

The treatment of distal radius articular fractures of C1-C2 type with DVR plate: analysis of 40 cases

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Abstract The aim of this investigation was to evaluate the efficiency of fixed angle plates DVR in the treatment of C1 and C2 type articular wrist fractures according to the AO classification. From July 2005 to March 2009, 40 wrist fractures were treated: 18 were of C1 type while 22 of C2 type according to AO classification. The age of patients varied from 25 to 79 years old. The average length of follow-up was 17 months (range, 4–37 months). The average articular motility was flexion 59.4° and extension 62.7°. Final radiographic parameters were of 18.7° of average ulnar inclination, 10.3° of average dorsal inclination, and 1.45 mm of negative ulnar variance. All patients were reassessed according to Mayo Modified Wrist Score getting a very good/good result in 82% of cases and a medium/poor one in 18%. The DASH score pulled off 46.3 points in the first group, 5.1 in the second group, and 6 in the third one. The statistical analysis based on Student's *t* test showed how C1 and C2 classification did not influence the results using the same treatment. DVR plate

showed a very good reliability and a sufficient stability with both C1 and C2 fractures.

Keywords Wrist · DVR · Plate · Wrist fractures C1, C2

Introduction

Articular fractures of radius distal epiphysis are the most common ones of the superior limb and account for 17% of all fractures treated in the emergency department and a sixth of the fractures treated in an operating theater [1]. Radius distal fractures are of very different kind as demonstrated by the great number of classifications proposed up to now [2, 3] and may require different treatments. These may vary from a simple plaster cast to external fixers or from a percutaneous osteosynthesis to an invasive reduction or to mixed techniques. The aim of the treatment is the reconstruction of the articular surface congruity and the recovery of the radius right length, its inclination, and its palmar tilt [4, 5]. Open reduction and internal fixation are more and more widespread providing patients an early rehabilitation and complication reduction [6, 7]. Surgical techniques in the treatment of wrist fractures with dorsal breakdown have frequently used a dorsal approach in the plate fixing. Despite the fair results achieved with this method, some complications may occur, like those concerning the loss of fracture reduction, pain, strength reduction, and above all damages in the extensor tendons [8–13]. The introduction of a new treatment approach based on a fixing system with a fixed angle and its use in the volar fixing of fractures with dorsal instability of distal radius has really been a great innovation in the treatment of both dorsal and volar fractures. This method, in fact, has provided great advantages in the internal stability without

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the complications of the dorsal approach. The open reduction and the internal fixation allow an accurate reconstruction of the articular surface. Moreover, they enhance the repair of potential associated intercarpal pathologies allowing the evaluation of each single bone fragment, which may result unstable within the fracture [14]. Dorsal and volar fractures required different implantations combining a volar plate and a dorsal one in case of double surgical access or two orthogonal implantations [15]. New fixed angle plates do not require any longer a setting of the plate on the instable side of the fracture since they allow a sufficient stability even though the fixation is set on the opposite side of the breakdown. The result is that of treating with a single volar approach even those dorsal fractures, thus avoiding the employment of several synthesis and surgical approaches. Open reductions may be performed employing a wrist volar access according to Henry's technique [16]. This results less harmful as for tendons, enabling a better inspection of the fracture and allowing the plate covering by means of a square pronator. In fact, flexor tendons flow far from the radius volar surface and the positioning of the plate in this seat does not cause any adhesion problems or possible iatrogenic breakings. The aim of this investigation is the long-term evaluation of the results of volar fixed-angle implantations, such as DVR, in patients with C1 and C2 distal radius fractures.

