Volar Plate Fixation in Patients Older Than 70 Years with AO Type C Distal Radial Fractures: Clinical and Radiologic Outcomes

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Abstract

Introduction Treatment of unstable distal radial fractures (DRFs) in elderly patients is controversial, and considering the increasing life expectancy, their appropriate treatment is of growing importance. Our aim was to analyze the clinical and radiologic outcomes in the elderly patients with AO type C DRF treated with volar locking plate (VLP).

Materials and Methods Between 2007 and 2011, 572 DRFs were operated on in our hospital with open reduction and internal fixation with VLP. Of these, only 64 patients (66 DRFs) met the selection criteria (AO type C DRF, age > 70 years, minimum 12-month follow-up). Mean follow-up was 28 months. Outcome assessment included range of motion, grip strength, VAS pain, Mayo Clinic Score, and DASH score. Analysis of pre- and postoperative radiographs was performed. Complications were recorded. Statistical analysis was performed comparing the results with the contralateral side.

Results Mean postoperative range of motion of the injured wrist compared with the control contralateral side was 86% for flexion ($p < 0.001$), 92% for extension ($p < 0.001$). The average DASH was 12. Mayo Clinic Wrist Score showed 43 excellent results, 15 good, 4 satisfactory, and 4 poor. Articular step-offs were reduced in 34 of 38 wrists. Five (7%) patients required plate removal.

Conclusion The treatment of articular DRF (AO type C) with VLP in the elderly patients achieved greater than 90% of the wrist range of motion and grip strength with no residual pain in greater than 90% of the patients.

Level of Evidence Therapeutic IV, case series.

Keywords

- ▶ distal radial fracture
- ▶ internal fixation
- ▶ volar plate fixation
- ▶ elderly

The optimal treatment for displaced, unstable distal radial fractures (DRFs) in elderly patients is controversial.^{1–6} There is debate between conservative and surgical treatment, and the surgical indications that apply in this age group.⁷ Considering the increasing life expectancy and

level of activity of this population, the appropriate treatment for this common fracture is of growing importance.^{1,2} With an aging population, DRF incidence is expected to increase, with projections as high as up to 50% by 2030.⁸ Furthermore, the functional requirements of this

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population is increasing as the labor activity and sport practice prolong through the years.²

Multiple treatments for DRF have been described for unstable fractures in the elderly patients with satisfactory results, including cast immobilization, external fixation, percutaneous Kirschner wire, and volar plate fixation.^{4,7,9,10} However, the old-age group is characterized by osteoporosis that favors this metaphyseal bone fracture.¹¹ Consequent bone weakening and increased fracture instability are critical in the loss of reduction after close reduction and plaster treatment. On the other hand, fixation methods have to overcome poor bone quality with the risk of implant loosening. The development of volar locking plates (VLPs) could respond to this therapeutic need.

The purpose of this study is to analyze the clinical and radiologic outcome of a series of patients older than 70 years with AO type C DRF treated with open reduction and internal fixation (ORIF) with VLP.

Material and Methods

A retrospectively study was developed with the approval of our Institutional Review Board (IRB). We analyzed a series of patients between January 2007 and December 2011. Total 572 DRFs were operated on in our hospital (Level 1 Trauma Hospital) with ORIF with VLP. We defined as inclusion criteria for this study: (1) patients older than 70 years at the time of surgery who have been both operated and followed up at our hospital; (2) only type C DRF of the AO classification; (3) surgical treatment with ORIF with VLP with double row distal fixation; and (4) minimum 12-month follow-up with both

clinical and radiologic evaluation. We excluded all patients operated in another center and patients with previous fractures or lesion in the same upper extremity and mental illness.

Fracture pattern were classified on initial anterior-posterior (AP) and lateral radiographs by three authors (EZ, NP, and PDC). In cases in which no agreement was achieved, we appealed to the opinion of two other senior authors (GG and JB). We identified 172 complete articular DRFs (AO classification 23-C). Of these, only 64 patients met the selection criteria, and a total of 66 DRFs were included in our study (→ Fig. 1).

In all cases, the distal radius bone was exposed through a Henry's approach. After releasing the pronator quadratus muscle, the fracture site was exposed, and the distal volar radius plate was placed and first fixed at the gliding hole to enable a correct positioning after the restoration of radial height. Direct reduction using the plate as a template was performed in all fractures, and either locking pins or locking screws were placed to fix the subchondral bone.^{12,13} Distal double row VLPs of different manufactures were used (Acu-lock VDR Plate, Acumed, Hillsboro, OR; DVR-Hand Innovations, Biomet, Warsaw, IN; VariAx Distal Radius Locking Plate, Stryker, Kalamazoo, MI). No additional bone grafting was used in this series of patients. Patients were immobilized with a below-elbow splint for 2 weeks until stitches were removed. Fractures with an unstable dorsoulnar fragment of the distal radius were immobilized with an above-elbow splint for 3 weeks. Subsequently in all cases, passive and active movements were allowed with intermittent use of the splint for 4 more weeks.

