Primary Wrist Hemiarthroplasty for Irreparable Distal Radius Fracture in the Independent Elderly

Guillaume Herzberg, MD, PhD¹ Marion Burnier, MD¹ Antoine Marc, MD¹ Yadar Izem, MD¹

¹Wrist Surgery Unit, Herriot Hospital, Lyon, France

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Address for correspondence G. Herzberg, MD, PhD, Wrist Surgery Unit, Herriot Hospital, Pavillon T., 5 Place d'Arsonval, 69437-LYON, Cedex 03, France (e-mail: guillaume.herzberg@chu-lyon.fr).

Abstract

Background Volar plating for acute distal radius fractures (DRF) in the elderly has been recommended. Some studies have suggested that open reduction with internal fixation (ORIF) in this situation results in frequent complications.

Our purposes were to provide a definition of irreparable DRF in independent elderly patients and to review the results of a preliminary retrospective series of wrist hemiarthroplasty (WHA) in this patient population.

Materials Between 2011 and 2014, 11 consecutive independent elderly patients (12 wrists) with irreparable intra-articular DRF were treated with primary WHA at the acute stage. A resection of the ulnar head was associated in nine wrists. A total of 11 wrists with more than 2 years of follow-up form the basis of this paper.

Description of Technique The approach was dorsal longitudinal. An osteotome longitudinally entered the dorsal aspect of the fracture medial to the Lister tubercle. Two thick osteoperiosteal flaps were elevated radially and ulnarly in a fashion similar to opening a book. The distal radius articular surface was excised. The implant was pressed into the radial canal with attention to restoring distal radius length. The two osteoperiosteal flaps were brought back together and sutured so as to close, again like a book, the osseous and soft tissues around the implant.

Results At mean follow-up of 30 months, average visual analog scale (VAS) pain was 1/10. Mean QuickDASH (Disabilities of the Arm, Shoulder and Hand) score was 32, and mean Patient-Rated Wrist Evaluation (PRWE) score was 24. Mean forearm rotation arc was 151°. Mean active flexion-extension arc was 60°. Mean active extension was 34°. Mean grip strength was 14 kg (64% of contralateral wrist). Mean Lyon wrist score was 73%. Bone healing around the implants was satisfactory in all but one case.

Conclusions Our data suggest that treatment of irreparable DRF in the independent elderly patient with a bone-preserving WHA may be a viable option. Longer-term follow-up and comparative studies are needed to confirm the validity of this concept.

Keywords

- wrist
- distal radius fracture
- arthroplasty
- independent elderly
- elderly

Open reduction and internal fixation (ORIF) with volar plating for acute distal radius fractures (DRF) is widely used, even for elderly patients.^{1,2} However, some studies have recently questioned its use for DRF in the elderly.^{3,4} It has been suggested that ORIF fails to confer a clinical benefit and results in frequent complications.^{3,4}

Roux^{5,6} proposed to treat elderly patients presenting with acute DRF with a wrist hemiarthroplasty (WHA). His preliminary series included six wrists operated on at the acute stage. Vergnenègre,⁷ using the same implant, reported satisfactory clinical and radiological results in eight patients.

Fig. 1 Posteroanterior (PA) view of an irreparable DRF in a disabled independent 65-year-old woman. See text for radiological criteria.

Our hypothesis was that some complex impacted intra-articular DRF in the elderly would be amenable to treatment with a new bone stock-preserving wrist WHA. This surgery would obviate the need for hardware removal in the absence of complications and would be followed by early mobilization.

The purpose of this paper was (1) to provide a definition of irreparable DRF in the independent elderly patient and (2) to review the results of a preliminary prospective series of WHA for this subgroup of patients.

Patients and Methods

Between 2011 and 2014, 11 consecutive independent elderly patients (12 wrists) with irreparable intra-articular DRF were treated with primary WHA at the acute stage at a single institution. A resection of the ulnar head was associated in nine wrists (83%). A total of 11 wrists with more than 2 years of follow-up form the basis of this article.

