Open versus arthroscopic treatment of post-traumatic stiff elbow

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Background
Post-traumatic elbow stiffness is a common orthopedic problem following various injuries due to late presentation and inadequate initial management. Several techniques have been proposed to treat post-traumatic elbow stiffness. Nonoperative management remains the treatment of choice. However, when functional impairment results from a loss of elbow motion that remains refractory to conservative measures, surgical treatment is indicated. The aim of this study was to compare two different techniques of elbow arthrolysis, each method constituting a method of treatment.

Patients and methods
Thirty-three patients with post-traumatic stiff elbow joints had been treated first by conservative measures for at least 6 months. The patients were divided into two groups; the first group included 18 patients with an average age of 31.05 years treated by open arthrolysis. The second group included 15 patients with an average age of 31.66 years treated by the arthroscopic method.

Results
The results were evaluated using the Mayo clinic score for elbow function and the Krishnamoorthy score. In the open group, after an average follow-up period of 19.33 months, the average Mayo clinic score improved from 63.38 to 92.83 and the average range of motion improved from 51.11° to 103.94°; 13 cases (72.22%) showed excellent results, four (22.22%) showed good results, and one case (5.55%) showed a poor result according to the Krishnamoorthy score. In the arthroscopic group, after an average follow-up period of 17.73 months, the average Mayo clinic score improved from 62.93 to 92.73, and the average range of motion improved from 59.46° to 101.53°; 10 cases (66.66%) showed excellent results, three cases (20%) showed good results, and two cases (13.33%) showed a poor result according to the Krishnamoorthy score.

Conclusion
Both open and arthroscopic treatment can be effective in the treatment of post-traumatic stiff elbows. Arthroscopic treatment is associated with less postoperative pain and morbidity. However, open treatment provides better range of motion and marked improvement of elbow function.

Keywords:
arthroscopic treatment, Mayo clinic performance score, open arthrolysis, post-traumatic stiff elbow

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Introduction

The normal arc of motion of the elbow is from 0° to 145° of flexion [1]. A functional arc of elbow motion between 30° and 130° is necessary to complete activities of daily living, but higher-demand vocational and athletic activities may require broader arcs and should be addressed accordingly on an individualized basis [2].

Consequently, a stiff elbow has been defined as an elbow with a reduction in extension greater than 30° and/or a flexion less than 120–130° [3].

Morrey [4] classified elbow stiffness into two groups based on etiology and anatomic location of the pathology. Intrinsic contractures are characterized by intra-articular conditions such as degenerative osteophytes, osteochondritis dissecans, articular incongruity, loose and foreign bodies, intra-articular adhesions, and synovitis. Extrinsic contractures are characterized by extra-articular conditions such as scarring of the capsule, collateral ligaments, musculature, and skin.

Treatment of the stiff elbow begins with clinical evaluation of elbow stiffness and identification of indications for surgical intervention. Techniques of open and arthroscopic elbow contracture release are evolving. Assessment and management of elbow contracture associated with heterotopic ossification, and treatment of distal humerus nonunion, should be performed early to restore elbow motion [5].

Nonoperative management remains the treatment of choice for the stiff elbow. Nonsurgical modalities that may be effective in improving elbow motion

include physical therapy, serial casting, splinting, and manipulation [6].

When conservative treatment fails to restore an acceptable range of motion in the elbow, open techniques have been shown to be successful options [7].

The early application of elbow arthroscopy for treatment of stiff elbows was limited to those patients with less severe contractures, or to those requiring minimal osteophytic release to improve motion [8–10].

With advances in technique, however, arthroscopic management has supplanted open management of the stiff elbow as the operative treatment of choice in many cases. Much more extensive processes are currently treated arthroscopically, with outcomes and complication rates comparable to open releases [11–19].

The use of arthroscopy has become more popular for several reasons. These include better visualization of intra-articular structures, less tissue trauma from open incisions, and potentially the ability to begin early postoperative motion [7].

When performed in properly selected patients, both arthroscopic and open treatment of elbow stiffness can yield satisfactory results [6].

Patients and methods

The study was conducted between September 2008 and December 2011 and included two groups of patients suffering from post-traumatic stiff elbows. The first group included 18 cases (11 male and seven female patients) treated by means of the open technique of elbow arthrolysis. The age of the patients within this group ranged between 9 and 47 years with an average age of 31.05 years. The time to operation ranged between 6 and 24 months with an average of 11.44 months. The preoperative Mayo clinic score ranged from 38 to 68 with an average of 63.38, and the preoperative range of motion ranged from 38° to 68° with an average of 51.11°.

