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Original article

# Pre- and postoperative complications of adult forearm fractures treated with plate fixation

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ABSTRACT

*Introduction:* Adult forearm fractures account for 1–2% of all fractures of the limbs. The main objective of this retrospective multicenter study was to evaluate pre- and postoperative complications of forearm fractures. The secondary objective was to evaluate functional and radiological results of plate osteosynthesis for these fractures.
*Material and methods:* Between January 2008 and March 2014, 131 forearm fractures were reviewed retrospectively. Fractures were classified preoperatively according to the AO classification. Clinical outcomes were classified into four categories according to the Tschnerne and Oestern classification. Pre- and postoperative complications were sought systematically.
*Results:* Before surgery, 12 patients had neurological impairment (9%). At the last follow-up, nine patients had persistent neurological disorders (6.9%). Union of forearm fractures was obtained in 122 patients at 4.6 months on average (± 2.6). Nine patients with nonunion were observed (6.9%) and five patients had radioulnar synostosis (3.8%).
*Discussion:* The frequency of neurological complications concomitant to forearm fractures is noteworthy. Similar cases with essentially irritative neurological disease have been reported in the literature, in particular for the ulnar nerve. Fracture nonunion is a relatively common complication: between 2 and 10% of cases depending on the study.
*Level of evidence:* IV.



## 1. Introduction

Diaphyseal forearm fractures in adults account for 1–2% of all fractures of the limbs. One out of two of these fractures occur in men under 50 years of age, with stable frequency over time [1–3]. Few scientific articles have reported on these fractures [4–6].

Their treatment is generally based on open osteosynthesis with plates and screws on each of the forearm bones. Nonunion of the fracture seems to be the most frequent complication of these fractures [7,8]. All authors therefore emphasize the need for anatomical reduction with compression of the fracture site to encourage bone union [7–11]. Recent use of plates with locking screws does not seem to have modified these radiological results (nonunion rate: 2% and 10% in the literature) [12–16]. The main objective of this retrospective multicenter study was to assess the pre- and postoperative complications of adult forearm fractures. The secondary objective was to assess the functional and radiological results of the plate osteosynthesis of these fractures. We hypothesized that there were predictive factors of poor radiological results during surgical treatment of diaphyseal forearm fractures in the adult.

## 2. Materials and methods

This was a retrospective, multicenter (three centers) study. Single-bone antebrachial fractures (Monteggia or Galeazzi) were excluded from the study, as were distal and proximal metaphyseal fractures. All the adult diaphyseal forearm factures treated surgically between January 2008 and March 2014 were included in this

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**Table 1**
Criteria relating to results according to Tscherne and Oestern [18] reported by M'Seddi et al. [5].

| Result | Range of motion deficit | Function | Complaints |
|---|---|---|---|
| Very good | Elbow: extension: 0°; flexion: 15° Pronosupination: 15° Wrist dorsal-palmar flexion: 15° Wrist abduction/adduction: 5° | No limitation in strength Full neurological functions | None |
| Good | Elbow: extension: 10°; flexion: 30° Pronosupination: 25° Wrist dorsal-palmar flexion: 25° Wrist abduction/adduction: 10° | Slight deficit in strength Full neurological functions | Subjective, minimal |
| Fair | Elbow: extension: 20°; flexion: 45° Pronosupination: 45° Wrist dorsal-palmar flexion: 35° Wrist abduction/adduction: 10° | Slight to intermediate deficit in strength Preoperative nerve function deficit | Greater subjective complaint during all movements |
| Poor | All deficits greater than previously | Very high reduction in strength, nerve function deficit with no preoperative lesions | Substantial subjective complaints with reduction of joint range of motion |

study for a total of 131 fractures. All patients were reviewed radiologically and clinically in May 2014 by an independent operator in each center.

The fractures were classified preoperatively according to the AO classification [17]. In all the patients, open fixation was placed in less than 24 h via a direct approach on the ulnar crest for the ulnar component and via an anterior Henry approach for the radial component, adapted to the fracture level. Preoperative complications were determined from the surgical reports and hospitalization reports (open skin, compartment syndrome, neurological disorders). At the last follow-up, the clinical results were classified into four categories using the Tschnerne and Oestern classification [18] (Table 1). Pronosupination was measured using a goniometer. Union of the fracture was demonstrated by radiological obliteration of the fracture site on the cortex opposite the plate on two images and the presence of trabeculae bridging the fracture site. During this consultation we looked for different postoperative complications: infection, radioulnar synostosis, nonunion, and neurological impairment. Nonunion was suggested in patients with pain presenting mobilization of the osteosynthesis material and/or absence of radiological obliteration of the fracture site on the cortex opposite the plate on two images and the presence of trabeculae bridging the fracture site. Nonunion was confirmed with CT.

