

## Percutaneous elastic-dynamic fixation for the treatment of volar displaced distal radius fractures. A solution for elderly patients?

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### ABSTRACT

**Aim** The Epibloc elastic-dynamic fixation has been applied for many years at several hand surgery centres in Italy. This technique has been considered safe and reliable in the treatment of distal meta-epiphyseal fractures of the radius with dorsal displacement. The aim of this study was to evaluate an alternative use of this method in the treatment of volar displaced wrist fractures in cases where an internal fixation could not be recommended.

**Methods** The procedure consisted of two flexible pins with a trocar tip and an external plate for locking fixation with compression. The surgical technique was derived from the original procedure, modifying the placement of the pins and performing small surgical accesses to preserve the neuro-vascular structures of the volar aspect of the wrist. To achieve and preserve the reduction of the volar fragment, a third pin was inserted into the fracture with a similar procedure to Kapandji's reduction technique.

**Results** At three-month follow-up, most patients did not experience any pain. In 14 cases, the strength grip was recovered between 75% and 90%, compared to the contralateral hand (Jamar test). In 15 patients, the wrist range of motion was restored with values greater than 100. In 17 cases, forearm pronation-supination was restored to more than 120°.

**Conclusion** In cases of non-comminuted, one or two fragments volar displaced wrist fractures, the elastic-dynamic fixation associated with an intrafocal pinning reduction may be proposed as an alternative to open reduction and internal fixation in elderly patients.

**Key words:** comorbidities, Epibloc, fragile, non-invasive, wrist

## INTRODUCTION

The Epibloc elastic-dynamic fixation (EDF), developed in the 90s (1-2), has been applied at several Hand Surgery Centres in Italy for the treatment of metaphyseal dorsal distal radius fractures. Several reports have been published on this topic (1-6), among which a multicentre study consisting of 326 cases operated with this method (2). The procedure is based on manual reduction of the fracture under fluoroscopic control, followed by the percutaneous introduction of 2 steel alloy pins into the medullary canal of the radius (1). To stabilize the fracture, a small external plate is used to tighten each pin with two screws, dynamizing the fixation in distraction, assisted by a mechanism of ligamentotaxis (2). This method, conceived for metaphyseal fractures with dorsal displacement, was originally considered inadequate for volar displaced fractures (4,7). Those fractures are characterized by a deeper bone plane that makes manual reduction difficult and sometimes impossible. Furthermore, numerous and vulnerable subcutaneous vascular, nervous, and tendinous structures lie in the same area (8). Many new and less invasive techniques have been adopted worldwide to treat hand issues in elderly patients (9,10) or patients with comorbidities. Being confident with the experience we have developed in using the Epibloc system for dorsally displaced distal radius fractures, we have started to use it also for volar displaced fractures.

A retrospective study was conducted to evaluate this procedure in the treatment of volar displaced distal radius fractures in patients for whom open surgery could not be recommended. The aim of this study was to clearly describe how to perform this procedure and to determine the patients for whom it would be mostly indicated.

## PATIENTS AND METHODS

### Patients and study design

A retrospective study was conducted in the Orthopaedics and Hand Surgery department of the Gemelli University Hospital of Rome in Italy involving patients attended to the Emergency Department in the period January 2015 to December 2020 with volar displaced distal radius fracture treated with the Epibloc elastic-dynamic fixation (EDF).

Twenty-two cases of volar displaced, non-comminuted, one or two-fragments, distal radius fractures (type 1 and 2 according to Fernandez classification) (11) with EDF were treated and followed up. Of the total of 22 patients, 18 were elderly (over 70 years of age) with some comorbidities, and four were younger patients (range 58-66 years of age) on anticoagulant therapy, which could not be converted or suspended.

