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Critical time period for recovery of functional range of motion after surgical treatment of complex elbow instability: Prospective study on 76 patients

Giuseppe Giannicola *, David Polimanti, Gianluca Bullitta, Federico M. Sacchetti, Gianluca Cinotti

Department of Orthopedic Surgery, "Sapienza" University of Rome, Rome, Italy

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ABSTRACT

Introduction and aim: Complex elbow instability (CEI) is one of the most troublesome pathologies that orthopaedic surgeons have to face. One of the key requirements regarding the CEI surgical treatment is an early rehabilitation programme to avoid the elbow stiffness caused by a long period of immobilisation. Although this is well known, no study has ever examined how, and to what extent, the functional range of motion (ROM) is recovered during the various stages of a prompt rehabilitation. Our aims were: (1) to prospectively analyse the pattern of ROM recovery in a series of patients with CEI who underwent early rehabilitation and (2) to identify the period of time during rehabilitation in which the greatest degree of motion recovery is obtained.

Materials and methods: A total of 76 patients (78 elbows) with CEI were followed up for 2 years. All the patients underwent anatomical and stable ostheosynthesis of all the fractures, radial head replacement in Mason III fractures, ligament injuries reconstruction and early rehabilitation that started 2 days after surgery. Two surgeons evaluated the ROM with a hand-held goniometer every 3 weeks for the first 3 months, then at 6, 12 and 24 months after surgery.

Results: At the 3-week follow-up, the mean flexion (F), extension (E), pronation (P) and supination (S) were 113°, 29°, 60° and 62°, respectively. At the 6-week and 9-week follow-up, F, E, P and S were 119°, 23°, 70° and 69° and 123°, 24°, 72° and 71°, respectively. At the 3-month follow-up, these values were 131°, 18°, 76° and 72°, while at the 6-month follow-up they were 136°, 15°, 79° and 77°, respectively. Thereafter, the ROM improvement was not significant.

Discussion: This study shows that the first 6 months represent the critical rehabilitation period to obtain a functional elbow; indeed, 70% of the patients recovered functional ROM between the third and sixth month, though the recovery of flexion proved to be slower than that of the other elbow movements. Thereafter, improvement continued, though at a lower rate, until the end of the first year, when approximately 80% of the patients had recovered the functional ROM.

Conclusions: Following CEI surgical treatment, a rehabilitation programme needs to be started promptly and continued for at least 6 months because a significant improvement of ROM occurs prevalently in this period, which should be considered the critical time period to obtain a functional elbow in a majority of patients.

Introduction

Fracture–dislocations of the elbow are complex injuries historically associated with unsatisfactory outcomes [1–5]. In the last decade, advances in our knowledge of functional anatomy combined with improved implants and surgical techniques have translated into better outcomes for patients affected by complex elbow instability (CEI) [6–10]. To date, the primary goals of surgery are the anatomical and stable ostheosynthesis of all articular fractures and the reconstruction of ligament injuries to recover elbow stability, which allow early motion and thus avoid elbow stiffness [9–14]. In this regard, several studies recommend that rehabilitation should be initiated as early as possible because an extended postoperative period of immobilisation is associated with significant functional impairment [15–18]. Although it is well known that functional outcomes are better in patients who undergo early rehabilitation, no study has ever examined how, and

* Corresponding author at: Via Emilio Repossi 15, C.A.P. 00185 Rome, Italy. Tel.: +39 3484934300; fax: +39 0687198146.
E-mail address: giannicola.giuseppe@gmail.com (G. Giannicola).

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to what extent, the range of motion (ROM) is recovered during the various stages of a prompt rehabilitation programme [18]. Indeed, previous studies on this topic have only analysed the clinical results of CEI treatment and reported the ROM achieved at the final follow-up, without however providing any information on the recovery of ROM in the various stages of rehabilitation [4,5,7,8,13].

The purposes of the current study were: (1) to prospectively analyse the pattern of ROM recovery in a series of patients with CEI who underwent an early rehabilitation programme and (2) to identify the period of time during rehabilitation in which the greatest degree of elbow joint motion recovery is made. The hypothesis of this study is that immediate postoperative elbow mobilisation ensures a recovery of functional ROM in the majority of cases.

Materials and methods

Between 2005 and 2011, a single surgeon (G.G.) performed surgery on 76 patients (78 cases) with CEI. The patients comprised 41 females and 35 males. All the patients were skeletally mature and had a mean age of 52 years (range 16–86 years). Two patients had a bilateral injury.

The injury patterns included: five radial head fracture–dislocations, five coronoid fracture–dislocations, 22 terrible triads, 35 fracture–dislocations of the proximal ulna and radius (Monteggia-like injury) and 11 capitulum humeri and trochlea fractures with ligament injuries.