Materials and methods

In the period between July 2005 and March 2009, 40 distal radius articular fractures of C1 and C2 type, according to AO classification, were treated. Eighteen men and twenty-two women, with an average age of 54 years (range, 25–79 years), were surgically treated with volar DVR plate. DVR system is based on a double peg row in the distal side of the plate, the head of which allows angle stability and conventional screws for shaft grip. All syntheses were performed with a volar approach even in cases of dorsal breakdown fractures. Fifteen right wrists and twenty-five left ones were treated. All patients were right handed. Fractures were classified according to AO system: eighteen were C1 type and 22 of C2 one. Sixteen patients underwent a preoperative TC with a 3D reconstruction of the articular surface. The volar approach was described by Henry (Fig. 1). It consisted in a cutaneous cut along the radial edge of the tendon of the radial flexor carpi, from the wrist flexory plica in a proximal direction for about 7–8 cm [16]. At a distal level, as a support for the subchondral bone, smooth pegs were used instead of screws. At the end of the operation, the square pronator was sutured allowing an almost complete coverage of the plate. Carpal tunnels

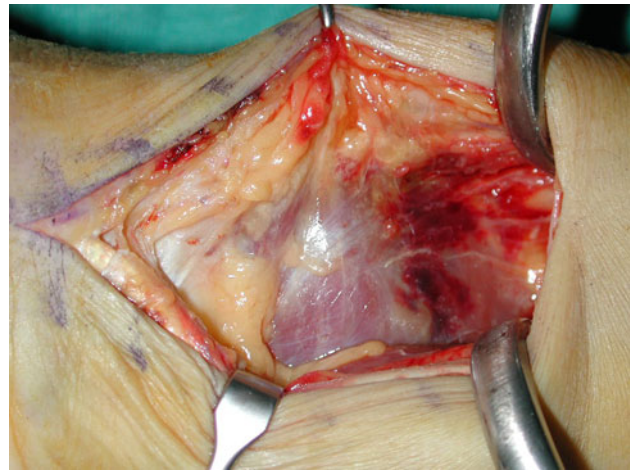


Fig. 1 Henry's volar approach

were never opened. Finally, a plaster valve in a functional position was applied. It has to be kept for 2 weeks and to be removed after such period to start the wrist rehabilitation. All patients were reclassified using the DASH [17] questionnaire (*disabilities of the arm, shoulder, and hand*) in the Italian version. It evaluates the ability of using the upper limb, in particular shoulder and hand, in the daily routine. Also, Mayo Modified Wrist Score was employed: It allows a more objective evaluation of the pain, wrist function in the daily routine as well as in the movement range and the grip strength (see Table 1). The pain level was evaluated with a 10-point Visual Analogue Scale (VAS). Grip strength was measured with a Jamar dynamometer at the second handle setting, and the subject in the position was recommended by the American Society of Hand Therapists [18]. Grip strength scores were calculated at the average (measured in kilograms) of three grip strength per hand. All cases were documented with photographs, and all patients underwent a X-ray check. The latter allowed an analysis of the ulnar inclination degrees, dorsal tilt, and ulnar variance. Six cases underwent a postoperative TC in order to provide information of the effective reconstruction of the articular surface. The forty patients were divided into two groups: eighteen patients with C1 type fracture (group A) and twenty-two patients with C2 type one (group B). Group A (C1 type fracture) was made up by eighteen patients (13 women and 5 men), average age 59.4 (range, 15–79) (Fig. 2). The most involved side was the left one (13 cases) in comparison with the right one (5 cases). The average follow-up was 17.7 months (range, 4–37). Group B consisted in twenty-two patients (12 men and 10 women), average age 50.7 (range, 34–79) (Fig. 3). The most involved side was the left one (12 cases) in comparison with the right one (10 cases). The average follow-up was 20 months (range, 7–32).

