Additional external hinged fixator after open repositioning and internal fixation of acute elbow instability in non-compliant patients

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Abstract

This is a retrospective analysis of the clinical and radiological outcome in 11 patients with complex acute posttraumatic elbow instability after dislocation. These patients had also been treated with a hinged external fixator after open reduction, capsular and ligamentous reconstruction and internal fixation, because of an expected diminished compliance, to avoid a secondary dislocation of the internal fixation. Concentric stability and a sufficient range of motion of the elbow joint were achieved in all cases. Non-compliant patients were classified by the surgeon as not compliant or not able or not willing to cooperate post-operatively for various reasons, such as alcoholism, drug abuse, mental disability, cerebral trauma or senile dementia. Non-compliant patients had undergone open reduction and internal fixation of an acute posttraumatic unstable elbow. The addition of a hinged external fixator allows early intensive mobilization, and can protect and improve the clinical outcome after these complex elbow injuries. This evaluation remains, of course, largely subjective and decision making is not easy because in most cases, the patient was not known before surgery. Thus, the only patient exclusion criteria in this study was surgeon classification as "compliant".

Introduction

After dislocation of the patella, a part of the knee joint, a dislocation of the elbow is described as one of the most frequent joint dislocations in adults, next to shoulder dislocation.[1,2] This is usually caused by a hyperextension injury following a fall on the outstretched arm, a motor vehicle accident or a direct trauma, resulting in a dorsal or dorso-radial dislocation in 80-90% of cases.[3] Each trauma is associated with capsular and ligamentous structure injuries, and in 50% of dislocations, an additional bone injury. Concomitant radial head and coronoid process fractures are of particular importance for joint stability.[4-9] After fracture dislocation of the elbow, up to 70% of the patients suffer severely restricted range of motion.[10] The risk of persistent instability and osteoarthritis increases significantly with the severity of the concomitant bone injury.[11] The gold standard of treatment after elbow fracture dislocation is an early open reduction, internal fixation and restoration of stability, including reconstruction of capsular and ligamentous structures, to allow early mobilization.[6,12-14] Usually, a stable condition is achieved without the need for immobilization by using an external fixator.[15-25] Naturally, patients have to avoid carrying and lifting heavy weights and axial compression for approximately six weeks. The duration of post-operative immobilization with a cast, brace or external fixation device is determined by the clinical stability of the joint. Prolonged splinting jeopardizes early rehabilitation and recovery of joint function. Different types of external fixation devices offer controlled hinged motion using the combination of stable reduction of the joint and possibility of concentric (isometric) early functional mobilization.[26-34]

In non-compliant patients, and those who are likely to be non-compliant after surgery, it may be necessary to secure the operative result with an external fixator instead of a brace to avoid a secondary dislocation of the internal fixation, persistent instability and significantly increased osteoarthritis after acute trauma.[35] However, as yet no results have been published. In the present study, we assessed the clinical and radiological outcome of these 11 cases with use of the Orthofix®. The Orthofix® is minimally invasive, rapidly applied and allows early controlled movement about the axis of rotation of the elbow joint, and early flexion and extension. It also allows immediate pronation and supination, is well tolerated by the patient and offers the option of gradual extension or flexion where required.

Orthofix International was a result of the work of orthopedic researcher Giovanni de Bastiani of the University of Verona in Italy. Toward the end of the 1970s, Bastiani proposed the concept of "dynamization", based on the natural ability of bone to repair itself. He developed a modular system of external axial frame devices that could be fitted to a bone, allowing micromovement at the fracture site to stimulate bone healing. Bastiani founded Orthofix Srl in 1980 in order to continue the development of the device and launch it on the commercial market (Orthofix GmbH, Valley, Germany).

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Key words: elbow, trauma, instability, hinged external fixator, fracture dislocation.

Received for publication: 24 August 2010.
Accepted for publication: 27 August 2010.

Orthopedic Reviews 2010; 2:e21
doi:10.4081/or.2010.e21

Materials and Methods

We retrospectively analyzed the medical records and the clinical and X-ray results of 11 patients (5 female, 6 male) who had been treated at our institution with a hinged external Orthofix® fixator following open reduction and internal fixation within the past four years.

Usually, these patients would not need an additional brace but the expected patient non-compliance forced the operator to adopt this approach in order to support the stable internal fixation.

The device was applied during reduction and stabilization surgery. In the acute fracture dislocations, however, the application was delayed 9-19 days in 4 patients because the compliance of the patients had not been correctly evaluated at the time of surgery. Average patient age was 55.3 years (range 30.7-80.8 years). Patient outcome at the latest follow-up visit was assessed clinically in terms of stability and range of motion. The Jäger-Wirth score[35] was used to classify stiffness. Grade I, minor stiffness: >90° extension/flexion mobility; grade II, moderate stiffness: 60-90°; grade III, severe stiffness: 30-60°; grade IV, very severe stiffness: <30°. General regional anesthesia was used in all surgical procedures. The capsule-ligamentous structures were reconstructed after joint reduction and fracture reposition. The application technique of the Orthofix® external fixator is described in detail elsewhere.[36] A K-wire was drilled from lateral to medial through the center of rotation of the elbow joint. This center of rotation was identified using fluoroscopy as the circle produced in the lateral view of the elbow. When the K-wire followed the center of rotation, it appeared as a dot in the middle of the condyles. The wire was advanced into the medial epicondyle without penetrating the medial cortex.

