et al.* described a medial "over the top" approach (MOTT)<sup>26</sup> This, like the lateral column approach, involves release of anterior and posterior capsule with preservation of collateral ligaments.

*The operation is performed under general anaesthesia with the patient supine and with the arm across the chest. A lateral incision is normally used but if the elbow is very stiff a posterior incision is preferred as this will enable medial and lateral skin flaps to be developed in order to gain access to both the lateral and medial sides of the joint. The joint is normally initially opened on the lateral side exposing the radio-humeral joint (Fig 2). Inspection of the capsule invariably shows it to be markedly thickened. The brachialis muscle is separated from the capsule using a periosteal elevator after which the anterior capsule is excised (Fig 3). Often it is difficult to excise the anteromedial capsule using this approach but it is normally possible to reach to at least the level of the coronoid. Loose bodies within the anterior compartment and osteophytes are also removed at this stage.*



**FIGURE 3.** Anterior capsule dissected off the muscles in the front and excised.

*If restricted extension is still significant, a medial column approach can be performed in order to resect the anteromedial capsule.*

*Less frequently loss of flexion is a concern and is usually due to adhesions and scarring within the posterior compartment of the elbow joint. Treatment involves elevating the triceps, excising the posterior capsule and removing any posterior loose bodies and osteophytes.*

Mansat and Morret<sup>25</sup> reported the outcome on 38 patients who had undergone surgery for elbow stiffness at a mean of 43 months postoperatively. The main cause of stiffness was previous trauma, primary osteoarthritis was responsible in 7 patients. Following surgery the mean preoperative arc of flexion increased from 49° to 94° and there was a mean total gain in the arc of flexion-extension of 45°. The column procedure was found to be associated with a low rate of complications. Open release in general has a complication of 15% with ulnar nerve neuritis and residual stiffness being the more common.<sup>24</sup>

#### **Interposition Arthroplasty**

Interposition arthroplasty is undertaken in young high demand patients when the elbow stiffness is associated with articular surface damage.<sup>27</sup> The joint surfaces may need some contouring as first step followed by interposition using auto/allograft.

*Interposition arthroplasty involves interposing soft tissue between the articular surfaces of the elbow. Material that has been used includes autogenous skin, fascia and Achilles tendon allograft. The patient is positioned in lateral decubitus position with high arm tourniquet. A posterior incision is used. The incisura ridge of the olecranon is removed with a burr and bone excised from the trochlea and capitellum to facilitate insertion of the interposition material. This is then sutured via drill holes to the distal*

humerus. Finally the joint is reconstructed and an external fixator applied between the humerus and ulna. A dynamic joint distracter is applied and joint surfaces are distracted by approximately 2 or 3 mm. Postoperatively, the fixator is locked for 1 week to allow the soft tissues to settle after which progressive active mobilisation is permitted. The external fixator is removed at 6 weeks.

In general the use of an interposition arthroplasty in appropriate patients with significant pain can be expected to reduce the pain in 70–80%.<sup>27</sup> Cheng and Morrey<sup>28</sup> in their series of 13 mobile arthritic elbows used fascia lata as their interposition material. All patients had an external fixator applied allowing slight distraction of the elbow joint. Nine patients (69%) had satisfactory relief of pain with 8 (62%) having an excellent or good Mayo elbow performance score. Four patients required revision to a total elbow arthroplasty. Larson *et al.*<sup>29</sup> reported mixed results in 34 patients: thirteen patients had a good or excellent result, fourteen had a fair result, eleven had a poor result and the remaining seven underwent revision. Interposition is therefore a salvage procedure that should be reserved for a few patients in whom conservative treatment has failed and replacement arthroplasty is contra-indicated.

#### ***Distraction Arthroplasty***

Distraction of the elbow joint with a fixator as an adjuvant to open arthrolysis has been reported to provide gratifying results but the technique is very demanding and has high complication rate.<sup>5</sup> Mechanical distraction using a hinged distractor allowing stability and continued ROM without performing an open arthrolysis is considered to be the preferred procedure by some of the authors.<sup>30,31</sup> This technique may be useful if the stiffness is purely due to soft tissue contracture in the absence of any bone block. This still remains to be a technically challenging procedure and hence preferred by only few authors.

#### ***Excision of Heterotopic Ossification***

Formation of 'ectopic' bone in the soft tissues around the elbow could lead to significant loss for elbow flexion-extension and pronation-supination. Once heterotopic bone has developed restricting the ROM, then conservative treatment is unlikely to help in improving the ROM and surgical excision should be considered. Historically, surgical excision was considered once the heterotopic bone formation is fully matured however there is increasing evidence supporting early excision of heterotopic bone.<sup>32–36</sup> Timing of surgery should be tailor made to the individual patients presentation.

Heterotopic bone formation can occur anywhere around the elbow. Some common sites are anteriorly in the brachialis and posteriorly in the triceps. In the triceps it can occur along the medial border of triceps

from olecranon extending to medial epicondylar ridge or postero laterally. Another typical site around the elbow is between radius and ulna causing proximal radioulnar synostosis.

A lateral approach as described in column procedure or a medial approach may be used in the surgical exposure. In case of proximal radioulnar synostosis dissection could be carried out along the posterolateral edge of ulna elevating anconeus and extensor carpi ulnaris muscles subperiosteally. In complete radio-ulnar synostosis, after excision, soft tissue interposition grafts/flaps may be used. Postoperatively, radiation therapy, indomethacin and other non-steroidal anti-inflammatories may be used as adjuvant to prevent recurrence of heterotopic ossification.

#### ***Total Elbow Replacement***

Total elbow replacement (TER) is the mainstay of treatment for rheumatoid patients with severe pain or elbow instability. Replacement arthroplasty provides reliable pain relief, with good functional outcomes and survivorship. TER in post-traumatic arthritis is limited to elderly patients who agree to use their elbow with caution. Heavy activities will result in early failure of the arthroplasty and the need for revision surgery. Elbow instability often results from open release of a stiff elbow hence a semi constrained implant is recommended. Significant improvement in ROM has been reported following total elbow arthroplasty in stiff elbows.<sup>37,38</sup> In view of the high complication rate, these are reserved for selected patients and should be performed by an experienced surgeon.

In general terms, if the elbow has a reasonably well preserved joint space, but with osteophyte formation, either arthroscopic or open joint preservation surgery is offered. The radial head can be excised if there is established radio-capitellar degeneration combined with positive clinical signs. The ulnar nerve is transposed or decompressed if ulnar nerve symptoms are present. However, if there is significant joint destruction, interposition or replacement arthroplasty may need to be considered. Interposition arthroplasty is suitable for younger (<65 year olds), higher demand patients with a stable joint, whilst in the older, lower demand patient total elbow arthroplasty may be appropriate.

#### **POSTOPERATIVE REHABILITATION**

Patient's elbow is fitted with a CPM machine in the immediate post-operative period and full ROM is started. CPM helps to prevent post-operative stiffness by minimizing scarring and adhesion, also helps to reduce edema and pain.<sup>39,40</sup> CPM is continued for 48–72 hours as an in-patient and patient is discharged home advising active elbow ROM exercises. A static

extension splint is provided for night use, which is continued for 3 months.

## CONCLUSION

Elbow joint motion is crucial for the function of upper extremity. Stiff elbow poses considerable challenges in management and hence prevention of stiffness is the key. The various non-operative and operative options described above should help the surgeon to formulate a management strategy and it should be applied on an individualized basis.

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