Of the 131 fractures included, 93 occurred in males and 38 in females. The mean age of the patients was 35.1 years (± 17 years). The left forearm was fractured in 88 cases and the right forearm in 43 cases. Fifteen patients were smokers and seven patients were alcoholic. The lesional mechanism resulted from low-energy injury in 15 cases (11%) and in 116 cases high-energy injury (89%). For these high-energy accidents, 31 were two-wheeled-vehicle traffic accidents (27%), 32 were four-wheeled-vehicle traffic accidents (28%), 19 were sports injuries (16%), and 34 resulted from diverse mechanisms (29%). These 131 forearm fractures were isolated in 89 cases (68%) and within a context of multiple injuries or multiple fractures in 42 cases (32%). Three patients presented a floating elbow associating an antebrachial fracture with a humeral fracture.

**Table 2**
Distribution of fractures according to AO classification [17].

| Type of fracture according to AO [20] | *n* (%) |
|---|---|
| A 3 1 | 3 (2) |
| A 3 2 | 49 (37) |
| A 3 3 | 4 (3) |
| B 3 1 | 19 (15) |
| B 3 2 | 18 (14) |
| B 3 3 | 11 (8) |
| C 1 2 | 6 (5) |
| C 1 3 | 3 (2) |
| C 2 2 | 5 (5) |
| C 2 3 | 1 (1) |
| C 3 1 | 3 (2) |
| C 3 2 | 5 (4) |
| C 3 3 | 4 (3) |

Of the 131 fractures, 89 were closed (68%) and 42 open (32%), 31 of which were type I according to the Gustillo classification, ten were type II, and one was type III A in the context of a forearm degloving injury [19]. One patient presented compartment syndrome of the forearm upon admission.

According to the AO classification [17], 56 fractures were type A3 (simple fracture of both bones), 48 type B3 (one bone wedge fracture combined with a simple fracture of the other bone), and 27 type C (complex fracture of both bones). The lesions are detailed in Table 2.

All the fixation plates used were DCP 3.5 locking plates (Depuy-Synthes®, Etupes, France) in 91 cases and LC-DCP 3.5 in 40 cases. The site was compressed systematically by the plate and/or an independent screw. Three screws or more were positioned on both sides of the fracture site in 109 radial and 96 ulnar fixators. The mean surgical time was 80 min (range: 45–120 min) and the mean hospital stay was 9 days (± 16.7 days). The elbow was immobilized in 75 cases for 3–6 weeks, for a mean of 38.9 days (± 15.8 days).

The statistical analysis was conducted by a statistician using Statview 5.0 and SAS 9.1.3 software (SAS Institute, Cary, NC, USA). The results of the quantitative variables are presented as mean ± standard deviation, range, and median. The results of the qualitative variables are expressed as frequencies and percentages. The qualitative variables of the two groups of subjects were compared using chi-square tests or Fisher exact tests depending on the theoretical numbers of patients and the number of classes of the variables considered. The significance threshold set for all the statistical analyses was 0.05.

## 3. Results

### 3.1. Pre- and postoperative neurological complications

At admission, 12 patients presented neurological impairment (9%): seven cases of paresthesia in the median nerve territory, two cases in the ulnar nerve area, and one case in both median and ulnar territories. Two patients presented high radial nerve paralysis in the context of floating elbow. The preoperative neurological problems totally regressed in seven cases and persisted in five.

Immediately after surgery, we observed 8.7% neurological complications (11 cases): 4.6% paresthesia, or six new patients compared to the preoperative period (two in the median nerve territory, two in the ulnar nerve area, one in the median-ulnar nerve territory, and one in the radial nerve area) and 3.8% paralysis, or five new patients compared to the preoperative state (one case of ulnar nerve paralysis, two of radial nerve paralysis, and two cases of anterior interosseous nerve paralysis).