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Original article

CLINICAL AND RADIOLOGICAL OUTCOMES OF DISTAL RADIUS FRACTURES TREATED WITH ORIF WITH VOLAR FIXED-ANGLE PLATES.

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Summary

Distal radius fractures are the most common fractures of the upper limbs and represent 17% of all fractures treated in emergency medicine. The purpose of the present study is to evaluate the correlation between the clinical and radiographic outcomes obtained with surgical osteosynthesis using volar plates for the treatment of articular fractures of the wrist. We evaluated a series of 50 consecutive patients from January 2010 to December 2013 who had undergone surgery, aged 24 to 75, for distal meta-epiphyseal fractures of the radius, with or without distal ulnar involvement. All patients were evaluated clinically and radiographically, pre-operatively and post-operatively. For the clinical evaluation, the DASH score and Mayo Wrist clinical rating scale were used. After one year, the range of movement of the wrist was very satisfactory, and the mean grip strength was 77.5% of the opposite wrist. The Disabilities of the Arm, Shoulder, and Hand (DASH) score was 18 and the Mayo Modified Wrist Score was 82.5. Complex articular distal radius fractures, like those of other sites, needed an appropriate surgical treatment and the fixation with the volar LCP system demonstrated its validity for the stabilization of these fractures, the articular surface reconstruction and prompt mobilization. All the clinical results were related to the patients' age, the functional needs, the physiotherapy and the individual recovery

Introduction

Distal radius fractures are the most common fractures of the upper limbs and the most common fractures treated in emergency [1]. These fractures, with or without ulnar involvement, are about 75% of forearm fractures [2]. The incidence of these fractures is more common in two groups of patients: those aged between 6 – 10

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years old and those between 60 – 70 years old [1-3]. In the first group, the fracture is a consequence of a high-energy trauma; in the second, it is the result of a low-energy trauma [4, 5]. The highest incidence in older patients is in females, as a consequence of increased bone fragility. The annual incidence of distal radius fractures in people aged 35 and older is 9/10,000 in males and 37/10,000 in females; 14% of these fractures need surgical treatment [5].
The purpose of the present study is to evaluate the correlation between the clinical and radiographic outcome obtained with surgical osteosynthesis using volar plates for the treatment of articular fractures of the wrist, in order to highlight the need of anatomical feature restoration with particular precision due to the considerable influence on functional recovery.

Methods

The present study includes fifty consecutive patients surgically treated from January 2010 to December 2013 for distal meta-epiphyseal radius fractures, with or without distal ulnar involvement. All patients were treated by the same expert surgeon with open reduction and internal synthesis. The choice of the surgical treatment was based on the evaluation of the fracture stability.
Surgery indications were given according to the modern literature [6-16]:
1. Meta-epiphyseal comminution of the fracture
2. Intra-articular fragment
3. Radial shortening > 0.5 cm
4. Palmar or volar fragment dislocation > 20°
Exclusion criteria: patients younger than 20 or older than 75 with high perioperative risk evaluated with ASA score and/or patients with neurological preoperative deficits.
We never treated distal ulnar fractures when associated with distal radius fractures. When we found them, we applied a palmar splint after surgery.
All the patients were radiologically assessed according to the following radiographic parameters: the radial inclination (19° - 30°, mean value 23°), palmar inclination (4° - 18°, mean value 10°) and ulnar variance (2mm). As clinical evaluation scores, we used Dash and the Mayo Wrist Score. A radiographic evaluation, in AP and LL projection, was made once the patients entered the emergency room. We kept patients in a palmar cast for the first 15 – 21 days if they presented fractures with higher comminution or in patients with presumable bad compliance. Radiographic and clinical follow-ups were made immediately after the operation, then repeated at 30 days, 3 months and 1 year after. From the first post-operative day, we started active mobilization and massage to control the edema. In the period between the second and third month, patients began specific exercises to recover strength. Written consent was obtained from all patients.

Statistical analysis

The non-parametric Wilcoxon test for paired data was used to compare the scores before and after surgery. Statistical analysis was performed using IBM SPSS software, version 22.0, 2013 (IBM Corp, Armonk, NY). Statistical significance was defined at the 5% level ($p > .05$).

Surgical technique

The surgical procedure was performed with peripheral or general anesthesia, always using a tourniquet. The modified Henry approach to the distal radius was performed through the plane between FCR tendon and the radial artery. When exposition of the fracture site was necessary, the incision was extended over the flexor wrist fringe (Figure 1).
The antebrachial fascia is incised and the flexor tendons are dislocated towards the ulna, the pronator quadratus muscle is cut and separated from its insertion on the radius (Figure 2). After that, it is necessary to reduce the fracture and make a temporary stabilization with Kirschner wires. If required, a plate is positioned and fixed with screws to maintain a permanent reduction. The wrist is moved in all directions to insure the absence of excessive limitations of the R.O.M. (Figure 3).