Inclusion criteria were patients aged more than 65 years, living at home without any help for their activities of daily living, and presenting with a so-called “irreparable DRF,” operated on with WHA at the acute stage. The follow-up duration had to be greater than 2 years. Fractures were considered as irreparable if they displayed a combination of six criteria, which are included in the criteria related to the patient/energy of the accident/characteristics of the fracture (PAF) chart:^{8,9} AO type “C” complete intra-articular fracture, high extra- and intra-articular displacement scores exceeding 6/12, main fracture line distal to the watershed line, impaction, and circumferential comminution (►Fig. 1 and ►Fig. 2).

Exclusion criteria were irreparable DRF in dependent patients, failure of a previous treatment for DRF, and follow-up duration of less than 2 years. All patients meeting the inclusion and exclusion criteria constituted the cohort of this study. This retrospective study was approved by our institutional review board (IRB).

Fig. 2 Same patient, lateral view. In this particular patient, satisfactory ORIF with volar plating would be very difficult to achieve. Treatment with closed reduction-casting or external fixation would be debatable regarding their efficacy.

All patients were female. The average age was 76 years (minimum 65 years, maximum 88 years). All patients had some degree of comorbidities (►Table 1) but were living at home without any help for activities of daily living. All patients underwent primary surgery for acute irreparable DRF. The average time from injury to surgery was 4 days (minimum 1, maximum 7 days). The average follow-up was 30 months (minimum 24 months, maximum 41 months).

Implants

In 9 wrists we used the radial component of the press-fit Re-Motion total wrist arthroplasty (Small Bone Innovations,

Table 1 Comorbidities of the patients analyzed in the current series

	Comorbidities
Patient 1	High blood pressure (HBP), depression disorder
Patient 2	Depression disorder, splenic disease
Patient 3	HBP
Patient 4	Systemic acute lupus
Patient 5	HBP, polyneuritis
Patient 6	Hypothyroidism, depression disorder
Patient 7	Renal disease
Patient 8	HBP, colic cancer, cardiac arrhythmia
Patient 9	Cardiovascular disease
Patient 10	Bowel disease
Patient 11	HBP, chronic alcoholism

Morrisville, PA, USA).¹⁰ In two wrists we used the press-fit Cobra implant (Groupe Lépine, Lyon, France), a new implant specifically designed for fractures. The Cobra implant has an adequate stem length to facilitate implant placement and primary stability. Two lateral flanges are provided to help rotational control. Two intraflange holes are available to help peripheral bone fixation with sutures if necessary. The Cobra implant includes a volar offset to replicate the shape of the distal radial epiphysis (►Fig. 3). Both Re-Motion and Cobra implants are provided in right and left versions.

Operative Technique and Postoperative Management

An 8-cm dorsal longitudinal cutaneous incision is made in line with the third metacarpal. The extensor retinaculum is opened at the third compartment level and the extensor pollicis longus (EPL) tendon is retracted.

A sharp osteotome is used to enter longitudinally the comminuted dorsal aspect of fracture just medial to the Lister tubercle up to the radius diaphysis proximally. The periosteum covering the distal part of the radius diaphysis is elevated. By doing so, the posterior interosseous nerve is automatically resected. In line with this fracture rent, a longitudinal 1-cm incision, preserving the dorsal intercarpal ligament and dorsal scapholunate ligamentous complex, is made into the dorsal wrist capsule to expose the convexity of the first carpal row. With the osteotome, two thick osteoperiosteal flaps (5 to 7 mm thickness) are elevated radially and ulnarly in a fashion similar to opening a book. The radial flap contains the second extensor compartment (which is not opened) and the dorsal and radial part of the distal radius fracture, including the radial styloid. The ulnar flap contains the fourth extensor compartment (which is not opened) and the medial-dorsal part of the distal radius fracture (►Fig. 4). The comminuted distal radius articular surface and central epiphyseal cancellous bone are excised.