The fixator was then attached to the wire and the proximal pins were placed, guided by the proximal jaws of the fixator. A mini open approach on the lateral aspect of the humerus allowed visualization of the radial nerve. Placement of the distal, ulnar pins was again guided by the distal jaws in maximal flexion of the elbow joint in order to keep the fracture reduced. The K-wire was then removed. A dynamic check of the joint congruency was carried out under fluoroscopy. In order to prevent heterotopic ossification, patients were given indometacin 25 mg twice a day for two weeks.

Statistical analysis

Student's t-test was used to determine the significance of differences between groups. Correlations between two continuous variables were assessed using Pearson's linear regression. A P value less than 0.05 was considered statistically significant. All statistical analysis was performed using SPSS software package (version 12.0, SPSS Inc., Chicago, IL, USA).

Results

The average time in external fixation was 5.8 weeks (range 1.1-11.1). Within the follow-up period of 9.4 months (range 3.1-13.0), the final extension deficit of the elbow joint averaged 24° (range 0-40°), flexion averaged 112° (range 80-130°), pronation 64° (range 40-90°) and supination 53° (range 5-90°). A concentric and stable elbow joint could be restored in all patients. Five patients achieved Jäger-Wirth Grade I minor stiffness; no patient was classified as Jäger-Wirth grade III or IV. In all but 2 patients there was an extension-deficit of 20-40°. The external fixator was applied 5.5 days ± 5.8 after injury (range 0-19 days).

A radial head prosthesis was implanted in one patient with acute instability. In one case, soft tissue damage caused the early removal of the fixator. No patients had preexisting nerve damage and no other event in which a nerve was compromised by the application of the fixator was noted. Figure 1 shows the pre- and post-operative clinical course of a fracture-dislocation combined with a radial head fracture. Figure 2 shows the clinical pictures after the application of the external fixator.

Discussion

Even complex fracture dislocations of the elbow or their sequelae can be reconstructed and eventually achieve a good clinical outcome, if treated by an experienced surgelo.[3,6,12,13] First, of paramount importance is the

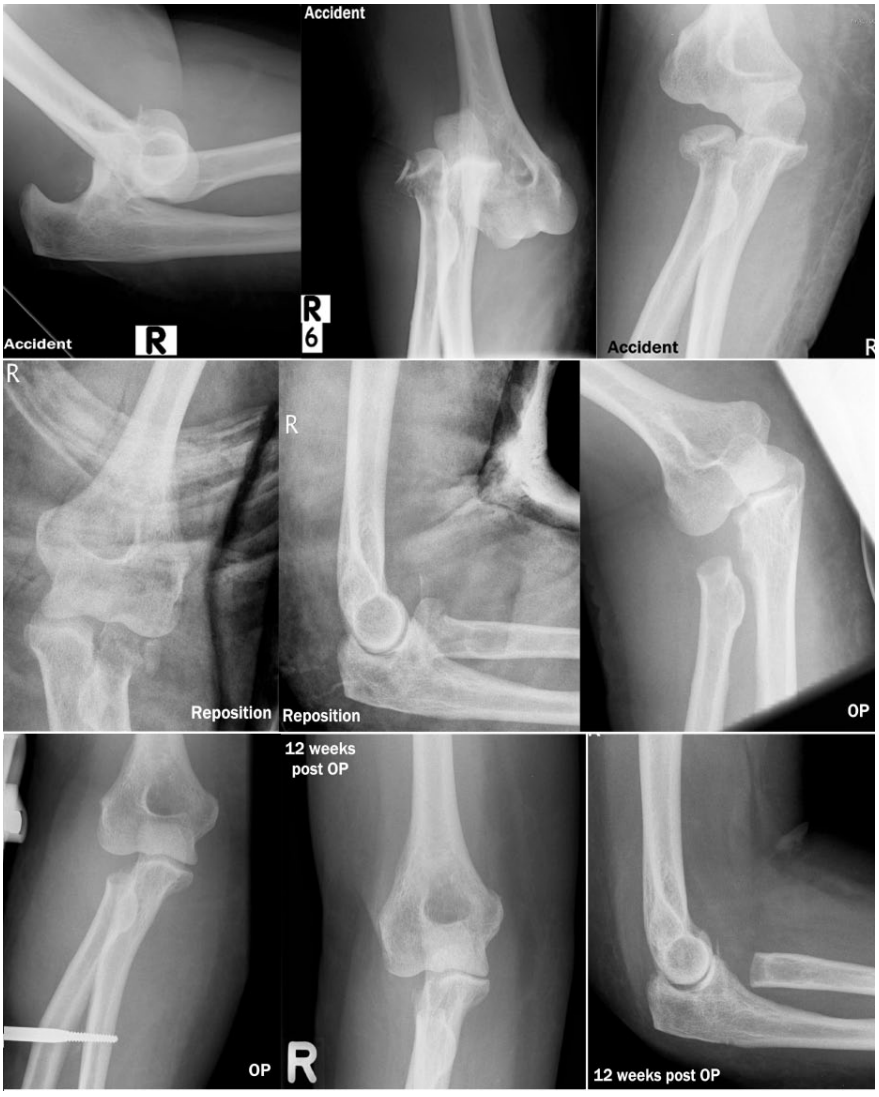

Figure 1. Pre- and post-operative clinical course of a fracture-dislocation: first X-rays after the accident, after reposition/cast, after application of the external fixator with radial head removement, and twelve weeks after the accident.