Results

There were 18 males (35%) and 32 females (64%) with an average age of 55 years old (range 24-75). 25 patients (50%) were treated with Hand Innovation (DVR) volar plate (GROUP A) and 25

Figure 1. Modified Henry's Approach to the distal radius

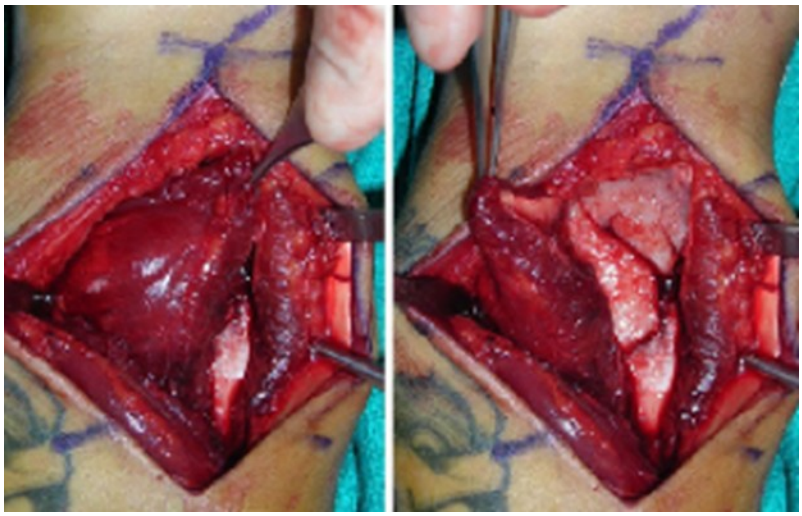

Figure 2. Incision of the pronator quadratus muscle

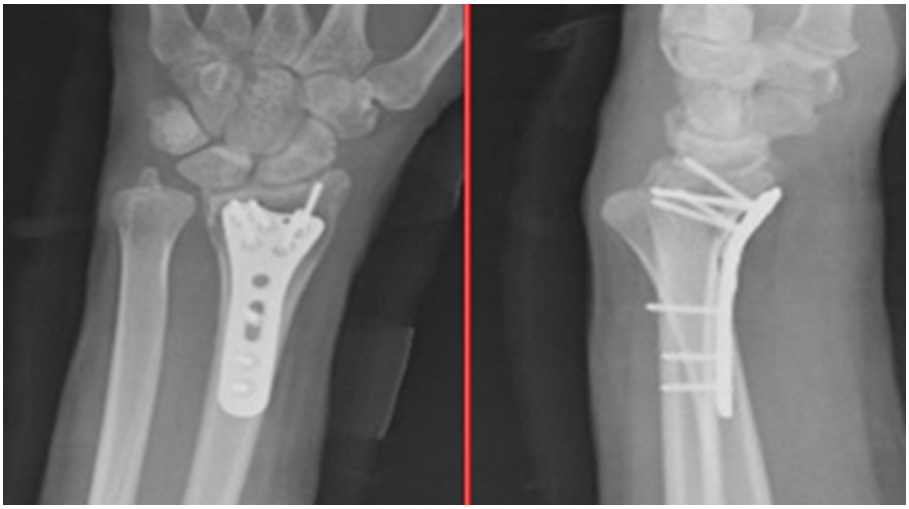

Figure 3. Post-operative X-ray control.

patients (50%) with Stryker® VariAx distal locking plate (GROUP B). The patients were assigned to the two groups randomly. The AO classification was used to rank all the fractures: we had 15 A-type fractures (30%), 15 B-type fractures (30%) and 20 C-type fractures (40%).

The average time of the operation was 77' (55' – 85'). There was no statistical difference between the two groups (P >.05), so the results were collected together.

There was no significant difference in the mean scores between the 2 groups (P > 0.05).

None of the patients had surgical wound complications. We had three cases (6%) of partial mobilization with screws, four cases of medium-severe articular rigidity (8%), 2 cases of flexor tenosynovitis (4%), and 1 case (2%) of thumb flexor tendon rupture 5 months after the operation. 25 patients (50%) were very satisfied, 15 (30%) satisfied, 8 (16%) partially satisfied, 2 (4%) unsatisfied (Figure 4). The recovery of daily/working activities was completed in 38 patients (76%), with a few limitations in 10 patients (20%). In 2 cases there was a severe functional reduction. The patients who used to do sport came back to their practices (2 golf players, 8 swimmers, 10 soccer players). Only one of them showed minimal limitations.