Table 1 Follow-up data

Variables	Group A (mean ± SD)	Group B (mean ± SD)	<i>P</i> (<i>t</i> test)
Clinical evaluation			
Flexion (°)	58.6 ± 16.0	60.0 ± 17.6	0.50
Extension (°)	61.1 ± 16.5	63.8 ± 17.1	0.25
Radial deviation (°)	25.7 ± 8.8	20.7 ± 7.6	0.07
Ulnar deviation (°)	35.6 ± 11.3	31.6 ± 14.0	0.32
Pronation (°)	80.6 ± 6.5	78.9 ± 12.0	0.27
Supination (°)	78.7 ± 9.7	77.0 ± 14.2	0.30
Grip strength injured limb (Kg)	18.1 ± 9.8	21.4 ± 10.4	0.14
Grip strength controlateral limb (Kg)	25.2 ± 13.3	27.5 ± 12.7	0.29
Pain (points)	1.1 ± 1.9	0.4 ± 1.2	0.07
Rx			
Ulnar inclination (°)	17.4 ± 5.0	19.7 ± 3.7	0.05
Dorsal inclination (°)	11.3 ± 3.7	9.5 ± 3.3	0.04
Ulnar variance (mm)	1.75 ± 1.8	1.3 ± 2.2	0.22
Scores			
Mayo (points)	86.8 ± 12.9	87.7 ± 17.9	0.42
DASH I (points)	45.4 ± 14.3	46.8 ± 21.9	0.42
DASH II (points)	4.5 ± 1.8	5.6 ± 2.5	0.20
DASH III (points)	6.3 ± 3.4	6.0 ± 4.1	0.41

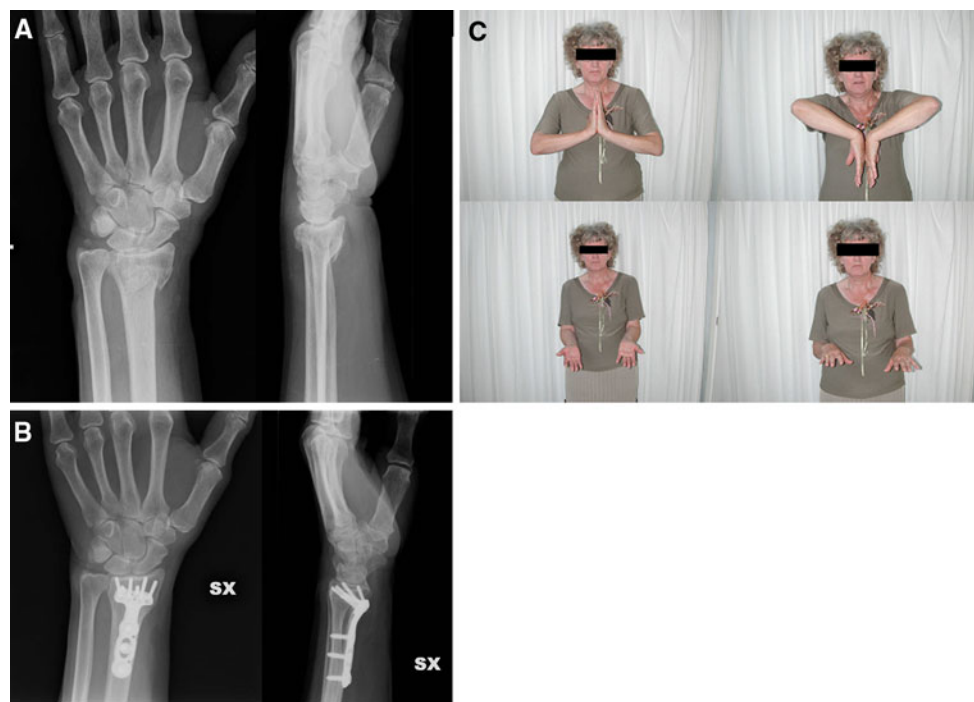


Fig. 2 Case 1 (woman, 57 years old). **a** Wrist fracture type C1 of AO Classification. **b** Osteosynthesis with DVR plate, Rx after 3 months. **c** Clinical follow-up 3 months

Results

At baseline, the demographic characteristics of the two groups were very similar for age and sex. No complications,

such as carpal tunnel syndrome, plaque rupture, nonunion of the fracture, infection, flexor/extensor tendon rupture, were observed at follow-up. In no cases, the plate has been removed, because it was well tolerated. The clinical