The second group included 15 cases (10 males and five females) treated by the arthroscopic method of elbow arthrolysis. The age of the patients within this group ranged between 17 and 50 years with an average age of 31.66 years. The time to operation ranged between 6 and 22 months with an average of 11.2 months. The preoperative Mayo clinic score ranged from 57 to 71 with an average of 62.93, and the preoperative range of motion ranged from 40° to 70° with an average of 59.46°.

Inclusion criteria

Patients with post-traumatic stiff elbow after a minimum period of 6 months of conservative treatment were eligible for inclusion in the study.

Exclusion criteria

(1) Nontraumatic causes of stiff elbow.
(2) Neglected fractures or dislocations of the elbow or the head of the radius, or cases with marked alteration of anatomy (e.g. radial head dislocation, unreduced radial head fractures, nonunited fractures, etc.) as seen on the preoperative radiograph or computed tomography scan, which are treated only by open techniques.
(3) Previous ulnar nerve transposition anteriorly, which may require open exploration to ensure safe medial portal placement.
(4) Traumatic causes associated with chronic inflammatory diseases such as collagen diseases or active myositis.
(5) Burns or head injury.
(6) Elbow instability.

Preoperative preparation

All patients were preoperatively evaluated by radiography of the elbow (anteroposterior, lateral, medial oblique, and lateral oblique views) and if required by computed tomography scans (Table 1 and Fig. 1).

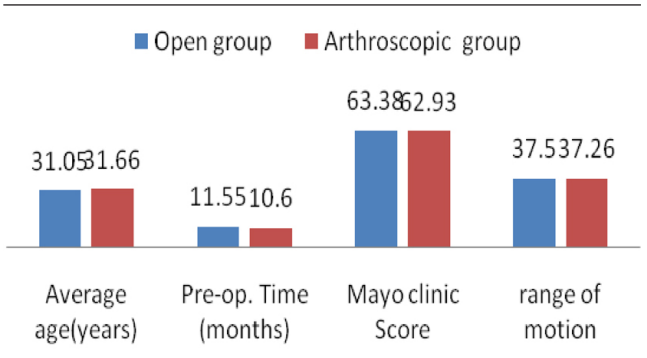
Open technique [4]

Place the patient supine on the operating table with a sandbag under the ipsilateral shoulder. Drape the

Table 1 Preoperative data

Preoperative data	Open group	Arthroscopic group
Average age (years)	31.05 (9–47)	31.66 (17–50)
Sex (male/female)	11/7	10/5
Time to operation (months)	11.44 (6–24)	11.2 (6–22)
Preoperative Mayo clinic Score	63.38 (58–75)	62.93 (57–71)
Preoperative range of motion	51.11° (38–68)	59.46° (40–70)

Figure 1



Preoperative data.

extremity free, and bring the forearm across the abdomen. Extend the Kocher approach by making an extensile skin incision (15 cm) proximally along the supracondylar ridge; continue it distally to the lateral epicondyle, ending over the subcutaneous border of the ulna. Proximally carry the dissection into the supracondylar ridge, with subperiosteal stripping anterior to the anterior aspect of the capsule. Distally, open the interval between the extensor carpi ulnaris and anconeus to expose the elbow joint. Place retractors deep into the extensor carpi radialis longus, brachioradialis, and brachialis. Reflect the anconeus subperiosteally off the ulna. Reflect the distal triceps off the posterior humerus and its tendon subperiosteally off the olecranon. Perform an anterior capsulectomy from lateral to medial. The lateral collateral ligament has to be reflected in a distally based flap to do this. Completely extend the elbow. If extension is incomplete, débride the olecranon fossa and the top of the olecranon, along with any enlargement of its margins. To improve flexion, perform a tenolysis of the triceps and a posterior capsulectomy. If flexion to 135° is impossible, look for a source of anterior impingement. If necessary, remove scar tissue in the coronoid fossa or a portion of the coronoid proximal to the brachialis insertion. Suture the lateral collateral ligament with nonabsorbable sutures to its anatomical position, and carefully repair the entire lateral tissue sleeve. Apply a splint with the elbow in full extension.