Fig. 1 Population flowchart.

All patients were objectively, subjectively, and radiologically evaluated at last follow-up.

Objectively, we assessed the range of motion comparative-ly with the contralateral sides—flexion and extension, ulnar and radial deviation, pronation and supination—which were measured using a goniometer by independent researchers not involved in the surgical procedure. Grip strength was assessed with Jamar Hand Dynamometer (Lafayette Instrument, Lafayette, IN) calculating the mean of three consecutive measurements.

Pain was evaluated using visual analogue scale (VAS)—both at rest and during activity—and the Swanson scale that classifies patients' pain-related symptom as no pain, mild, moderate, severe, and constant pain. The subjective function was examined by VAS from 0, considering as total disability, to 10, as normal function, and DASH (The Disabilities of the Arm, Shoulder and Hand) score.¹⁴ We also determined the Mayo Clinic Score¹⁵ for each patient at the final follow-up.

AP and lateral view radiographs of both the wrists were performed at baseline. Postoperatively we analyzed the affected side radiographs at the last follow-up, to perform pertinent measures. Two independent authors (EZ and NP) evaluated and measured in each radiograph: volar tilt, radial height, radial inclination, ulnar variance, and the presence of residual articular step-off and osteoarthritis. All these were measured according to the guidelines of Kreder et al.¹⁶ The presence of articular step-off (> 2 mm) was measured as a dichotomous variable (Yes/No) in pre- and postoperative radiographs and computed tomographic (CT) scan. The grade of posttraumatic osteoarthritis was evaluated according to Knirk and Jupiter in the last follow-up X-rays (grade 0, normal radiographs; grade 1, slight narrowing of the joint space; grade 2, marked narrowing, formation of osteophytes; and grade 3, bone-on-bone narrowing with formation of cyst and osteophytes).¹⁷

Complications and need for reoperations were recorded. They were subdivided into minor and major according to a validated complication checklist developed by McKay and colleagues.¹⁸ Complications not requiring surgical treatment (i.e., superficial wound infections, complex regional pain syndrome [CRPS], steroid injection, and physiotherapy) or further investigations (i.e., electromyography) in the studied populations were graded as minor. Major complications included deep infections, nerve or tendon injury, and hardware loosening or failure that led to reoperation.^{11,13,19–23}

The statistical analysis was performed using STATA 12 software (StataCorp LP, College Station, TX). A p value of less than 0.05 was considered statistically significant. Student's t -test was used for comparing means. The results were presented as mean standard deviation (SD) or number (%) where applicable.

Results

Sixty-six wrists with type C DRFs were retrospectively evaluated in 64 patients who met the inclusion criteria (56 females and 8 males). Patient's age at the time of surgery was a mean 77 years old (range: 70–88 years old). Twelve fractures were

classified as 23-C.1 (►Fig. 2A–D), 18 as 23-C.2 (►Fig. 3A–D), and 36 as 23-C.3 (►Fig. 4A–D). Every fracture was treated with distal double row volar fixed-angled plate. In 32 of the 66 fractured wrists, the patient's dominant side was involved. All fractures were closed except one that presented less than 1 mm exposure on the ulnar side. Mean follow-up was 28 months (range: 12–71 months).

In the objective evaluation, the mean postoperative range of motion compared with the contralateral side was 86% for flexion, 92% for extension, 91% for supination whereas 94% for pronation and 95% for both radial-ulnar deviation (►Table 1). Our data analysis showed that the mean difference between the operated and the healthy hand was of 8.4 degrees SD ± 11.5 for flexion and 4.7 degrees SD ± 10.1 for extension. The p value was less than 0.001 for both measurements demonstrating a statistically significant difference between both wrists. Similar results came from the analysis of radial deviation with a mean difference of 2 degrees SD ± 7.2 and a p value of 0.035. However, there was no statistically significant difference considering ulnar deviation, pronation, and supination, with p values of 0.156 and 0.113, respectively. These results demonstrate that the range of motion in the operated wrist resembles the noninjured side.

Grip strength was 94% compared with the unaffected side. Average value was 16 kg for the operated side (range: 3–42); and 17 kg for contralateral side (range: 5–51 kg). The mean difference was 0.45 kg SD ± 4.7 kg and p value nonstatistically significant of 0.476.