The R.O.M. of the operated side, compared to the contralateral, was:

- FLEXION, MIN 40°; MAX 85°; average 75°
- EXTENSION, MIN 30°; MAX 80°; average 72°
- PRONATION, MIN 70°; MAX 90°; average 84°
- SUPINATION, MIN 65°; MAX 90°; average 80°
- RADIAL DEVIATION, MIN 8°; MAX 15°; average 11°
- ULNAR DEVIATION, MIN 15°; MAX° 25°; average 20°
- GRIP, MIN 11,5 kg; MAX 47,3 kg; average 18,3 kg

The average DASH score was 18 (min 1, max 40) (P<.001). The score obtained with the Mayo Modified Wrist Score was good; it was an average value of 82.5 (range 0 - 100) (P<.001) with 28 excellent results (56%), 12 good (24%), 8 moderate (16%) and 2 poor (4%). None of the patients showed pain during pronation/supination of the forearm. The radiography revealed the bone healing 10 – 18 weeks after the operation (average 12 weeks). The average radiographic parameters calculated at the last follow up (12 months) are reported in Table 1.

Discussion

Many studies showed that the majority of the patients with radial distal fractures were middle-aged females with a direct trauma caused by accidental falls [1-4]. After an initial period of conservative treatment, most of the 50 patients were surgically treated, an average of 5 days post-trauma, due to a lack of fracture reduction [5-6]. Old patients with osteoporosis or patients who needed a quick

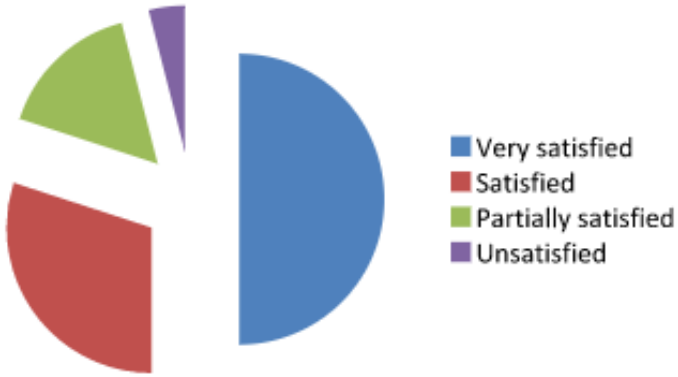

Figure 4. Representative graphic of patient satisfaction.

functional recovery were also surgically treated after an unsatisfactory initial conservative treatment (articular step > 2mm) after reduction (radial shortening > 3mm, radial inclination >10°) [5-9]. The subjective evaluation was positive in most cases. In fact, handgrip strength was good and patients quickly returned to work and sports [10]. Radiographic parameters reported in the post-operative follow-up, compared to standard parameters, confirmed the ORIF with volar plate effectiveness to restore the distal radius anatomy. Complications were rare and often temporary following a surgeon's mistake [9.11-13]. Surgical techniques by volar access and the synthesis method (LCP) demonstrated their effectiveness in obtaining positive results with any type of fracture [11-16]. Our examinations showed that this treatment gave optimal results in these lesions, especially in young or middle-aged people, who needed a correct anatomical recovery, complete wrist functionality and prevention from arthritic complications [16-17]. In compound and stable fractures, or in older patients with poor functional demand, conservative treatment is the best choice [16]. The positive aspects of the use of plates and screws are described in the medical literature [11-15]. The volar access seems to produce better clinical results regarding functional recovery and stability and reduces complications like tenosynovitis, bone collapse and rigidity [18]. The volar approach is also the best when dealing with the dorsal dislocation of a fragment because it allows for a better visualization of the fracture's site while respecting the vascular and tendon structures [18]. The pronator quadratus muscle is sutured to cover the plate, even if this process can be difficult due to muscular fragility. Considering the wide variability of results, treatments, specific functional recoveries, and rehabilitation protocols, there is no absolute evidence in the literature of the superiority of one surgical treatment over another. Some studies demonstrate the same long term functional results for both groups of patients with distal radius fractures: those which were surgically treated and those which were conservatively treated [11-18]. To obtain satisfactory results, prompt physiotherapy and active mobilization are crucial. A splint can be useful immediately after the operation to protect comminuted fractures.

Conclusions

The purpose of the surgical treatment in distal radius fractures is the same as any other articular fracture: the reconstruction of the articular congruity, the maintenance of reduction, the preservation of mobility and function. For these reasons, it is important to recognize the possible associated lesions. Correct indications and adequate surgical approaches lead to good functional and radiographic results. Complex articular distal radius fractures, like those of other sites, need an appropriate surgical treatment. The stabilization technique with volar LCP demonstrates its validity for stabilization of these fractures, articular surface reconstruction and prompt mobilization. All clinical results are related to the patients' age, their functional needs, physiotherapy and individual recovery.

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	Pre-operative	Post-operative	V.N.
Ulnar variance (mm)	3.2	1	-1 (+/- 2)
Radial height (mm)	6	10	10 - 12
Radial inclination (°)	16	19	22 (+/- 3)
Volar tilt (°)	7	12	0 - 22

Table 1. Pre- and Post-operative Radiological Parameters

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