Rehabilitation

A constant passive motion machine is used 12 h a day for 1 week. After this first phase, active and passive range of motion exercises are performed hourly, with the elbow splinted between exercise sessions and at night. Supervised physical therapy visits continue for 6 weeks, two or three times a week. At 6 weeks, daytime splinting is discontinued, although night splinting is continued for another 6 weeks.

Arthroscopic technique [6]

The patient is placed in the prone position. The operative arm is elevated on a 4-inch padded block with the elbow flexed over an arm board at the patient's side parallel to the table to prevent compression of neurovascular structures in the axilla and facilitate medial or lateral access for any contemplated open procedure by means of internal or external rotation of the forearm onto the arm board. A pneumatic tourniquet is applied to the arm and inflated to 250 mmHg after exsanguinating the limb. The arm is sterilely prepared and draped. The forearm and hand are wrapped with a compressive material to restrict fluid extravasation. A 4.0-mm 30° arthroscope and a 3.5-mm full-radius arthroscopic shaver are used. Insufflation of the elbow is attempted through a direct lateral portal or through a direct posterior portal. The medial epicondyle and medial intramuscular septum are used as landmarks to establish initial entrance into the joint through a proximal medial portal. A scalpel incision is made through skin only, and penetration through capsule is attempted with a blunt trochar. A proximal lateral portal is established with an outside-in technique, or an inside-out technique, with a Wissinger rod. Debridement should continue with removal of adhesions from the radiocapitellar joint. The anterior capsule is stripped off the humerus proximally to provide additional capsular mobility, and to afford increased working room for adequate capsular release. An anterior capsulotomy then begins near the coronoid fossa and continues laterally until the lateral intermuscular septum is reached. The arthroscope is switched to the lateral side, and the capsulotomy is continued from the previous release medially to the medial intermuscular septum. Capsular excision should be extended until the anterior structures are no longer tight, but should not exceed more than 2 cm distally. Once maximum extension through anterior capsular release has been achieved, a posterior central portal is established with a scalpel skin incision carried deep through the triceps muscle and capsule into the olecranon fossa, and a cannula is introduced through this portal with a blunt trochar. The olecranon fossa is debrided and the posterior capsule is elevated off the distal humerus. The medial and lateral gutters are then cleared of scar tissue and adhesions. A retractor portal is placed ~2 cm proximal to the direct posterior portal to allow for the use of a retractor to improve visualization into the gutters, and to protect the ulnar nerve. Release should proceed from the olecranon with the nerve retracted toward the medial epicondyle. Excision of lateral gutter adhesions continues proximally to distally and can be facilitated with debridement of the posterior radiocapitellar recess through a direct lateral portal. Posterior capsulectomy is performed as required in a sequential fashion, posteriorly, then posterolaterally, and finally posteromedially.

Thus, the surgical sequence for arthroscopic management of the arthrofibrotic elbow is as follows:

(1) Diagnostic arthroscopy of the anterior compartment.
(2) Anterior debridement:
    (a) Loose body removal.
    (b) Coronoid spur resection.
    (c) Radiocapitellar debridement.
(3) Anterior capsular release with excision:
    (a) Medial to lateral resection.
    (b) Exposure of the brachialis.
(4) Diagnostic arthroscopy of the posterior compartment.

(5) Posterior debridement:
  (a) Loose body removal
  (b) Olecranon fossa debridement.
  (c) Elevate triceps with capsular release as necessary.
  (d) Olecranon spur resection.
(6) Medial gutter debridement.
(7) Lateral gutter debridement.
(8) Olecranon fossa fenestration.

Postoperative management

Continuous passive motion is initiated in the recovery room at the maximum operative motion achieved, and continued for 3 weeks. An aggressive stretching and strengthening program beginning on the day of surgery is initiated simultaneously, continuing daily for 3 weeks, and three times per week thereafter. Adjustable static splinting may be used after 3 weeks. If significant postoperative motion loss occurs, gentle manipulation under anesthesia to break up the early accumulation of adhesions can be considered within the first 3 weeks. This subset of patients may be at increased risk for ulnar nerve dysfunction, however, if the nerve has not been previously decompressed or translocated [6].