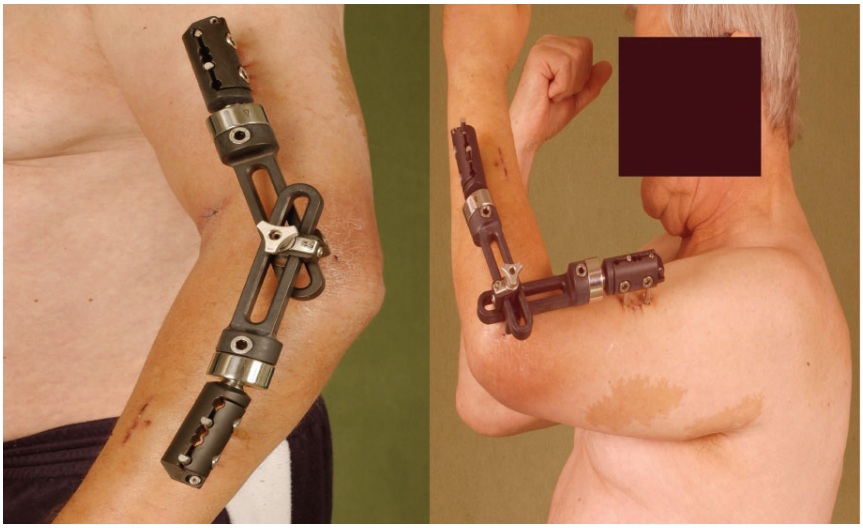

Figure 2. Pictures after the application of external fixator.

reconstruction of the radial head, coronoid process and capsule-ligamentous structures.[6] A second, often underestimated factor, is patient compliance. If the patient does not cooperate post-operatively, even a good surgical result with anatomic reduction and reconstruction of the joint and ligaments will lead to an unfavorable clinical outcome. Thus, an external fixator is applied primarily to protect the internal fixation and maintain concentric reduction during the early post-operative physical therapy, not to achieve stability. Compared to a regular brace, only the external fixator allows early moderate functional mobilization. If the patient proved to be non-cooperative or if the surgeon had any concerns about the patient's post-operative compliance, the fixator was applied during surgery. The surgeon rated each patient as not compliant or unable or unwilling to cooperate post-operatively for various reasons, such as alcoholism, drug abuse, mental disability, cerebral trauma or senile dementia, even though it is difficult to verify classification of this kind after acute trauma. The Orthofix® elbow external fixator must respect the normal ulnohumeral kinematics of a hinged joint. If the normal rotational axis is reconstructed, concentric ulnohumeral motion is possible while the periarticular soft tissues are protected against strain, which would compromise correct healing. Favorable short and intermediate-term clinical results have been reported for the treatment of complex elbow injuries with different hinged elbow fixators.[28,32,33,37] Good short- and intermediate-term results by using the external fixator for the post-operative treatment of complex elbow injuries are reported in various publications.[14,28,29,33,37]

As the correct application of the external fixator is technically demanding, we recommend the critical application of this device. The most important step is to place the axis pin correctly at the center of rotation in order to reduce frictional resistance and to avoid loosening.[2] A deviation of only 5° from the center of rotation results in a 3.7 fold increase in kinetic energy, and a deviation of 10° in a 7.1 fold increase.[30] A kinematic study of 8 elbow preparations resulting unstable after ligament section concluded that the Orthofix® external fixator efficiently stabilized the unstable elbow joint by accepting changes in the physiological motion pattern.[36] This emphasizes the need for a correct placement of the device.

A major shortcoming of this study was the use of medical records made at routine follow-up examinations without having a functional outcome score. In spite of this, we believe we have demonstrated that concentric stability of the elbow joint and a satisfactory overall clinical and radiological outcome can be achieved in acute elbow trauma, since no patient had to undergo further surgery because of recurrent instability. No severe elbow stiffness (grade III- IV) was observed at the latest follow up.[38] In one case, the fixator had to be removed after one week because of soft-tissue status. Regarding these and other possible complications, like nerve injury and infection, we recommend that use of the external fixator must be carefully evaluated. In non-compliant patients with a complex acute instability, in whom compliance is difficult to determine, the external fixator device is used to preserve the painstakingly achieved positive surgical result, with anatomic reduction and reconstruction of the joint allowing moderate functional mobilization and avoiding an impending secondary dislocation.

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