All patients were followed up in our Outpatient Clinic. Clinical checks were performed at seven days (radiography), 15 days (dressing), and 30 days (dressing and radiography). In all patients, the fixation hardware was removed between the 35<sup>th</sup> and the 45<sup>th</sup> day. After hardware removal, eight sessions of rehabilitation with a specialized therapist were prescribed to each patient. Successive clinical checks were performed in all patients at three months and at 12 months. The patients were encouraged to move the wrist actively immediately after surgery (Figure 1) as no immobilization was used.



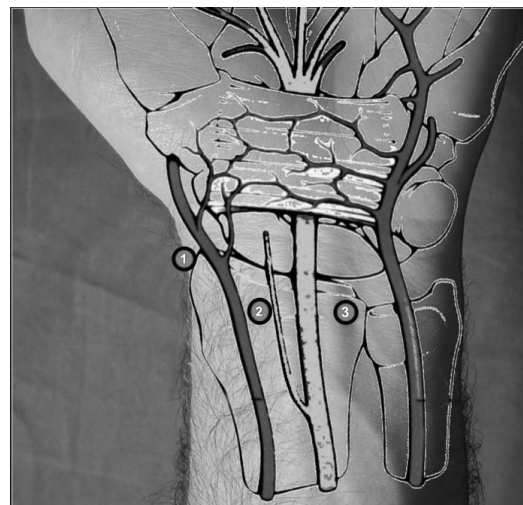
**Figure 1. A) Pre-operative x-ray of a volar displaced distal radius fracture; B) Post-operative x-ray after treatment with the Epibloc elastic-dynamic fixation; C) Post-operative active wrist motion at seven days follow-up (Rocchi L, 2017)**

All procedures were performed following a written informed consent and in accordance with the ethical standards of the Research Committee of the Università Cattolica del Sacro Cuore of Rome, Italy, and the 1964 Declaration of Helsinki, and its subsequent ethical standards.

## Methods

The Epibloc fixation is based on the use of highly flexible steel alloy pins, 2.5 mm in diameter and 35 cm long, equipped with a sharp tip on one side and blunt on the other. These pins are able to penetrate the diaphyseal canal of the radius and slide inside it without penetrating the second cortical layer. This intramedullary fixation, with high elasticity, can be dynamized through an external plate (2). In the original technique, conceived for dorsal fractures, after a manual fracture's reduction in peripheral anaesthesia, the pins are inserted percutaneously on the dorsal aspect of the wrist under fluoroscopic control. Pins were drilled or inserted manually in the distal epiphysis of the radius, at the radial edge of the styloid, and at the internal dorsal epiphysis angle, respectively. They passed through the fracture site, penetrating the epiphyseal canal. Once the tip of the pin was turned on the half-round side, they were pushed to slide along the internal cortex up to the proximal epiphysis. Outside of the wrist, pins were locked in distraction with an external plate. The fixation resulted in transversal ligamentotaxis on the radiocarpal ligaments, which collaborates to maintain the reduction (1-2).

Taking into consideration the vascular and nervous anatomy of the palmar side of the wrist, three points were selected as access points for an intramedullary fixation in the radius: the styloid apex, radially to the radial artery, the central portion of the distal epiphysis, just ulnar to the *flexor carpi radialis* tendon, and the ulnar edge of the epiphysis on the volar side (Figure 2). Bony landmarks were identified by palpation and marked on the skin with a surgical sterile pen. To operate through these access points, a small incision, limited to the skin, was performed on the marked point. Subsequently, the bone plane was reached by bluntly retracting all the soft parts with a dissector scissor and small retractors, with a similar technique to that used to reach the joint in arthroscopy (12). A manual reduction of the fracture on the volar side can be unsuccessful at this step because of the difficulty of manoeuvring through the thickness of interposed tissues. This could result in a persistent breakdown of the fragment and unsatisfactory clinical results. For this reason, in addition to the EDF, we conceived to associate additional pinning inspired by the Kapandji intrafocal reduction technique (13-15).