Fig. 2 (A–D) Radiographic case example 1: DRF AO classification 23-C.1: Preoperative AP (A) and lateral (B) view radiographs, and postoperative AP (C) and lateral (D) view radiographs.

Fig. 3 (A–D) Radiographic case example 2: DRF AO classification 23-C.2: Preoperative AP (A) and lateral (B) view radiographs, and postoperative AP (C) and lateral (D) view radiographs.

Pain, according to Swanson scale, was no pain, 50 wrists; mild to great efforts, 14; moderate, 1 patient; severe pain, no patient; and constant pain, 1. According to the VAS, resting average pain was 0.5 (0–10), and 52 patients had no pain at rest; during activity, average pain was 0.9 (0–10), and 44 patients had no pain whatever their activity was. The average DASH was 12 (0–70). The subjective function measured with VAS was 9.6 (3–10), 10 being normal function and 0 maximum disability. According to the Mayo Clinic Wrist Score, 43 results were excellent, 15 good, 4 satisfactory, and 4 poor.

Articular step-off was detected on preoperative radiography or tomography in 38 wrists. A complete correction was

Fig. 4 (A–D) Radiographic case example 3: DRF AO classification 23-C.3: Preoperative AP (A) and lateral (B) view radiographs, and postoperative AP (C) and lateral (D) view radiographs.

achieved in 34 wrists. However, we detected persistence of articular step in four patients at the final follow-up. According to the Knirk classification of posttraumatic arthritis,¹⁷ 46 (70%) of the 66 DRFs were stage 0 or 1, 15 (23%) patients were stage 2, and 3 (7%) were stage 3 at the final follow-up. The persistence of articular step was correlated in two of the four patients with worst radiologic outcomes (stage 3).

Five patients (7% of fractures treated) suffered a major complication that required a subsequent removal of the plate: one deep infection, two flexor tendinitis of the thumb and/or index, extensor tendinitis by protrusion of a screw on the dorsal aspect of the distal radius, and one intra-articular screw.

Table 1 Objective clinical outcome comparing injured wrist with contralateral side at last follow-up

Range of motion (mean degrees)	Injured side	Contralateral side	Injured side/contralateral side (%)	Diff/SD	<i>p</i>
Flexion	54°	63°	86	8.45°/11.51°	< 0.001
Extension	59°	64°	92	4.72°/10.11°	< 0.001
Supination	80°	88°	91	1.02°/6.03°	0.101
Pronation	82°	87°	94	1.3°/6.17°	0.113
Radial deviation	40°	42°	95	2.1°/7.28°	0.035
Ulnar deviation	22°	23°	95	2.4°/12.6°	0.156
Grip	14.7	15.2	96	0.45/4.78	0.476

Abbreviations: diff, difference; SD, standard deviation.

Discussion

An homogenous series of patients, older than 70 years, with unstable complete DRF treated with ORIF with VLP was analyzed in the present study. Evaluating radiologic and clinical outcomes, satisfactory results were obtained with this approach, although implant removal was required in five cases (7% of the cases).

In the literature there is controversy regarding the ideal treatment option between operative and conservative treatment in this age group.^{7,8,11,13,19–21,23–25} In 2011, the guidelines of American Academy of Orthopedic Surgeons²⁶ did not recommend for or against operative treatment for elderly patients with DRFs because of lack of compelling evidence whether operative management produces better outcomes than nonsurgical approaches.

Although in many recent publication, the need for operative treatment of DRF in elderly patients has been relativized,^{7,8,13} it is important to point out that these reports do not differentiate intra-articular from extra-articular fractures, and consequently the results could be misleading.^{3,7,8,16,18,20–22} In young and active patients, there is agreement in the need to reduce articular step-offs and restore articular congruity to obtain better functional outcome.^{26,27} However, these criteria are not unified regarding the elderly population.

In a randomized multicenter study of ORIF versus close reduction and cast immobilization for patients older than 65 years with articular DRF, Bartl et al²⁴ reported that mobility, functionality, and quality of life provide marginal and inconsistent evidence for the superiority of operation over closed reduction and casting, but they stand out that ORIF led to better radiologic results and wrist mobility at 3-month follow-up, with faster return to daily activity life.

In recent years, several authors have analyzed the need for anatomical reduction with surgical fixation of DRF to achieve a good outcome in older patients with low demand. Both Arora et al²⁰ and Egol et al²⁵ performed a randomized prospective study comparing immobilization and surgery in patients older than 65 years. Their clinical results were similar in both treatment groups; however, their populations included all types of fractures, mixing both articular (AO 23-B and 23-C) and extra-articular fractures (AO 23-A). Moreover, the persistence of articular step-off and prognostic implications in more severe fracture patterns were not analyzed.

