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Ten Years' Follow-Up on Combined Palmar and Dorsal Internal Fixation of Complex Distal Radius Fractures

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Abstract: Complex distal intra-articular radial fractures (AO Type C3) are rare, but are life-changing injuries. They are usually related to high-velocity trauma mechanisms in a working male population.

We surveyed a cohort of these fractures treated in our institution to assess the functional long-term outcome.

Twelve consecutive patients with comminuted intra-articular distal radial fractures were treated at our institution. Osteosynthesis was performed by a single senior surgeon with volar and dorsal extended approaches. The intermediate and final control included conventional X-ray, range of motion (ROM), grip strength, and the Disabilities of the Arm, Shoulder, and Hand index (DASH), as well as the Patient-rated Wrist Evaluation (PRWE) score for functional outcome at 1 and 10 years' of follow-up.

At 10 years' follow-up, anatomic reconstruction with a step or gap of <1 mm was achieved in 10 of the 12 above-mentioned patients, whereas 2 patients were lost to follow-up. ROM was good to excellent in 8 patients. Median grip strength was 107% of the contralateral side. Median DASH-Index and PRWE were 2.3 and 6 respectively, at 10 years. Eight patients returned to premorbid heavy labor. One patient was retired at the time of injury.

Combined volar and dorsal approaches allow achieving anatomical reconstruction in comminuted intra-articular distal radius fractures and reveal good functional outcomes at intermediate and long-time follow-up.

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Abbreviations: AO = Arbeitsgemeinschaft für Osteosynthesefragen - Association for the Study of Internal Fixation, CRPS = Complex Regional Pain Syndrome, CT = Computer Tomography, DASH = Disabilities of the Arm, Shoulder and Hand index, PRWE = Patient Rated Wrist Evaluation, ROM = Range of Motion, RTW = Return to Work.

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INTRODUCTION

Complex distal intra-articular radial fractures (AO Type C3) are a relatively rare subgroup of the AO Type C fractures, corresponding to about 5% of distal radial fractures,[1] and become more common with higher energy trauma.[2] It has been advocated that good functional outcome in distal radius fractures is best (and most quickly) achieved by anatomical reduction, stable internal fixation, and early function[3,4] in analogy to the treatment principles of any other major joint injury. In recent years, a better understanding of pathophysiology[5] and biomechanics,[6,7] including the 3-column concept, better surgical approaches,[8] and new fixation concepts (locking implants) has provided the prerequisites to realize these goals. Today, many authors treat extra-articular extension fractures (AO Types Ax + Bx) by primary palmar plating with a locking plate.[10–12] This is a straightforward way to reliably restore radial length and allow for early motion with low morbidity and a high rate of complete functional recovery. There is however less agreement in the treatment strategy for intra-articular fractures (AO Type C). Some authors prefer external fixation in combination with K-wires,[14,15] whereas some advocate an extended palmar approach for complex and comminuted articular injuries (AO Type C3).[16–18] Following our established treatment algorithm for complex high-energy intra-articular distal radial fractures, a preoperative traction CT scan is necessary for preoperative planning.[19] A small subset of patients are considered to need a combined palmar and dorsal approach with either double or triple plating according to the following criteria, established from CT-scan examination: a hyperextended palmar articular fragment and/or loss of palmar cortical buttress combined with a displaced dorsoulnar fragment (that has not reduced with ligamentotaxis under external fixation), or with a centrally impacted articular fragment, or with an associated scapholunate carpal ligament tear, or both.

In this article, we report on a small series of initially 12 patients with comminuted intra-articular distal radius fractures that were treated with combined approaches.

MATERIAL AND METHODS

After approval by an institutional review board, 12 consecutive patients who were treated between 2002 and 2004 and fulfilled the above-mentioned criteria were analyzed. All patients gave informed consent to the temporary external fixation with an additional CT scan.