**Figure 2.** Access points for volar displaced distal radius fractures with the Epibloc elastic-dynamic fixation: 1 - styloid apex, radially to the radial artery; 2 - central portion of the distal epiphysis, just radially to the *flexor carpi radialis* tendon and ulnar to the radial artery; 3 - ulnar edge of the epiphysis on the volar side (Rocchi L, 2015)

This third pin was inserted percutaneously into the fracture rhyme, and used as a lever to reduce the fragment, then fixed to the radius to correct height and inclination.

**Volar fractures surgical technique.** The patient was settled in the supine position with the arm resting on a hand operating table. Under brachial plexus anaesthesia and fluoroscopic control, the wrist was pulled and extended over a folded cloth to obtain a partial fracture reduction. The first approach was performed on the central portion of the epiphysis (access point 2) by bluntly retracting all the soft parts to reach the fracture gap. Through this way, a Kirschner wire, 2-2.5 mm in diameter, was manually inserted from proximal-to-distal through the fracture, passing by blunt way between the radial artery and the flexor carpi radialis tendon and then used as a lever completing the bone reduction on the lateral plane. This pin crossed the medullary canal obliquely and was then drilled to the dorsal cortex of the radius (Figure 3A). During the second time of surgery, using the EDF pins, two pins were introduced into the medullary canal through the lateral and medial accesses (access points 1 and 3) (Figure 3B). Bone fixation was finally stabilized by locking pins in distraction with their external plate (Figure 4). At the end of the surgical procedure, skin incisions were sutured, and a soft dressing was applied around the wrist up to the metacarpal region.



**Figure 3.** A) A Kirschner wire was inserted from proximal-to-distal through the fracture (a), then it was translated distally to reduce the fracture (b) working like a buttress against the displaced fragment, properly handled under fluoroscopic control; B) two more pins were introduced into the medullary canal through the lateral and medial accesses (c-d) to stabilize fracture' reduction (Rocchi L, 2017)



**Figure 4.** A) Pre-operative x-ray of a volar displaced distal radius fracture; B) Post-operative x-ray after treatment with the Epibloc elastic-dynamic fixation; C) X-ray one week after Epibloc removal (Rocchi L, 2018)

**RESULTS**

At the follow-up of 3 months, 13 patients did not experience any pain, seven reported minimal or occasional wrist pain, and two reported moderate pain under strain. No patient referred to severe or intolerable pain. The strength grip was recovered between 75% and 90% in 14 patients, compared to the contralateral hand (Jamar test). In 15 patients wrist range of motion was restored with values greater than 100° and in 17 patients forearm pronation-supination was restored to more than 120°. Results remained similar at the last follow-up (between 12 and 18 months) for the 14 re-evaluated patients (Table 1).

**Table 1.** Clinical results on 22 patients treated with the Epibloc® elastic-dynamic fixation for volar displaced distal radius fracture at 3 months follow-up

Variable	No of patients after 3 months follow-up
<b>Pain</b>	
No pain	13
Minimal or occasional	7
Moderate, under strain	2
Severe or intolerable	0
<b>Range of motion (°)</b>	
>100	15
60-100	5
<60	2
<b>Strength (compared with the other side) (%)</b>	
75-90	14
60-75	6
20-50	2
<b>Pronation-supination (°)</b>	
>120	17
60-120	5
<60	0

In post-operative radiographic checks, the mean radial angle of inclination in the A-P projection was equal to 21°, and the inclination angle of the radial glenoid in the L-L projection was equal to +4°. Among the complications, we recorded the following: 3 superficial skin infections treated with antibiotic therapy and (in two cases) removal of the hardware several days before programmed; a case of algodystrophic syndrome, resolved after four weeks of physiotherapy; a case of loss of reduction in the fracture which presented a misdiagnosed comminution. No cases of non-union, bone infection, tendons, or vascular or nervous injuries were observed.

At one-year follow-up, all results were maintained, and no further complications were described.