Care is taken to preserve thick peripheral dorsal, lateral, and volar osteoperiosteal flaps to save the bone stock of the

distal radius and facilitate bony surrounding of the implant at the end of the procedure. If the sigmoid notch remnants are reparable, they are approximated with transosseous nonabsorbable sutures and the ulnar head is left intact for later distal radioulnar joint (DRUJ) salvage. If the sigmoid notch remnants are too comminuted to be repaired, or if there is an associated ulnar head or neck fracture, the ulnar head is removed. We use a slightly oblique distal ulna resection and a stabilization using the volar capsule, which is secured to the dorsal part of the ulnar stump with transosseous sutures. After the wrist is placed on towels allowing 90° of flexion, the radius diaphysis is broached. The depth of broaching should be planned preoperatively so as to maintain the distal radius length (and variance if the ulnar head is left intact). The implant is gently pressed into the radial canal. The length of the stem should provide primary stability into the radial canal and yet protrude enough to allow satisfactory peripheral bony surrounding at the end of the procedure. Proper restoration of distal radius length is critical. Too long an implant will create too much pressure on the concavity of the proximal carpal row, leading to stiffness, pain, and cartilage injury. Too short an implant will be followed by instability of the proximal row with respect to the distal aspect of the implant, with a high risk of dislocation. There should be not more than 2 mm of pistoning and a good stability both in flexion-extension and dorsal-volar translation.

If the reduction is too loose, bone graft or cement should be used to restore radial length better.

The thick peripheral osteoperiosteal distal radial flaps are brought back together so as to close the peripheral osseous and soft tissues around the implant, again like a book (►Fig. 5). If the osteoperiosteal flap(s) are too thin, the surgeon should add part of the cancellous bone that was just removed from the central part of the distal radius epiphysis.

Nonabsorbable transosseous sutures are used to stabilize the bone stock around the implant. By doing this, the

Fig. 3 PA and lateral views of the new Cobra implant.

Fig. 4 Through a longitudinal approach, the radial and ulnar flaps are elevated as described in the text.

peripheral edges of the implant are covered with bone. This prevents impingement of the extensor tendons on the implant.

If the DRUJ is to be reconstructed, the transosseous sutures inserted into the volar medial and dorsal medial parts of the distal radius are first brought together and tied so as to restore the sigmoid notch. Then the peripheral osteoperiosteal distal radial flaps are brought back together around the implant. The short dorsal capsule incision is closed with two nonabsorbable sutures. During the whole procedure, all the extensor compartments but the third were left intact. The dorsal retinaculum is closed. If the closure of the dorsal retinaculum is too tight, the EPL tendon is left out of the dorsal retinaculum.

After wound closure and drainage, the wrist is immobilized in 20° extension and neutral radioulnar deviation in a long-arm cast for 3 weeks. Then a volar wrist splint in 20° wrist extension is applied for 3 weeks. During this period, patient's rehabilitation, alone or with the help of a physiotherapist, is performed. Active wrist extension combined

with long-fingers flexion is encouraged, as well as forearm rotation. Immobilization is discarded at day 45.

Clinical and Radiological Review

All patients returned for a comprehensive clinical and radiological review. The follow-up evaluation consisted of an interview, physical examination, and standard anteroposterior (AP) and lateral radiographs.

Follow-up clinical evaluation included rating of pain on a 10-point visual analog scale (VAS), QuickDASH (Disabilities of the Arm, Shoulder and Hand), Patient-Rated Wrist Evaluation (PRWE), evaluation of functional status, range of motion (ROM), and grip strength. The Lyon wrist score¹¹ (→Fig. 6), including information about pain, functional limitation with forearm rotation/wrist flexion-extension, active forearm rotation/wrist flexion-extension, and grip strength (Jamar dynamometer) was used. The Lyon wrist score allows a diamond-shaped representation of clinical results, which is not possible with other currently available scores.

Follow-up radiological criteria included search for periprosthetic osteolysis as well as evaluation of ulnar or volar translation of the carpus. Coronal and sagittal inclination of the implant were also evaluated. We measured, in both coronal and sagittal planes, the angle between the longitudinal axis of the radial diaphysis and the stem of each implant. By convention, if the proximal tip of the stem pointed radially/ulnarly in the coronal plane, the implant was considered as ulnarly/radially deviated and the calculated angle was negative/positive. In the sagittal plane, if the proximal tip of the stem pointed dorsally/volarly, the implant was considered as volarly/dorsally deviated and the calculated angle was negative/positive. Only values exceeding 5° toward either direction were considered as significant. Measurements were done with Centricity Enterprise 3.0 software (GE Healthcare, Little Chalfont, Buckinghamshire, UK).