Results

The results were evaluated using the Mayo clinic score [20] for elbow function and the Krishnamoorthy score [21]. In the open group, the period of follow-up ranged between 7 and 39 months, with an average period of 19.33 months. The postoperative Mayo clinic score improved from 80 to 107, with an average of 92.83, and the range of motion improved from 98° to 120°, with an average of 103.94°. Thirteen cases (72.22%) showed excellent results, four (22.22%) showed good results, and one case (5.55%) showed a poor result according to the Krishnamoorthy score.

In the arthroscopic group, the period of follow-up ranged between 7 and 31 months, with an average period of 17.73 months. The postoperative Mayo clinic score improved from 85 to 101, with an average of 92.73.94, and the range of motion improved from 98° to 120°, with an average of 101.53°. Ten cases (66.66%) showed excellent results, three (20%) showed good results, and two cases (13.33%) showed a poor result according to the Krishnamoorthy score.

Thus, the two groups gave comparable results for elbow joint function and range of motion, with slightly better results in the open group at late follow-up (Tables 2 and 3 and Figs 2 and 3).

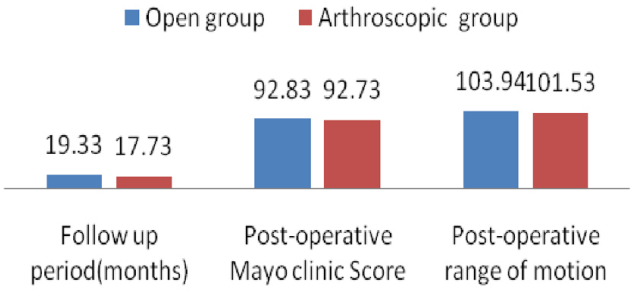
Table 2 Postoperative results

Preoperative data	Open group	Arthroscopic group
Follow-up period (months)	7–39 (19.33)	7–31 (17.73)
Postoperative Mayo clinic Score	80–107 (92.83)	85–101 (92.73)
Postoperative range of motion	98–120 (103.94°)	80–120 (101.53°)

Table 3 Results of the whole study

Krishnamoorthy score	*n* (%)	
	Open group	Arthroscopic group
Excellent	13 (72.22)	10 (66.66)
Good	4 (22.22)	3 (20)
Poor	1 (5.55)	2 (13.33)

Figure 2



Postoperative results.

Discussion

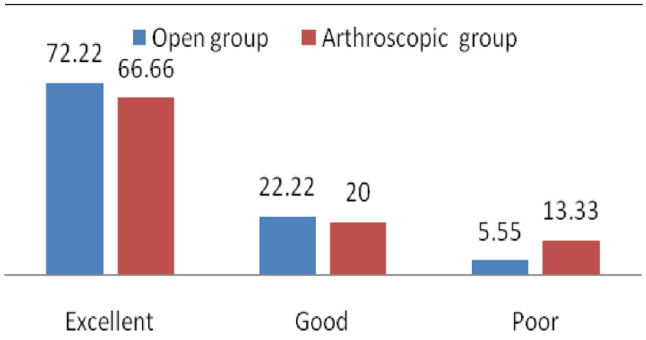
Stiffness of the elbow is not a rare event and it can frequently lead to significant functional impairment, which can be challenging to treat [22]. Historically, the literature suggests a low complication rate following open elbow capsulotomy, but these data do not seem to be confirmed after a more careful reading [7].

Open elbow release with excision of tethers and blocks is a valuable procedure for post-traumatic stiffness. Recurrence in the postoperative period is common but is responsive to manipulation under anesthesia and repeat releases [23].

Open release of post-traumatic elbow stiffness is more effective when heterotopic ossification hindering motion is removed than when there is capsular contracture alone [24].

Husband and Hastings [25] used the lateral approach to release a post-traumatic contracture of the elbow in seven patients, and the results were evaluated an average of 38 months postoperatively. Extension improved from an average flexion contracture of 45° preoperatively to one to 12° postoperatively, and the average point of maximum flexion increased from 116° preoperatively to 129° postoperatively. The average arc of motion increased by 46°.

Figure 3



Results of the whole study.

Cohen *et al.* [17] reported that open debridement is superior to arthroscopic fenestration of the olecranon fossa for improving range of motion. In their report, only eight of 26 arthroscopic debridement patients showed a mean gain of 4° in elbow flexion, whereas 12 of 16 patients who underwent the open procedure showed a mean gain of 15° in elbow flexion.