**DISCUSSION**

Currently, different methods are available for the treatment of distal radius fracture (16-18). The goal of the treatment is to achieve a good reduction to reach the best functional outcomes. Most of the volar displaced fractures of the distal radius, even not comminuted or multi-fragmentary, are commonly treated by open reduction and internal fixation (16) as there are many potential dangers of percutaneous pinning through the volar plane of the wrist. Such problems can be circumvented by carrying out minimal surgical access to reach the bone and to reduce the volar fragment by means of the lever exercised in the fracture rhyme by a Kirshner wire, which works like a buttress

against the displaced fragment, handled properly under fluoroscopic control (13-15).

In this study, we combined a wrist volar intrafocal pinning to provide good reduction, with an extrafocal fixation on the same side. The advantages of this method are those proper to the percutaneous bone fixations (19-21). These include minimal invasiveness, the absence of bleeding -which is particularly useful in some categories of patients, like patients with cardiovascular issues and anticoagulant therapy, minimal scarring and adhesions, a quick execution with reduced surgical time, one-day hospital, and rapid functional recovery (2-5). Among the disadvantages, the most dangerous one are potential iatrogenic lesions, which can occur if the surgical accesses are not carefully performed (13-15). For this reason, a deep knowledge of the anatomical site is required by the surgeon. A potential loss of reduction should also be considered if the fracture presents comminution or if it is composed of several fragments. In these cases, the method is not indicated (7). This complication occurred in one patient in this study, resulting in a poor outcome. Some minor complications, including local inflammatory disorders linked to the percutaneous pathways of the pins, can also occur (10,13,15). The skin pins' accesses can sometimes complicate into subcutaneous infections a few weeks after surgery, causing local pain and temporary loss of part of the active movement, such as those that occurred in three cases of the series (10,13). This complication, however, can be easily managed with antibiotics and anti-inflammatory therapy (10). Moreover, hardware removal can be anticipated, followed by a short period of wrist splinting (17,19). Most of the patients treated in this casuistry did not present complications and were satisfied with the treatment. It could also be considered that fractures treated with percutaneous fixations heal in a rather short time because the fracture hematoma is not drained (22-24).

Although all patients treated in this study were operated on under general anaesthesia, a possible further advantage of this technique could be the possibility of using the Wide Awake Local Anaesthesia No Tourniquet (WALANT) (25-26) to

further reduce risks in fragile and possibly complicated patients.

A potential complication of this technique could be a secondary displacement due to a state of advanced osteoporosis, which could be possible in elderly patients (27,28). However, no cases of secondary displacement clearly correlated with osteoporosis were observed in the patients. In any case, if, due to osteoporosis, the fracture loses its reduction, other methods (plate with screws, external fixation) can be used after the pins have been removed (29). For this reason, an X-ray check should always be carried out one week after surgery. Furthermore, despite numerous advantages of percutaneous fixation, it might have some drawbacks, such as not allowing the release of the transverse carpal ligament at the time of fracture fixation, which has been shown to reduce post-operative median nerve dysfunction (30).

To the authors' knowledge, this technique - offering a unique solution for fragile patients - has never been described previously. Anyhow, this study presents some limitations such as the retrospective and non-comparative aspects and the small casuistry analysed. An expansion of the case study and follow-up will allow to confirm these results.

In conclusion, based on the experience gained and the results of this study, we believe that, in case of not-comminuted, one or two fragments, volar displaced distal radius fractures, the use of this minimally-invasive surgery may be proposed as an alternative to open reduction and internal fixation, in low-function, elderly patients or other patients with critical medical comorbidities. Another indication could be wrist injuries with minimal fracture exposure as an alternative to external fixation. The patients treated with this inversed EDF, associated with a Kapandji's pinning, demonstrated satisfactory clinical and radiological results. Among the disadvantages of this technique, there are intraoperative exposures to X-rays and a specific learning curve.

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## TRANSPARENCY DECLARATION

Conflict of interest: None to declare.

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