



Application of distal radius–positioned hinged external fixator in complete open release for severe elbow stiffness



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Background: Radical release for severe stiff elbows may lead to instability. Hinged external fixation is used to treat unstable elbows. We hypothesized that extensive open release combined with a distal radius–positioned hinged external fixator would have good performance and low complications rate in treating severe elbow stiffness. Thus, the efficacy and security of this technique were assessed in this study.

Methods: We retrospectively reviewed 38 post-traumatic elbows with severe stiffness that underwent arthrolysis between February 2011 and February 2014. All patients were assessed as having elbow instability after complete arthrolysis. Ligament repair was combined with implantation of a hinged external fixator (fixed to the humerus and distal radius) to maintain elbow stability. Flexion arc, forearm rotation, Mayo Elbow Performance Score, elbow stability, and radiographs were evaluated preoperatively and postoperatively, and complications were documented.

Results: Mean follow-up was 31 months. Significant improvement was noted in flexion-extension arc (from 27° to 126°), forearm rotation (from 148° to 153°), and mean Mayo Elbow Performance Score (from 68 points to 96 points). Mean pronation arc decreased from 66° preoperatively to 6° at 1.5 months of follow-up and showed a transient reduction during first 6 months postoperatively. Pin-related infection occurred in 2 patients, which was cured with conservative treatment. Two patients had moderate instability after removal of the fixator and regained stability at the 12-month follow-up. At the last follow-up, complications included ulnar nerve paralysis in 3, recurrence of heterotopic ossification in 1, and moderate pain in 1.

Conclusions: Complete open release combined with a distal radius–positioned hinged external fixator is an effective treatment for severe stiff elbows. This technique had a low complication rate.

Level of evidence: Level IV; Case Series; Treatment Study

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Keywords: Elbow stiffness; arthrolysis; instability; ligament; distal radius; hinged external fixation

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Elbow stiffness is a common complication of elbow trauma. Despite advances in elbow surgery, elbow stiffness develops in approximately 12% of patients with elbow injuries and directly results in a limited range of motion (ROM) and restricted function.^{4,7,26} Disability associated with elbow stiffness

hinders daily activities. Severe elbow stiffness is commonly defined as a flexion-extension arc of $<60^\circ$ and $>30^\circ$. A flexion-extension arc of $<30^\circ$ is classified as “very severe”.²³ Complete open release for severe elbow stiffness has shown to be effective, but the surgical procedure may lead to elbow instability.¹ Ligament repair and hinged external fixation is a recommended surgical technique to maintain elbow stability and permit postoperative mobilization.^{9,22} A hinged external fixator helps to resist lateral force, thus protecting the repaired ligament, and also allows early rehabilitation. However, pin-related complications of hinged external fixation have a high rate of morbidity (17%) and adversely affect clinical outcomes.^{2,18}

We developed an alternative distal radius–positioned hinged external fixation technique and hypothesized that the technique would have good clinical outcome and a low complications rate. We assessed the practical application and the associated complications rate of the hinged external fixator. Therefore, the objectives of this study were to evaluate and report the treatment outcomes and complications rate in patients with severely stiff elbows who underwent an extensive open release ligament repair combined with a distal radius–positioned hinged external fixator.

Materials and methods

Patients

We retrospectively analyzed data pertaining to patients with severe stiff elbows who underwent complete open elbow arthrolysis and distal radius–positioned hinged external fixation at our institution between February 2011 and February 2014. The inclusion criteria were (1) skeletal maturity, (2) post-traumatic severe stiffness of elbows with a flexion-extension arc $<60^\circ$, (3) unrestricted forearm rotation with both pronation and supination arcs $>50^\circ$, (4) elbow instability after complete open elbow release that required ligament repair or reattachment, and (5) underwent hinged external fixation fixed in the middle humerus and distal radius.

The exclusion criteria were (1) ipsilateral upper limb infection, osteoporosis, bone tumor, or material sensitivity that rejected hinged external fixation; (2) stiff elbows treated with total elbow arthroplasty, interposition arthroplasty, or arthroscopic arthrolysis; and (3) those who underwent radial head resection or radial head prosthesis replacement or had a previously injured interosseous membrane.

During the reference period for this study, 117 patients with severe elbow stiffness and unrestricted forearm rotation underwent arthrolysis. Elbow instability after complete release was detected in 40 patients, the remaining 77 were stable and did not require hinged external fixation. Among the 40 patients who met the criteria, 2 patients were lost-to follow up. The final analysis included the data of 38 patients (21 men and 17 women), who were a mean age of 37 years (range, 18–58 years; [Table I](#)).

The mean interval from initial injury to arthrolysis was 21 months (range, 6 months–18 years). A total of 26 patients had sustained low-energy initial trauma, and 12 had sustained high-energy trauma. Open reduction and internal fixation of the fracture was performed in 29 patients as the initial treatment. Single plaster or splint

Table I Patient demographics and clinical characteristics

Variables	Data (n = 38)
Gender, No.	
Male	21
Female	17
Age, mean (range), y	37 (18–58)
Affected side, No.	
Right	20
Left	18
Injury mechanism, No.	
Fall from standing height	26
Fall from height >2 m	6
Road traffic accident	6
Injury type, No.	
Distal humeral fracture	19
Olecranon fracture	8
Radial head fracture	2
Humeral fracture associated with	
Ulnar fracture	4
Radial fracture	1
Monteggia fracture	1
Elbow dislocation	3
Associated injuries, No.	
Nerve symptoms	9
Ulnar	9
Radial	1
Medial	1
Multiple fractures	6
Initial treatment, No.	
ORIF	25
ORIF combined with external fixation	4
Plaster or splint immobilization	9
Interval between initial injury and index release, median (range) mo	21 (6–216)

ORIF, open reduction and internal fixation.

immobilization was performed in 9 patients for a mean duration of 4 weeks (range, 1–7 weeks).

Before our arthrolysis, mean extension and flexion of the elbows were 46° (range, 10° – 95°) and 72° (range, 30° – 100°), mean elbow ROM was 27° (range, 0° – 60°). Mean preoperative pronation arc was 66° (range, 50° – 90°), the supination arc was 82° (range, 60° – 90°), and the forearm rotation arc was 148° (range, 110° – 180°). The mean preoperative Mayo Elbow Performance Score (MEPS)²⁵ was 68 points (range, 45–85 points). Elbow stability was graded the same as MEPS. All elbows were preoperatively tested by lateral stress test and pivot shift test and were stable.

As graded by MEPS, 6 patients had mild pain, and no moderate or severe pain was reported. According to the McGowan classification,²¹ ulnar nerve injury was preoperatively detected and classified: grade I in 8 patients and grade II in 1. The latter patient presented with grade II ulnar nerve symptom associated with medial and radial nerve injury. Mobility of the wrist and hand was normal in all patients.

Before our arthrolysis, radiographic evidence was obtained to assess fracture union, heterotopic ossification (HO), and arthritic changes. Preoperative x-rays and computed tomography scans

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