Results

Complications

There were no dislocations, loosening, or superficial/deep infections of the implants. We did not remove any implants. We observed three instances of complex regional pain

Fig. 5 After implantation of the prosthesis, the two flaps were closed like a book, and the retinaculum was repaired.

LYON WRIST SCORE							
Patient's Name		Age	Side	Dominance			
Physician's Name							
Date							
A/2	Pain	with forearm rotation	0	5	10	15	20
B/2	Pain	with Wrist Flexion-extension	A	B	C	D	E
C/2	Functional impairment	with forearm rotation	at sleep	at rest	with motion	heavy use or climatic	none
D/2	Functional impairment	with wrist flexion-extension	at sleep	at rest	with motion	heavy use or climatic	none
E/2	Active Motion	Forearm rotation arc (degrees)	severe	important	moderate	minimal	no
F/2	Active Motion	Wrist Flexion - extension arc (degrees)	severe	important	moderate	minimal	no
G	Grip Strength		E	F	G		
			[0-40]	[40-80]	[80-120]	[120-160]	> 160°
			[0-30]	[30-75]	[75-110]	[110-150]	> 150°
			[0-25 %]	[25-50 %]	[50-75 %]	[75-100 %]	100 % @
X	Score /80	Grip strength (kg): GS1	(GS1/GS2) x 100: @				
Y	Score/100	Contralateral Grip strength (kg): GS2					

Fig. 6 Electronic version of the Lyon Wrist Score.

Fig. 7 Diamond-shaped representation of the average values found in this series.

syndrome (CRPS); all resolved in less than 18 months. One patient was reoperated 20 months after the index operation because she presented a significant stiffness due to tendon adhesions along with a tendency to ulnar deviation of the wrist. Through a dorsal approach we performed extensor tendon tenolysis combined with tendon transfer

of extensor carpi radialis longus (ECRL) to extensor carpi radialis brevis (ECRB). At final follow-up of 31 months her clinical status was markedly improved and she could make a fist easily.

Clinical Results

At final follow-up, the average VAS pain was 1/10 (range 0–4). The mean QuickDASH score was 32 (range 0–77), and the mean PRWE score was 24 (range 0–63). Among the nine cases with combined ulnar head resection no patient complained about painful radioulnar impingement. The mean forearm rotation arc was 151° (range 120–170°). The mean active wrist flexion-extension arc was 60° (range 35–85°). The mean active wrist extension was 34° (range 15–50°). The mean grip strength was 14 kg, which was 64% of the contralateral wrist (range 36–100%). The mean Lyon wrist score was 73% (range 62.5–87.5) (►Fig. 7). A case example is shown in ►Fig. 8 and ►Fig. 9a–f.

Radiological Results

Bone healing around the implants was satisfactory in all wrists (►Figs. 10a,b). According to the definitions given in the Methods section, coronal radial inclination of the implant

Fig. 8 (a–h) Case example of a 70-year-old woman, independent at home, presenting with irreparable DRF and treated with WHA. Follow-up of this case was 2 years.

Fig. 9 (a–f) Same patient, clinical result.

Fig. 10 Case example of satisfactory bone healing around the implant. (a) Preoperative CT scan of an irreparable DRF in an independent elderly woman. Note the marked comminution with impaction and dorsal subluxation of the DRUJ. (b) Postoperative CT scan at 31 months of follow-up showing satisfactory bone healing around the implant and restoration of a sigmoid notch and stable DRUJ.

