

## ***CLINICAL STUDY***

### **Treatment Results Of Diaphyseal Forearm Fractures With Dynamique Compression Plate A Retrospective study of 156 Cases.**

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#### **ABSTRACT**

This retrospective study addresses a series of 156 cases of forearm fractures. These 156 cases were managed in the trauma-orthopedic department (B4) of Fez University Hospital, Morocco, from May 2008 till January 2013. The purpose of this study is to analyze epidemiological and clinical factors of diaphyseal forearm fractures and the results of their treatment with dynamic compression plate (DCP), as well as the complications and therapeutic errors of this surgical technique. The frequency of hospitalization in the trauma-orthopedic department was 3,96%. Ages ranged between 16 and 83, the average age was 32. 132 patients were male (85%). 90% were managed at the day of trauma. Traffic accidents were the most frequent cause in 52% patients. The fracture was in the left forearm in 65% of patients. 53% of fracture lines were in the middle third of the forearm. 38 fractures were open, and 30 were admitted for polytrauma. Osteosynthesis was performed with dynamic compression plate for all patients. In comparison with the literature, our series shows the predominance of young male patients, with traffic accidents being the cause. Osteosynthesis with dynamic compression plate remains the treatment of choice that provides satisfactory results if the accuracy in this technique was respected.

**KEY WORDS:** forearm, shaft fracture, dynamic compression plate, clinical and radiological results.

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#### **INTRODUCTION**

Fractures of both bones of the forearm are relatively frequent trauma lesions in the common practice of orthopedic surgery (1, 2). They include all fractures that affect one or both bones of the forearm, where the line is at the interosseous membrane height, ie any fracture line being two centimeters below the bicipital tuberosity and four centimeters above the radiocarpal space. This radio-clinical entity does not cause a diagnostic problem, but mainly causes a problem of therapeutic order linked to the anatomical characteristics of the forearm, supporting pronation and supination. An accurate diagnosis of these lesions is important in order to provide appropriate and urgent treatment to restore normal anatomy of the forearm. Screening and treatment of associated lesions and the

upper and lower radioulnar joints are mandatory as they allow obtaining an accurate functional result. The treatment of this clinical entity could be orthopedic or surgical (1).

In the treatment of diaphyseal forearm fractures in adults, the main treatment goals are: to restore the length of the forearm, to control axial rotation disorders, and to restore anatomical alignment of the two forearm bones, and maintain them until a total consolidation is achieved (3). There are three forms of osteosynthesis that are currently operating, each of which has their own specificities and complications: screwed plate, which is the subject of our study, locked centromedullary nailing, and external fixation. These proposed treatments will tend to block the torsion and distraction forces which mainly develop. The

purpose of surgical treatment is to achieve total consolidation of the fracture site and restore the functional anatomy between the radius and ulna, in order to get a normal hand function (4). The open reduction and internal fixation of diaphyseal forearm fractures with the use of a dynamic compression plate (DCP) is a known therapeutic procedure (3, 5).

In this monocentric retrospective study, we want to analyze epidemiological and clinical factors of diaphyseal forearm fractures and the results of their treatment with screwed plate (DCP), as well as the complications and therapeutic errors of this surgical technique. We will compare, through a review of literature, the results of different treatment methods.

## MATERIAL AND METHODS

This is a monocentric retrospective study of 156 patients treated between May 2008 and January 2013 for diaphyseal forearm fractures. The inclusion criterion referred to the existence of a fracture of the diaphysis of one or both bones of the forearm, isolated radius fracture, isolated ulnar fracture, Galeazzi or Monteggia fracture-dislocation, treated with a dynamic compression plate (DCP) and comprehensive clinical records with initial radiological assessment and postoperative follow-ups. The following fractures were excluded: fractures treated by another screwed plate type 1/3 tubular plate and other therapeutic modalities, metaphyseal-epiphyseal fractures, open fractures initially treated by other technique and treated afterwards with dynamic compression plate (DCP), and forearm nonunions, and patients who died before consolidation.

We used, in the initial X-rays, the AO classification (6) to classify the forearm fractures. Based on immediate X-rays of the third and the sixth month and at last follow-up, we analyzed the level of the fracture and the associated lesions. Furthermore, the interpretation of the X-rays also enabled the search for technical errors and contributing factors to nonunion. Our study included 156 patients, 132 men and 24 women, with a sex ratio of 5.5, an average age of 32 (16 years and 83 years). Traffic accidents are the most frequent cause of fractures of both bones of the forearm constituting 52% of cases in our series, followed by falling in 21% of cases, attacks in 20%, sports accidents in 5% and work accidents in 2%. The left side was more frequently affected than the right side in 65% of cases. Skin lesions were found in 27 of our patients, classified according to Cauchoix. We noted three nerve sections (radial nerve, ulnar nerve and median nerve), while 30 patients had associated lesions. The distribution of affected bones was 65 cases of the two forearm bones, 40 cases of ulna only, 36 cases of radius only, 10 cases of Galeazzi fracture-dislocations and 8 cases of Monteggia fracture-dislocation. 53% of fractures lines were in the middle third, with a predominance of simple fractures 74.77% (transverse, short oblique and spiral fractures). 130 of our patients were treated on the same day of their consultations (83%). 20 patients (13%) were treated during the second day and only 6 patients were managed after this period (4%).