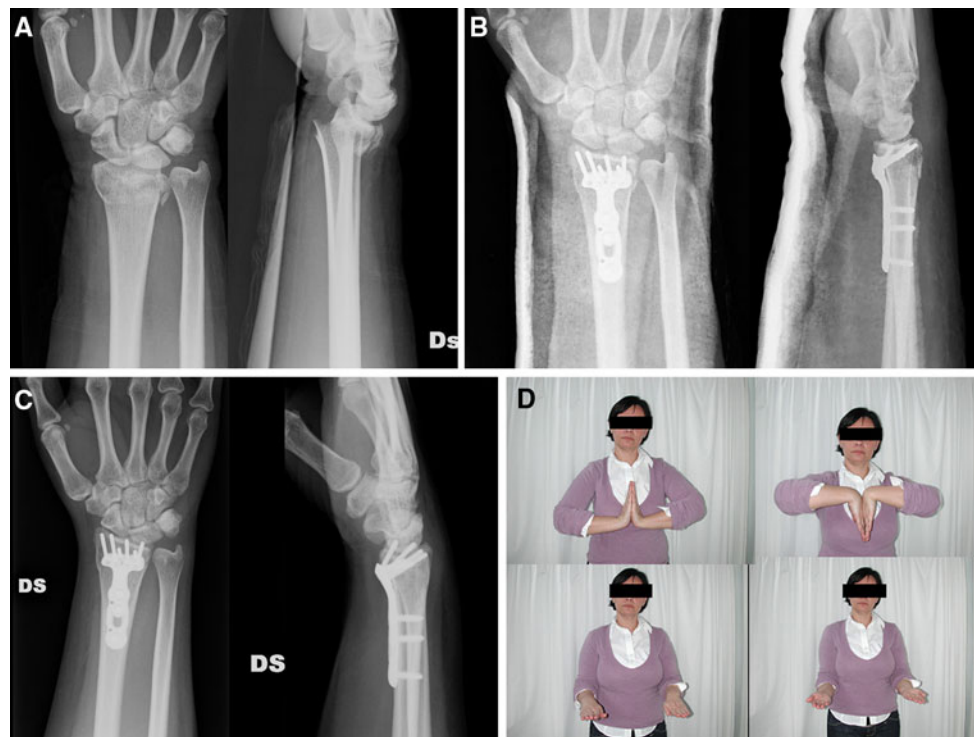


Fig. 3 Case 2 (woman, 45 years old). **a** Wrist fracture type C2 of AO Classification. **b** Postoperative Rx with DVR plate. **c** Follow-up Rx after 3 months. **d** Clinical follow-up after 3 months

evaluations, radiographic assessment, and outcome scores at follow-up are summarized in Table 1. In particular, in the group A, the score obtained using the Mayo Modified Wrist Score was good with an average value of 86.8 points (range, 60–100) scoring a very good result in 8 patients (44.1%), a good one in six patients (31.2%), and an average result in 3 patients (18.7%). Only one patient scored a poor result (6%) (Table 1). The average DASH score was of 45 points (range, 32–87) in the first section. The second section scored 4.5 points (range, 4–8), while the third one got 6 points (range, 4–16) (Table 1). In the group B, the score obtained with the Mayo Modified Wrist Score was good with an average value of 87.7 points (range, 30–100). Eleven patients got a very good result (51%); eight obtained a fine result (36%) while one patient scored an average result (4%) and two got a poor one (9%) (Table 1). The average of the DASH score obtained was of 46.8 points (range, 30–94) in the first section, 5.6 points (range, 4–12) in the second, and 6 points (range, 4–19) in the third one (Table 1). Comparing the average of the results obtained between these two samples by means of the “Student’s *t* test”, they could be considered superimposable even if slight differences were detected (Table 1). The statistical analysis underlined how the further subdivision into sub-categories C1 and C2 of the distal radius fractures did not influence results even in case of the same surgical treatment. Thus, the results of this paper could be evaluated

considering the two groups of patients belonging to a single sample represented by the C group of the distal radius fractures, according to the AO classification (grading).

