



## Treatment of distal radius fractures with palmar plates and locking screws. Comparisson of two different types of plate

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Various plating systems are available to fix distal radius fractures, each with a specific design. The purpose of this study was to compare radiological outcome and complications of the Variable Angle LCP Plate 2.4-mm (DePuy Synthes) with the VariAx volar locking plate (Stryker). One hundred patients (103 wrists) operated on for a distal radius fracture were retrospectively reviewed with a mean follow-up of 3.5 years. Seventy-three wrists were treated with a DePuy Synthes plate and 30 with a VariAx plate. The overall complication rate was 32%. Nineteen cases underwent revision surgery, 18 had malunion and 3 complex regional pain syndrome. Complicaton rate was 43% with DePuy Synthes plates and 27% with Variax plates, but the difference was not significant.

**Keywords :** distale radius fracture ; palmar plate ; complications.

### INTRODUCTION

Distal radius fractures are one of the most common fractures. In the Netherlands, the overall incidence was 20 per 10,000 person-years with a higher incidence in women increasing with age for both women and men. Fifty percent of all fractures were extra-articular or AO type A fractures, 24% partially articular or AO type B and 26% complete articular or AO type C (3). The most common injury mechanism is a low energy fall on the outstretched hand (12).

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In the last decade there has been an increased interest in operative treatment with palmar plates and locking screws (11). Main advantages are stable fixation, decreased period of immobilization, early rehabilitation and good anatomical restoration (7,9,19). Locking plates are particularly useful in patients with osteoporotic bones. The palmar approach has become more popular than the dorsal because of the lower risk of tendon rupture and hardware irritation (20). Several different palmar plate designs were introduced on the market, all with different features to reduce the risk of complications. Plates have become thinner and more adapted to the shape of the volar surface of the distal radius. It is possible to choose the direction of the locking screws and in some plates double rows of distal locking screws are available (14,17). Variable Angle LCP Two-Column Volar Distal Radius Plate 2.4-mm (DePuy Synthes) and the VariAx Distal Radius

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*Fig 1.* — A. DePuy Synthes plate. B. VariAx plate.

Plating System (Stryker) have an anatomical design and polyaxial (variable angle) locking screws (17) (Fig 1). The aim of the present study was to compare radiological outcomes and complications of these two different volar locking plate design systems.

#### PATIENTS AND METHODS

Between 2011 and 2014, 120 patients were operated on for a distal radius fracture, of whom



*Fig 2.* — A. Peri-implant fracture of the radius through the proximal screw. B. Treated with plate osteosynthesis.

4 bilaterally, with a Variable Angle LCP Plate 2.4-mm (DePuy Synthes) or a VariAx volar locking plate (Stryker) in the Orthopaedic department of the Ghent University Hospital. Fifteen patients were lost to follow-up and two did not want to participate in the study. Of those patients, 10 were treated with a Variable Angle LCP Plate and 7 with a VariAx plating system. Patients were excluded if concomitant ipsilateral fractures of the ulna or radius had been treated with a plate. This was the case in 3 patients (4 wrists). Three included patients

had a bilateral distal radius fracture and underwent bilateral palmar plate fixation, 2 with a DePuy Synthes plate and 1 with a VariAx plate. In total, 103 wrists of 100 patients were included in this study.

Patients were operated on by different surgeons under general anaesthesia and with the use of a tourniquet. First closed reduction of the distal radius fracture and temporary fixation with one or two K-wires was performed. The Henry approach was used to reach the distal radius fracture. The position of the fracture, plate and screws was checked with fluoroscopy. Postoperatively, a forearm plaster of Paris splint was applied. After one week skin sutures were removed and a circular forearm cast was applied for three more weeks. Patients were advised to move their fingers, elbow and shoulder.

Following information was collected from the electronic medical files : gender, age at the time of surgery, side, complications, revision surgery, fracture type and radiological parameters. In 84 patients, no secondary surgical procedures were reported in the medical files and they were contacted by telephone to find out if they had undergone revision surgery or any treatment for complications in another hospital.

Complications were defined as any condition severe enough to require a revision surgical procedure, complex regional pain syndrome (CRPS) or if there was radiological evidence of malunion. Additional surgery to remove the hardware was also considered as a complication.