\* Surgical technique: The operative instructions are based on the existence of clinical signs (pain and/or mobility of the fracture) and radiological signs (radiological fracture line). The patient was placed in supine position, the upper limb concerned in the operative site. The surgical approach used was the conventional anterior (Henry) approach for the radius, and posteromedial centered on the ulnar for the ulna. The first surgical step consisted in obtaining

anatomic reduction of the fracture. Then, osteosynthesis with a dynamic compression plate (DCP) was performed after manual compression of the fracture site, through fixation with two forceps. The optimal mounting included at least three screws for each side of the fracture site. After the osteosynthesis, a cast immobilization was performed, for analgesic purpose, with plaster splint brachial-anti-brachial-palmar in 146 patients. This immobilization was removed after the edematous and painful effects have disappeared. The ten patients with Galeazzi fracture-dislocation were immobilized by a circular plaster for 45 days. Rehabilitation was an essential component of treatment. All patients in our series underwent a passive and active postoperative rehabilitation period for variable durations and times. It involved the mobilization of the fingers, wrist and elbow to avoid stiffness and to have a better functional result. This rehabilitation has been undertaken since the removal of the Redon drainage and was extended to the recovery of pronation and supination. All patients were reviewed clinically with pain assessment on visual analog scale (7), assessment of mobility of elbow and wrist using a goniometer. An overall assessment of our functional results according to Grace-Eversmann criteria (8) and the DASH questionnaire (9).

Furthermore, postoperative radiological assessment included the X-rays anterior posterior and lateral views of the forearm. The consolidation was deemed to be performed after the existence of bony bridges, in the two orthogonal incidences, between the two edges in the site of nonunion, associated with a lack of spontaneous pain or palpation of the fracture site. The radiological study enables also the search for the presence or absence of malunion and measuring its angulation in the frontal and sagittal planes.

## RESULTS

All patients were operated for a diaphyseal forearm fracture with dynamic compression plate DCP (3.5mm). The average follow-up was 16 months, with extreme follow-ups of 12 and 48 months. All patients were operated by seven senior surgeons. Clinically, pain and limitation of pronation-supination movements were the main reasons for consultation, also all patients were in pain with an average of 8/10 (VAS: 6 to 10) on visual analog scale.

At the last follow-up, the average mobility of the wrist was 70 ° (40 ° -90 °) in flexion (postoperative improvement from the preoperative condition) and 80 ° (40 ° -90 °) in extension, 65 ° (0 ° -75 °) in pronation and 75 ° (0 ° -85 °) in supination. For the elbow, the average flexion was 130 ° (between 90 ° -140 °) and the average extension was 5 ° (Fig. 1)



**Figure 1:** Functional results after a 4-year follow-up (Case 113).

The therapeutic results according to Grace-Eversmann criteria (8) were excellent and good in 89.6% of cases (Table I). Furthermore, the overall average of DASH score was 12 (5-36). Radiological consolidation was performed

in 154 cases (Fig. 2). However, we noted two cases of nonunion. (Fig. 3).

Grace-Eversmann criteria	Percentage %
Excellent	86,6
Good	3,4%
Average	0%
Bad	10%

**Table I :** overall results.



**Figure 2.** Radiological results after a 4-year follow-up. (Case 113).



**Figure 3 :** a: Nonunion of the ulna with screwed plate after an 8-month follow-up ; b : immediate intraoperative appearance after treatment by autologous bone grafting, osteomuscular decortications and internal plate fixation; c : consolidation of the fracture site after a 10-month follow-up (Case 69).

#### Complications:

The specific complications to curing diaphyseal forearm fracture include seven hematomas (4.5%) that were absorbed with local treatments. 3.2% of patients showed an early superficial postoperative sepsis, well dried with appropriate antibiotic therapy. 8.3% of cases showed algodystrophy that well evolved after a year of evolution. Furthermore, there was one case of radioulnar synostosis and no cases of Volkmann contracture.

#### DISCUSSION

Fractures of both bones of the forearm can occur at any age. They often occur in young people who are very active and, therefore, more exposed to traffic accidents. The average age in our series is similar to that of Özkaya (10). In our series, more than 2/3 of patients were male, which is consistent with the literature data. Most authors report a slight predominance of fractures of both bones of the forearm on the left side, and this is consistent with the results of our series. We found, as in the series of the literature, the majority of fractures were due to a severe trauma, especially following a traffic accident, and this is undoubtedly related to the frequency of this scourge in our context.

The interview with the patient must first reveal the circumstances, the time, the mechanism of injury, the

dominant side and the type of professional activity. The pain was still present in the acute stage. Lameness is most often total, the patient holds his broken limb in the classic position for the upper limb trauma. The inspection, in case of displaced fracture, shows a swelling associated with deformation of the forearm. Palpation allows the identification of tender points, at the fracture site, associated with impossibility of pronation and supination. The loco-regional examination verifies the absence of cutaneous opening and neurovascular complications, especially by palpation of the radial and ulnar pulses to find a damaged ulnar nerve.