Intermediate follow-up was 13.2 (11.9–32.8 months) months, whereas median final follow-up was 10 years (106.8–146.2

TABLE 1. Range of Motion Expressed as % of the Contralateral Side at 10 Years Follow-Up

Direction	Flexion	Extension	Pronation	Supination	Radial Deviation	Ulnar Deviation
Case 1	66.7	100	100	70.6	75	66.7
Case 2	60	83.3	100	86.7	266.7*	77.8
Case 3	52.9	100	93.8	106.7	66.7	100
Case 4	80	100	100	94.1	100	100
Case 5	57.1	94.4	94.1	86.7	100	83.3
Case 6	88.2	78.6	106.7	100	100	100
Case 7	83.3	81.3	94.1	94.1	75	100
Case 8	93.3	88.9	106.3	93.8	100	88.9
Case 9	82.4	100	94.1	106.3	70	120
Case 10	94.1	93.8	94.4	88.2	83.3	75
Median	81.2	94.1	97.2	94.0	83.3 87.5	94.5
Mean	75.8	92.0	98.4	92.7	85.6 101.7	91.2

*Limited motion on the contralateral side without previous fracture, 20 vs 7.5 degree of motion = 266.7%.

months) and median age at trauma was 46.8 years (24.5–73.5 years). There were only male patients in the study group. Three patients had a fracture of the dominant hand, 9 patients were heavy workers, and 100 patients were right-handed. All sustained high-velocity trauma with a hyperextension injury of the wrist. Two patients had suffered a previous fracture of the uninjured side. Additional injuries were a fracture of the vertebral column in 1 patient, a fracture of the ipsilateral elbow in 1 patient, an additional tear of the scapholunate ligament in 1 patient, and a fracture of the radial head in 2 patients. Median operative delay from injury to definitive plate osteosynthesis was 7 days (2–14 days). All fractures were comminuted and intra-articular (AO23 type C3). There was 1 open fracture. The additional tear of the scapholunate ligament was treated with direct ligament reattachment using suture anchors, temporary scapholunate, and scaphocapitate K-wire transfixation and a neutralizing external fixator for 8 weeks. All patients underwent a 3-step procedure according to our protocol.

All patients with the exception of one (scapholunate tear, external fixation) received a removable Velcro wrist splint and were allowed to mobilize the wrist under the supervision of a physiotherapist beginning at day 1. Postoperative conventional X-ray was performed. Reduction was judged anatomical if there was a step or gap of <1 mm, satisfactory if the step or gap was of 1 to 2 mm, and unsatisfactory if it was of >2 mm.

In the follow-up setting, we analyzed the range of motion (ROM) and the grip strength (JAMAR dynamometer) as percentage of the opposite wrist corrected according to the 10% rule,[18] return to work (RTW, time lapse in months from the time of trauma to time of return to part- or fulltime work), the Disabilities of the Arm, Shoulder and Hand (DASH, patient opinions on symptoms as well as on ability to perform activities of daily living and work) index,[20] and the Patient-Rated Wrist Evaluation (PRWE, patient opinions on pain and on ability to perform activities of daily living and work) score[21,22] to measure clinical outcome. Clinical assessment was performed by 2 independent surgeons (DR and ASMB.). The radiological assessment was performed by means of conventional radiographs in 2 planes.

Operative Strategy

The procedure was performed with the external fixator left in place. First, a standard palmar approach between the radial artery and the tendon of the flexor carpi radialis was established. The intermediate column was approached by reducing the hyperextended palmar articular fragment, restoring radial length and preliminarily fixating the intermediate column with a locking plate that was contoured according to the individual situation. Then the radial column was reduced and buttressed with a locking, precontoured s-shaped plate over the same palmar approach. Third, a dorsal incision was made. Since the radial column was managed over the palmar approach, only the intermediate column was visualized through the third extensor compartment. A limited transverse dorsal arthrotomy was performed to control the joint surface and to check the proximal carpal row for any associated ligament tear. Any centrally impacted articular fragment was reduced to the joint level. The dorso-ulnar fragment was then reduced and the intermediate column was buttressed with a contoured locking plate (mostly L-shaped). The internal osteosynthesis was then completed. The external fixator was opened and stability of the fixation was checked under fluoroscopy. After closure of the incisions, the fixator was removed and replaced by a dorsal plaster splint. Early motion was established from day 1 under the supervision of a physiotherapist. When the swelling had subsided, the plaster splint was replaced by a removable Velcro splint up to 6 weeks postoperatively.

RESULTS

The complete results of clinical outcome are summarized in Tables 1 and 2. Eight patients could return to heavy labor after 3 to 6 months. One patient was already retired at the time of injury. For more adequate interpretation of grip strength, we indicated hand dominance of the injured side in Table 2 according to Petersen et al.[20]

In all cases, anatomical reduction was achieved. There was no implant dislocation during follow-up. In 3 patients, we removed the implants according to patient wish. There were no postoperative wound infections and no tendon rupture in all 10 cases during follow-up.