Radiographic images were evaluated with the picture archiving and communication system (PACS, GE Healthcare, Milwaukee, USA). Fractures were classified with the AO-classification system : extra-articular (type A), partial articular (type B) and complete articular (type C) fractures (23). It was noted if an additional fracture of the ulnar head was present. A fracture of the ulnar styloid process was not considered as an associated ulna fracture (24). Ulnar variance, radial inclination and radial tilt were determined on preoperative, immediate postoperative and at least one month postoperative wrist X-rays. In case of malunion, fractures were classified into four types : 1) Dorsal malunion (dorsal tilt greater than  $10^\circ$ ) ; 2) Palmar

malunion (palmar tilt greater than  $16^\circ$  or with palmar translation of the distal fracture fragment of more than 2 mm) ; 3) Intra-articular malunion (articular step of more than 2 mm, a palmar tilt less than  $17^\circ$ , a dorsal tilt no more than  $10^\circ$ , and no palmar translation) ; 4) Radial shortening (increase in ulnar variance of more than 2 mm without articular steps, palmar shift or major change in palmar tilt). Normal ulnar variance was estimated from radiographs of the normal wrist or from radiographs taken on the first postoperative day (8). Malunion could be evaluated in 82 patients.

The data were collected by the first author (JD), who was not involved in the surgical treatment or rehabilitation. The study has been approved by the medical ethics committee of the Ghent University.

Complications rate, revision surgery rate and malunion rate between the two plate systems and the three fracture types were analysed using the Pearson's chi-square test. The analysis was performed with SPSS data statistics, version 24 (IBM SPSS, Armonk, NY, USA). A P-value of  $<0.05$  was considered statistically significant.

## RESULTS

Fifty women and 50 men were included in the study. Three men had a bilateral radius fracture. Patients were reviewed with a mean follow-up of 44 months (range : 13, 74). Features of the patients included in the study and AO classification are presented in Table I.

The total overall complication rate was 32%. The complication rate of the DePuy Synthes plate was 43% and of the VariAx plate 27%. Nineteen cases (18%) underwent revision surgery. Comparison between the complications of the Variable Angle LCP Plate and the VariAx plate is presented in Table II.

Twelve patients treated with a DePuy Synthes plate needed revision surgery. A 37-year old man was operated on for acute carpal tunnel syndrome one day after the osteosynthesis. A 22-year old man sustained a fracture of the radius through the proximal screw hole of the plate after a fall on the hand during snowboarding 17 months after osteosynthesis (Fig 1). The plate had to be removed

Table I. — Features of patients treated with a DePuy Synthes and VariAx plate

	DePuy Synthes (N=73)	VariAx (N=30)
Men / Women	34 (47%) / 39 (53%)	19 (63%) / 11 (37%)
Age: mean (SD) (years)	51 (17)	54 (18)
Right side	29 (40%)	11 (37%)
Extra-articular fractures (AO-classification A)	28 (38%)	15 (50%)
Partial articular fractures (AO-classification B)	18 (25%)	2 (7%)
Intra-articular fractures (AO-classification C)	27 (37%)	13 (43%)
Associated ulna fracture	4 (6%)	1 (3%)

Table II. — Complications with the DePuy Synthes plate and the VariAx plate

	DePuy Synthes (N=73)	VariAx (N=30)
Revision surgery (number of patients)	12 (16%)	7 (23%)
Hardware removal	8 (11%)	7 (23%)
Extensor tendinitis	1	0
Flexor tendinitis	2	0
Intra-articular screw	0	1
Carpal tunnel release	1	1
Ulnar shortening osteotomy (ulnar instability)	1	0
Tendon transfer (rupture tendon extensor pollicis longus)	1	0
Peri-implant fracture	1	0
Proximal row carpectomy	1	0
Complex regional pain syndrome	2	1
Radiological results	N=53	N=29
Malunion	11 (21%)	7 (24%)
Dorsal malunion	0	1
Volar malunion	4	4
Intra-articular malunion	3	1
Radial shortening	5	1

and osteosynthesis with another plate was required. An ulnar shortening osteotomy was performed in a 35-year old man, four months postoperatively because of instability of the distal radio-ulnar joint in association with an ulna plus. A 54-year old woman with a comminuted fracture was reoperated for rupture of the tendon of the extensor pollicis longus 6 months postoperatively. In a 43-year old woman, plate and screws were removed 10 months postoperatively and four months later a proximal row carpectomy was performed in another hospital because of carpal instability. A 61-year old woman and a 67-year old man developed CRPS.

Of the 7 patients treated with a VariAx plate who needed revision surgery, there was a 77-year old woman in whom plate and screws had to be removed because of intra-articular screw placement. A 25-year old man had symptoms of median nerve compression two years postoperatively. This was confirmed by an electromyography and a carpal tunnel release was performed. In this patient plate and screws were also removed because of hardware irritation. A 31-year old woman was diagnosed with CRPS two months postoperatively.

Mean postoperative ulnar variance was 1 mm (range : -3, +7), mean postoperative palmar tilt 9°

(range : -11, 25) and mean radial inclination 23° (range : 3, 36).