The same diagnostic and therapeutic algorithm was applied to all the patients. Radiography and a computed tomography (CT) scan with three-dimensional (3D) reconstruction were performed before surgery in all the patients. Surgical treatment was performed a mean of 3 days (range 1–7 days) after trauma. All the operations were performed according to a one-step procedure. A posterior or extended postero-lateral skin incision was used in all the patients. The Kocher interval was used to expose the lateral compartment while an over-the-top approach, or elevation of the flexor–pronator muscles from the subcutaneous and medial border of the ulna, was adopted to expose the medial compartment.

Briefly, surgical treatment consisted of open reduction and internal fixation (ORIF) of all the fractures and radial head replacement in unreconstructible Mason III injuries. Following ORIF, soft tissue lesions of the lateral compartment were repaired in all patients. A fluoroscopic assessment of elbow stability was performed. If elbow stability was not achieved, the medial collateral ligament (MCL) was exposed and repaired. If elbow instability was still present at the end of surgery, a hinged elbow fixator (HEF) was positioned. At the end of the surgical procedure, one intra-articular drainage and one subcutaneous drainage were applied.

Postoperative management

The elbow was immobilised in extension and raised position for the first 48 h with a plaster splint. The HEF device, in the nine patients in whom it was implanted, was locked in extension for the same period of time. In patients with anterior coronoid fractures repaired with transosseous sutures (12 cases), the elbow extension was limited to 30° until 25 days postoperatively. Cryotherapy was applied and analgesic therapy was performed. Indomethacin (100 mg daily) was administered for 5 weeks to prevent heterotopic ossification (HO). After removal of the drainages (after 48 h), either a hinged elbow brace was applied for 45 days or the HEF was unlocked. The elbow rehabilitation programme began within 2 days of surgery. The HEF was removed between 6 and 7 weeks after surgery.

The rehabilitation programme was divided in three phases: (1) the 'acute phase' defined as a stage of bone nonunion, usually lasting between 0 and 6 weeks post injury, or until union occurred; (2) the 'sub-acute phase', defined as the next stage after bone healing, which occurred between 6 and 12 weeks post injury; and (3) the 'functional phase', after 3 months. In the acute stage, patients were instructed in rest, limb elevation, precautions, activity modification and pain management. Furthermore, patients started exercises for passive range of motion (PROM) (first seven postoperative days), active assisted range of motion (AAROM) (after first postoperative week) and active range of motion (AROM) (after second postoperative week) under the supervision of the personal therapist. Physiotherapy was performed with a therapist five times a week for an hour each time. In addition, the therapist treated the wrist, hand and shoulder to avoid secondary stiffness. Moreover, patients started a home exercise programme, consisting of at least five 20-min sessions per day. During the extension exercises performed in the first 6 weeks, the forearm was positioned in pronation or supination, respectively, in cases of lateral collateral ligament (LCL) or MCL deficiency, due to weak reconstruction (LCL) or not-repaired lesion (MCL); when both ligaments were repaired, the forearm was positioned in neutral rotation. Complete forearm rotation was allowed immediately at 90° of flexion.

During the second and third phases of the rehabilitation, therapists focussed to a greater degree on the restoration of elbow functions; in particular, patients not only continued AROM, AAROM and PROM exercises and followed the home programme (during the sixth to 12th week), but they also started stretching, strengthening and functional exercises (after the 12th week).

Clinical evaluation

Patients were followed up for 24 months postoperatively. Clinical evaluations were performed every three weeks for the first 3 months, thereafter at 6 months, 1 year and 2 years after surgery. Elbow ROM was measured by two independent surgeons using a hand-held goniometer centred on the lateral epicondyle and aligned along the axis of the arm and forearm to calculate the flexion/extension arch and aligned, on the frontal plane, along the arm's axis to calculate the forearm rotation. In case of disagreement between the two surgeons' values of elbow ROM, a third common evaluation was performed to reach an agreement.

Statistical analysis

Due to the small numbers of some CEI patterns, statistical analysis was performed on all 75 cases without splitting the initial patients into different CEI groups. The paired *t*-test was performed to assess the differences in elbow ROM values obtained at each follow-up while the McNemar test was used to assess the differences in the rate of patients who recovered the functional ROM. A p-value <0.05 was considered significant. All computations were carried out using SPSS software 21.0 (IBM Corporation, Armonk, NY, USA).

Results

We reviewed 75 out of 76 patients. At the final follow-up, the mean extension was 11.4° (range 0–60°), while the mean flexion (F) was 140.1° (range 100–155°). The mean flexion/extension arc of movement was 128.5° (range 50–155°), while the mean pronation and supination were 80.1° (5–90°) and 77.1 (0–90°), respectively. In Table 1 are reported the mean and the extreme values of F, extension (E), pronation (P) and supination (S) obtained at each follow-up in all 75 patients. We observed a statistically significant