Discussion

Unstable distal radius fractures C1 and C2 type require invasive reduction and internal osteosynthesis [13, 14]. The aim of this treatment is the same as all articular fractures: the reconstruction of the articular congruity and the achievement of a stable synthesis in order to allow an early mobilization of the wrist joint [4, 19–21]. Orbay suggests a volar approach in the treatment of distal radius fractures even in the presence of dorsal dislocation of the fragment. The results of this kind of approach are superimposable to those obtained with the dorsal plate use [11–13]. Osada et al., in a cadaveric study, evaluated the rigidity of several volar and dorsal plates used in the treatment of distal radius fractures even with dorsal instability, showing that the volar plate system in neutralization provides a very good stability to the fracture. It can be compared with the dorsal implantations on the same fracture type [22, 23]. According to Orbay [12], this kind of treatment is suitable for distal radius fractures in which the usual treatments do not produce fair results. Moreover, it is eligible in unstable fractures of young and active patients who require an

anatomic reconstruction as well as in multi-injured patients with complex rehabilitation phases and with lower limbs damages. Finally, it is recommended for old age patients who need a fast recovery of their functional independence. Also, multi-fragmented fractures with severe articular involvement or with poor bone quality can be considered as instable. On this subject, Orbay and Fernandez [24] define instable those fractures that, after an attempt of noninvasive reduction, show radiographic evidence of 15° angle at least on orthogonal plane as well as an articular step or possible radius shortening bigger than 2 mm. Fernandez also underlines the importance of regaining the normal articular radius carpal space by inner osteosynthesis operation. In fact, if this space is smaller than 2 mm, it can be the source of a posttraumatic arthrosis process [24]. The synthesis used was the DVR plate, that is can guarantee a remarkable stability in fixation within a short space. Such plate is constantly fixed by volar way nearer the distal epiphysis as not to cause impingement on the flexor tendons, thanks to its particular design reproducing the anatomy of the distal radius. The plate is distally fixed by means of pegs (consisting in smooth screws with heads allowing the tightening of the plate), which replace conventional tapping screws. The function of these pegs, which have a diverging orientation as far as the anatomic tilt volar and radius inclination are concerned, is that of fixing distal portion through their head, thus determining its angle stability. Their main function is supporting the subchondral bone; they do not have any thread for the synthesis of a possible dorsal fragment, but they work only as support for the articular surface, even if the system foresees their employment. The dorsal fragment shifting is avoided thanks to a double-row peg system located on the plate head which determines a greater subchondral support capacity than the single-row system. Orbay [14] claims that the reason of failure for an imperfect anatomic reduction is mostly to be found in an inadequate surgical reduction which should always be obtained before the plate fixation. It is well known that the final outcome of these fractures depends also on the perfect reconstruction of the anatomical and biomechanical axes of distal radius. In fact, an increase in the residual dorsal inclination is correlated with a loss of palmar flexion, while a radial shortening bigger than 4 mm is associated with a reduced forearm rotation. In an investigation of theirs, Porter and Stockley observed that when the dorsal angle is above 20° or when the radial angle is below 10°, the grip strength decreases [25]. Knirk and Jupiter observed that a grip strength reduction is associated with a significant radius length loss [26].

The obtained results were encouraging both in terms of functional recovery both in term almost total pain absence. All patients were satisfied by their treatment because they could enjoy an average movement range of 120° in flexion/

extension and no limitation in the pronation/supination. The DVR plate system proved to be reliable and well tolerated by patients since it does not cause any impingement in the flexor system and allows an early functional wrist recovery. In addition, its distal double-row peg system resulted a reliable support for the articular surface, and its fan positioning within the distal radius epiphysis enables a very good success, giving at the same time a guarantee of stability in the course of time. This was true even in the presence of fractures with severe articular damage, such as C1 and C2 type fractures according to the AO classification.

Conflict of interest None.

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