Tan *et al.* [23] conducted a retrospective review of 52 patients who underwent open surgical treatment for post-traumatic elbow contracture; the mean age of the group was 35.1 years. Surgery was performed at an average of 14 months from the time of injury. Follow-up was 18.7 months. The average extension-flexion arc of motion improved from 57° to 116° and forearm rotation improved from 119° to 145° postoperatively.

For many years open capsular release had been the standard treatment for elbow contractures. More recently, the use of arthroscopy has become more popular for several reasons, including better visualization of intra-articular structures, less tissue trauma from open incisions, and potentially the ability to begin early postoperative motion [26–28].

Arthroscopic management of the stiff elbow offers substantial advantages over open procedures. Limited skin incisions and soft tissue dissection not only decrease the risk of scarring but also allow the patient to safely undertake an immediate aggressive postoperative physical therapy program. These measures reduce the recurrence of contracture in a joint well recognized for its propensity for stiffness [6].

The minimal invasive nature of elbow arthroscopy is a reproducible and effective procedure for treating limitation of motion of the elbow with minimal morbidity [26].

Arthroscopy allows the surgeon to address extrinsic capsular and collateral ligament contractures, as well as intrinsic joint pathology, with increased visualization, and therefore a more comprehensive appreciation of the pathology. Concomitant procedures, such as radial head excision, when indicated, can also be performed arthroscopically. Recognition of the proximity of the neurovascular structures is critical to minimizing complications, but expertise in elbow arthroscopy and meticulous surgical technique can produce excellent results [6].

In comparing open and arthroscopic results for the treatment of elbow stiffness, it appears that both techniques can achieve satisfactory results when employed properly. It is also important to emphasize that neither technique reliably regains the last 10° of elbow extension. Complete arthroscopic evaluation is also useful diagnostically and for removal of occult loose bodies. When the radiocapitellar joint is arthrofibrotic, deformed, or has significant arthritis, arthroscopic radial head excision can be performed concomitantly. Because release is done arthroscopically, collateral ligament stability is not compromised and morbidity from surgical dissection is minimized [29].

In our study, the results were comparable in both groups concerning the postoperative range of motion and the overall function of the treated elbows, with slight advantage of the open technique.

Arthroscopic treatment of a stiff elbow is safe and effective when performed by surgeons with an appropriate level of surgical skills. Compared with open techniques, such treatment allows for better visualization and treatment of intra-articular causes of the contracture. The complication rates between the two techniques seem to be comparable [7].

Phillips and Strasburger [30] analyzed 25 patients with elbow contracture caused by post-traumatic arthritis in 15 cases and degenerative arthritis in 10 cases, with a mean follow-up of 18 months. They reported that the post-traumatic group achieved better results with a mean gain of 50°, whereas the degenerative arthritis group had a mean gain of only 27°.

Ball *et al.* [16] reported a retrospective study of 14 patients affected by post-traumatic elbow contracture. The minimum follow-up period was 1 year (12–29 months). The mean arc of motion gain was 41.5°. At the last follow-up the average pain level measured on a visual analogue scale was 3.25, and the average self-reported satisfaction score measured on a visual analogue scale was 8.4. The ASES functional ability score for the elbow improved in all patients, with an average score of 28.3 (25–30) out of 30 at the latest follow-up.

Arthroscopic capsular release is a technically demanding procedure that requires meticulous attention to detail and should only be attempted by surgeons with extensive experience in elbow arthroscopy [29].

The reported complications for elbow arthroscopy include compartment syndrome, septic arthritis, superficial infection, persistent drainage from portal sites, and, most frequently, nerve injuries (transient or permanent) [31].

Comparing complication rates between open and arthroscopic capsular release is difficult as there are no direct comparative studies in the literature [28].

In our study, we had no neurovascular complications in either open or arthroscopic groups.

Conclusion

Restoration of satisfactory elbow function after traumatic stiffness is a challenge for orthopedic surgeons.

Both open and arthroscopic treatment can be effective for the treatment of post-traumatic stiff elbow. Arthroscopic treatment gives a better chance to address intra-articular pathology and treat appropriately. Moreover, arthroscopic treatment is associated with less postoperative pain and morbidity.

However, open treatment provides better range of motion and marked improvement of elbow function. Open treatment is more suitable for patients with disturbed anatomy as it is safer and less technically demanding than the arthroscopic method.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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