The X-rays anterior posterior view and lateral of forearm are usually sufficient to diagnose and classify the fracture and guide therapy. The classification adopted concerning the fracture of both bones of the forearm is that of AO (6). The difficulty of classifying fractures, regardless of the site, lies in the choice of the selected criteria. If the theoretical interest of these criteria is to provide prognostic value, they are in fact rarely used in clinical practice, since the prognosis of a forearm fracture depends on several factors: the surgeon and the surgical technique used, as well as the type or mechanism of the fracture.

The goal of treatment of both forearm bones fractures is restoring a good function of pronation and supination, restoring normal length of the two bones of the forearm, keeping the physiological radius curvatures, and preserving the integrity of superior and inferior radioulnar joints (11). Surgical treatment offers the advantage of appropriately reducing the bone fragments and ensuring osteosynthesis, with screwed plate (12), intramedullary pinning, or external fixation (11). Surgical treatment of forearm fractures has been the subject of many publications. Thus, three forms of osteosynthesis are described, each with their own specificities and complications: the screwed plate, intramedullary nailing and external fixation. Surgical fixation of these fractures is essential for early mobilization of the overlying and underlying joints, as well as perfect bone healing and preventing the progression into nonunion where therapeutic treatment is more complicated (13).

The standard technique of osteosynthesis with dynamic compression plate of diaphyseal forearm fractures was well established (12), their consolidation ratio was always over 95%, with good functional results higher than 85% (3, 5, 13-15). An early mobilization is the key to avoiding stiffness, also soft and continued rehabilitation should be undertaken. Most authors recommend immediate therapy with mobilization of fingers, wrist and elbow.

The analysis of the rate of immediate complications shows that disparities exist between different series. Among the mostly found complications in the literature, we note: postoperative infections that are higher than 2% in the series of the literature; we noted no such cases among our patients and this is also the case for Volkmann contracture, in contrast, Bauer (16) reported a single case (0.6%) in the series of 167 cases. Kloen (17), noted 5.7% of cases of nonunion, which is consistent with our study. A number of risk factors were responsible for the development of these diaphyseal forearm fractures into nonunion, regardless of the surgical technique. These elements are associated with the following: age and osteoporosis, smoking, high energy trauma and comminuted fractures, open fractures with periosteal stripping and inadequate osteosynthesis. Those factors are confirmed by many authors (17-20).

Technical errors were found in the management of the forearm fractures which explains nonunion that was found in our series, namely: a plate of which the most proximal

of the three distal screws appeared in the fracture site, the use of a single pin in the ulna pinning (K-Wire), little filling and consisting of very fine pins, open fractures treated with external fixation. On the other hand, we insist on the absence of indications of minimally invasive techniques that can limit surgical exposure and prevent an anatomic reduction. The radioulnar synostosis is defined as the presence of a bone bridge between the radius and ulna that block pronation and supination which severely aggravates the functional prognosis of the forearm. We reported one such case in our series. Malunion is becoming increasingly rare with utilization of dynamic compression plates (DCP); it also remains possible with external fixation (21). No such cases were noted in our series. Bot (22), Noted 7% of iterative fracture, which is consistent with our series.

In the light of the results obtained in our series, we note that the treatment of diaphyseal forearm fractures with a dynamic compression plate (DCP) gives excellent results, if the principles of this technique are respected. These principles are: anatomical reduction of the fracture, the restoration of the alignment, the length and rotation. We used the same therapeutic procedure in all patients, osteosynthesis with screwed plate (DCP). Some authors of the literature showed that fixation of the two bones of the forearm fractures with intramedullary pinning (Kirschner wire) and an osteosynthesis with third tubular plate have a high risk of nonunion considering the fixation failure (15). Currently, the surgical technique of choice is the dynamic compression plate (3.5mm) where most authors recommend the use of six cortical bones on either side of the fracture and another suggests four cortical bones on each side of the fracture site for a better fixation (23). Our results are identical to those of the various authors published in the literature, with minimal complications and a consolidation ratio of 97% in our series and between 91 and 100% according to the literature, with excellent final functional results. So, this surgical method remains, in our opinion, an excellent technique for treating forearm fractures.

## CONCLUSION

This work shows that the use of osteosynthesis with DCP plate for fractures of both bones of the forearm allows perfect anatomic reduction. It provides an excellent and rapid consolidation, with complications that remain minimal in general, and a reduced hospital stay. Lastly, rehabilitation remains an essential complementary therapy; it must be done early and carefully. The fight against traffic accidents would dramatically reduce the frequency of these lesions.

## AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the [Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals](#) of the [International Committee of Medical Journal Editors](#). Indeed, all the authors have actively participated in the redaction, the revision of the manuscript and provided approval for this final revised version.

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Declared none.

## COMPETING INTERESTS

The authors declare no competing interests.

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