Table 2 Patient outcomes compared with literature

	Average Follow-up (months)	Pain (VAS)	Quick DASH score	PRWE score	Lyon wrist score	Forearm rotation Arc (°)	Wrist flexion/extension arc (°)	Wrist extension (°)	Grip strength (% of contralateral)
Vergnenègre (2014)	25	2	18.2	NA	78.6	160	89	44	92
Our series (2015)	27	1	32	25	73.1	151	60	34	67

was observed in one case and coronal ulnar inclination in three cases (in all of whom the Re-Motion implant was used). This resulted clinically in a slight wrist deformity. This was well tolerated in all four patients. Sagittal orientation of the implant was satisfactory in all cases.

We did not observe any abnormal ulnar or volar translation of the carpus relative to the implant. Each implant remained well seated within the distal cup of the implant. Active motion between the carpus and the implant was proportional to clinical radial/ulnar deviation. There was no subsidence of the implants or erosion of the carpus, but the follow-up is too short to allow definitive conclusions.

Discussion

Our current data suggest that treatment of irreparable DRF in the independent elderly patient with a bone-preserving WHA may be a viable option. There are no really good options to treat what we have defined as irreparable DRF in elderly patients. *Closed reduction and casting* may leave significant deformity although functional impairment may be minimal.¹² *Percutaneous pinning* often fails because of the very limited purchase into osteoporotic fractured fragments.¹³ *External fixation* is a cumbersome treatment for an elderly patient.¹⁴ *Distraction plating* is an invasive treatment that is more suitable for young patients with irreparable DRF.¹⁵ *Volar plating* may be in some cases a satisfactory option.² However, in Orbay's study,² only 33% were classified as AO type C fractures. In our experience, successful volar plating is difficult to achieve in so-called irreparable DRF in elderly patients, and secondary displacement frequently occurs. Arora³ showed in a level I study that ORIF with volar plating in this group of patients did not convey any improvement in terms of function and ROM compared with closed reduction and cast immobilization.

Following concepts used in the shoulder¹⁶ and elbow,¹⁷ Roux proposed to treat complex comminuted DRF in the elderly with a specific WHA replacing not only the distal carpal facet of the radius but also the sigmoid notch.^{5,6} Within Roux's series there were six cases of acute DRF in the elderly that were treated with primary WHA. The results of this subgroup were not specifically addressed. Using the same implant, Vergnenègre⁷ reported eight similar cases with satisfactory functional results and no implant removal at an average follow-up of 25 months. Their results were slightly better than ours, especially in terms of grip

strength (►Table 2). However, there are some drawbacks about the massive implant used in these studies. According to the recommended surgical technique, the periosteum surrounding the distal radius was in direct contact with the large metallic part of the implant. Moreover, in case of implant removal, the loss of a large solid volume would be very difficult to handle. The use of this implant is contraindicated if the DRF is associated with an ulnar neck or head fracture. This is not the case with the WHA we used in this series.

The implants used in our series have the advantage of preserving the distal radius bone stock. We found that the radial component of the Re-Motion implant was too short to provide a constantly straight orientation of the stem with respect to the radial diaphysis. This is why we designed a specific fracture implant with a similar ellipsoid distal surface but a longer stem and two lateral flanges to help rotational stability.

Because ORIF with volar plate is a validated option in many elderly patients with DRF, we must define the candidates for WHA, both in terms of patients and fractures. This is why we provided simple and reproducible criteria defining irreparable DRF.

Direct metal-on-cartilage contact between the implant and the convexity of the articular cartilage of the proximal carpal row is not the best contact for an arthroplasty. However, WHA for acute DRF in independent elderly patients is a salvage procedure. The metal-on-cartilage contact is well accepted for shoulder and elbow salvage procedures from acute trauma, since the advantages outweigh the drawbacks. Moreover, wrist WHA was recently proposed for treatment of wrist arthritis.^{18,19} Longer-term follow-up and comparative studies are needed to confirm the usefulness of the WHA approach for irreparable DRF in independent elderly patients as well as the fate of the cartilage of the first carpal row against the implant.

Conflict of Interest

There is a conflict of interest with one of the implants presented in this study (Lyon University, Herriot Hospital and corresponding author).

Ethical Statement

This prospective nonrandomized study was approved by our institutional review board.

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