There was no statistically significant difference in complication rate, revision surgery rate and malunion rate between the two plating systems ( $P=0.12$ ,  $P=0.41$  and  $P=0.72$ ). Complication rates were not significantly higher in one of the three different fracture types ( $P=0.16$ ).

## DISCUSSION

In recent years palmar plate fixation has become the preferred treatment for unstable distal radius fractures, but it is not without complications. In the present study the overall complication rate was 32%. In the literature, reported complication rates ranged between 0 and 48% (25). This variation can be explained by the different definition of complication. In some studies, hardware removal and malunion were not considered as a complication (6,15,25).

One of the most important risks of volar plate fixation is flexor and extensor tendon irritation and rupture. Excessive distal placement of the plate, prominent distal edge of the plate and prominent screws can irritate flexor tendons (2). The Watershed line is a surgical landmark on the volar radius which can serve as a distal margin for volar plating. To reduce the risk of tendon irritation, it is important to place the plate proximally of this line. Extensor tendons may rupture when screws perforate the dorsal radius cortex (17).

In the present study, hardware had to be removed in 15 cases. In two of those it was because of flexor tendonitis, in 1 because of extensor tendonitis and in another a screw was placed intra-articularly. The systematic review of Yamamoto showed that the most frequent reasons for hardware removal were routine removal, tendon irritation or tenosynovitis, hardware problem and patient's request (25). There is a high variety in removal rate and not all studies report hardware removal as a complication. The mean hardware removal rate according to the systematic review of Yamamoto et al. was 9%, ranging from 0 to 100%. Thorninger et al. reported a removal rate of 7% and Javed et al. a rate of 3% (9,22).

Carpal tunnel syndrome is a common complication after distal radius fracture (16). It can be idiopathic

(primary), secondary or acute. Acute carpal tunnel syndrome is progressive, develops rapidly and requires urgent decompression. Secondary carpal tunnel syndrome can occur months to years after the fracture and may be mild and not recognized (6,16). Prophylactic release of the carpal tunnel during plate fixation is not recommended (16). In the present study, 2 patients (2%) had carpal tunnel syndrome, one acute and another late. In the literature rates of carpal tunnel syndrome after plate fixation of distal radius fractures range between 2 to 6% (6,9,13,17,18,22).

Complex regional pain syndrome is a well known complication in patients with a distal radius fracture. It is a clinical diagnosis characterized by pain, swelling, neurovegetative symptoms and loss of function. Treatment is non-operatively with physiotherapy and painkillers. In the present study, two patients with CRPS were found. Some studies reported no CRPS, while others had rates of 4%, 5% and 9% (13,17,18).

In the present study, there was one patient re-operated with an ulnar shortening osteotomy. Esenwein et al. reported this procedure in 8 cases (1,2%) (6).

Other complications reported in the literature are compartment syndrome, deep and superficial infections, delayed unions and screw loosening (1,6). In the present study those complications were not found.

Several studies reported a link between malalignment and poor clinical outcome (4,5). Especially radial shortening and palmar malunion may be important (5). However, this correlation was less clear in elderly patients (5,21). We did not see a significant difference in malunion rate between the two types of plates. The total malunion rate was 18%. Knight et al. reported 25% malunions with fixed-angle locked T-plates. However, a different definition for malunion was used. Malunion was considered if the dorsal angle was more than 0°, the palmar angle more than 15° and radial shortening greater than 3 mm (10).

In the present study, two different plate designs were compared. Both were characterized by the variable angle (polyaxial) feature and the anatomical design. These characteristics make it easier to place

the plate on the optimal location on the radius surface (14,17). To our knowledge, this is the first study that compared these two plate designs. No significant difference in complication and malunion rate between the VariAx and the DePuy Synthes plate were found. Javed et al. compared three different plate designs : Stryker Variax, Synthes LCP (not reported if with fixed or variable angle), and Smith & Nephew Peri-Loc (fixed angle) with respectively 26%, 20% and 14% complication rates. The differences were not significant (9). Thorninger et al. compared the complication rates between the variable angle VariAx plate and the fixed angle Acu-Loc plate and did not find a significant difference (22). Mehrzad et al. compared two different types of volar plates : one design with locking screws with fixed angles and one new design with variable angle locking screws. They found significantly more plate related complications in the group with the fixed angle screws (15). Obert et al. compared also those two different types of plates. The new design had fewer implant related problems than the old (4.1% and 6.4%), but more tendon ruptures (5% and 0 %). The overall complication rate was similar for the old and new designs, 16.5% and 16.1%, respectively (17).

Limitations of the present study are its retrospective nature. Complications may be under-reported as postoperative CT scans were not studied to detect intra-articular screw placement. Some complications may not be related to the type of plate but to the nature of the fracture and the energy of the trauma.

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