Chen et al (2016)⁹ in their recent meta-analysis, comparing functional and radiographic outcomes in patients older than 60 years with DRF treated by ORIF with plate osteosynthesis or external fixation or by closed reduction and cast immobilization (CRCI), conclude that current literature does not support the theory that operative management can provide better clinical outcomes for elderly patients with DRF. Although operative management can offer better radiographic outcomes and grip strength than nonsurgical treatment, the risk of complications requiring surgical treatment seems to be greater. However, this article compares three different treatment protocols and there is no fracture differentiation. Their study was based on the assumption that

internal and external fixations were sufficiently similar to be evaluated together. Instead, we evaluated only one surgical approach using volar plating and only included AO type 23 C fractures.

Figl et al²⁸ studied 58 patients older than 75 years operated with VLP for DRF. No fracture type was specified. The results according to Castaign score were: perfect 25, good 30, and fair 3. The final range of motion was similar to those of patients in the present study, but the VAS and DASH mean scores were 3.1 and 28, respectively, both worse than those in this work. In the same manner, the study by Orbay and Fernandez et al⁵ analyzed 24 patients older than 75 years treated with volar fixed-angled plate, with good clinical outcome. Chung et al² compared 30 young patients with 25 patients older than 60 years, with the same treatment. Fractures were not limited to type C, and they concluded that clinical outcomes were similar, except that younger patients achieved this outcome faster than the older group.

As discussed, previous reports suggest that there are good clinical outcomes in elderly patients with DRFs treated both surgical and conservative treatment options. However, we could not find evidence that specifically analyzed AO 23 type C DRF, which may involve potential articular compromise as step-off, gap joint, or combination of both, that may have uncertain progression and outcome.

Chan et al¹ surmised that active elderly patients, older than 65 years, with unstable DRFs, who undergo ORIF, regain wrist motion and grip strength earlier than those treated nonsurgical for up to 6 months after the operation. In our series, with a statistical difference the patients achieved a range of motion of the 90% of the contralateral side with an average DASH score of 12 in the last postoperative follow-up.

Grip strength at final follow-up has been reported to be significantly greater with operative group in different studies, treated either by VLP^{1,21,24,25} or by external fixation.^{19,25} Many daily functions require high activity levels of the flexor musculature of the forearms and hands, carrying laundry, turning a doorknob, and vacuuming; they all require that some degree of grip strength is necessary to be successful. Therefore, it is a crucial variable in the life quality. When we compared the grip strength of the operated hand with the contralateral side, we found it to be 94% of the contralateral hand, and this difference was not statistically significant. Therefore, the strength resembled the nonoperated hand, resulting in an important factor for the return of the daily activities.

The need to reduce joint steps and inconsistencies in DRF in young patients is already well known and accepted.^{29,30} Trumble et al²⁹ studied 43 patients, mean age 37 (range: 17–79 years old) with types C2 and C3 fractures and concluded that improvement of joint steps and joint gaps led to a better clinical outcome. In our series, 38 wrists had initial articular step-off, which were corrected during surgery in all cases but four (94%).

We report five major complications (7%) in our series that required another intervention to remove the VLP. Reports in literature^{1,18–21,24,25} show that there are no differences in minor complication rates between operative and nonoperative

treatment options ($p = 0.78$). However, this difference becomes statistically significant when we search for mayor complications ($p = 0.2$).⁹ According to the Mayo Clinic Wrist Score, although 58 patients had excellent or good results, 8 presented satisfactory or 4 poor result. We observed that patients who presented complications tended to present worse outcome. Likewise, distal cubital fracture was present in six of the eight patients who had inferior outcome.

Our study withholds several limitations. First, this was a retrospective study. Second, there was no control group; hence, no conclusions can be made as to comparison with other types of treatment methods. Third, we did not evaluate physical activity levels or life quality. Nonetheless, we believe that this study presents the largest series reported analyzing a homogenous series of patients with the same fracture pattern, providing insight on the results obtained by ORIF with VLP. Future randomized controlled prospective study should evaluate the ideal treatment for complete articular DRF in the elderly patients incorporating not only chronological age but also physical activity levels and life quality measured by a validated activity scale.

Conclusion

The treatment of displaced unstable complete DRFs with VLP in patients older than 70 years achieved greater than 90% of the wrist range of motion and grip strength with no residual pain in greater than 90% of the patients, with correction of 94% of the preoperative articular step-off.

Conflict of Interest
None.

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