The patient with the additional scapholunate ligament tear developed a complex regional pain syndrome (CRPS). This patient and the patient with the ipsilateral elbow fracture (Case 1 and 2 in Tables 1 and 2) were not excluded from the final evaluation, even though the outcome could be negatively skewed by reasons not concerning the distal radius fracture.

TABLE 2. Clinical Outcome at 13.3 Months and at 10 Years' Follow-Up According to the DASH Index, the PRWE Score, and the Grip Strength as % of the Contralateral Side in Respect of the 10% Rule

	Intermediate Follow-Up at 13.2 (11.9–32.8) Months			Last Follow-Up at 10 Years (106.8–146.2 Months)			
Clinical Outcome	DASH Score	PRWE	Grip Strength	DASH Score	PRWE	Grip Strength	Comment
Case 1	91	88	50	54	65	56	IR, concomitant elbow fracture dislocation, RDH
Case 2	63	80	240	31	33.5	200	Tear of the scapholunate ligament, LNDH
Case 3	2	7	90	2.5	3.5	104	IR, RDH
Case 4	0	0	120	0	0	85.5	Previous fracture of the contralateral side, retired, LNDH
Case 5	0	0	105	0	0	117.5	LNDH
Case 6	2	0	110	1	8	109.5	RDH
Case 7	8	19	137.5	8	20	81.5	IR, LNDH
Case 8	13	22	105	5	14	118	Previous fracture of the contralateral side, LNDH
Case 9	2	0	93	2	4	96	RNDH
Case 10	0	0	83	0	0	123	LNDH
Median	2	3	105	2.3	6	106.8	
Mean	18	22	113.35	10.4	14.8	109.1	

DASH = Disabilities of the Arm, Shoulder, and Hand index, IR = implant removal, LDH = left dominant hand injured, LNDH = left non-dominant hand injured, PRWE = Patient-rated Wrist Evaluation, RDH = right dominant hand injured, RNDH = right non-dominant hand injured.

The radiologic follow-up showed no signs of secondary dislocation or further arthritic changes in all the patients. The patient with scapholunate ligament tear did not show any progressive wrist instability.

In Figure 1, the clinical and radiological outcome of case number 10 after 9 years of follow-up is illustrated (Figure 1).

DISCUSSION

During the last decade, the strategies to treat patients with comminuted intra-articular fractures (AO type C3) changed with better implants, but there remains a controversy on whether the results are better with formal open reduction and internal fixation (followed by early motion), or with closed reduction, external fixation, and/or K-wire fixation.[9–17,23]

The group of C3 fractures is heterogeneous. It is therefore difficult to compare these fractures in a randomized way based only on the classification of the injury into the C3 group. If an articular fracture is multifragmentary at the level of the radio-carpal joint surface, but the fragments are not substantially displaced and reduce with ligamentotaxis, the injury is still

FIGURE 1. Case 10: A) accident wrist ap/lateral; B) traction view CT-scan before definitive osteosynthesis; C) postoperative x-ray; D) x-ray 9 years postoperative; E) clinical result 9 years postoperative.

formally classified as C3. It is likely that the outcome of such fractures treated with external fixation and K-wires will be favorable. However, multifragmentary articular fractures may show considerable displacement, articular components may be firmly impacted into the metaphysis; they may be rotated 180 degree or incarcerated. Formally, this is still a C3 injury, but closed and even percutaneous direct reduction will hardly ever be successfull.[14] Most of these injuries may need a formal open approach. The traction CT-scan allows to thoroughly study the fracture characteristics and to identify the key fragments.[19] In traction, some articular fragments will come into alignment and key fragments that will influence the operative strategy and the placement of the hardware will be unmasked.

Ring et al[24] have presented their series of 25 cases of comminuted distal radial fractures treated with a combined palmar and dorsal approach. However, they did not follow a clearly defined strategy and some of their patients needed a second operation after single dorsal or palmar plating was unsuccessful.

Our small case series of highly comminuted C3 fractures treated with a triple plate osteosynthesis shows good functional results after 10 years of follow-up. In all cases, the anatomy was restored and early function was allowed, with the exception of one case with an associated scapholunate ligament tear. All regained good range of motion. No major complications occurred and 8 patients were able to return to heavy labor.

We show an intermediate and a long-term follow-up with these patients with nearly equal functional results 10 years after the initial trauma.

There is no study available to date in the current literature reporting such results.

CONCLUSION

Combined volar and dorsal approaches in ''shuttered wrists'' with double or triple plate osteosynthesis allow restoring articular congruency and achieving good intermediate and long-term functional results.

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