



Breakage of a volar locking plate after delayed union of a distal radius fracture

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This is a case report of a 58-year-old obese, diabetic female who sustained a dorsally angulated distal radius fracture, treated with a volar locking plate. Union was delayed and the plate broke. The fracture healed after repeated surgery involving replacement of the plate and grafting with demineralised bone matrix.

Delayed unions of distal radius fractures are rare. This case shows that fracture treatment with locking compression plates has some specific biomechanical consequences which have to be taken into account, and special attention will be given to technical peculiarities and possible drawbacks.

Keywords : distal radius ; locking plate ; hardware failure ; delayed union.

CASE REPORT

A 58-year-old right handed woman presented at our department after a fall. She complained of pain at the right wrist. The radiographs showed a dorsally displaced fracture of the distal radius with intra-articular extension (fig 1). According to the classification proposed by Jupiter and Fernandez this fracture was classified as type I (8). Her medical history revealed type II diabetes treated with oral antidiabetics, hypertension and significant obesity. She was not a smoker. Measurement of bone mineral density 7 months after this initial trauma was within the normal range (T-score : -0.34 at the lumbar spine, i.e. 96% of the normal value and T-score : -0.66 at the left hip, i.e. 91% of

INTRODUCTION

Fractures of the distal radius are among the most common musculoskeletal injuries (1). Non-union of these fractures however is uncommon (5,7,10). The functional outcome after distal radius fractures correlates closely with radiocarpal alignment and restoration of length (13,14).

Recently fixed angle internal fixation devices were developed to combine the facilities of conventional plate osteosynthesis with those of an internal fixator system (12). We present a case of non-union followed by plate breakage after volar plating of a distal radius fracture without bone grafting.

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Fig. 1. — Preoperative radiographs : Distal radius fracture with dorsal displacement. A : Anteroposterior view ; B : Lateral view

the normal value) for sex and age (Hologic, dual X-ray absorptiometry, measurements at the level of left hip and lumbar spine).

Open reduction and internal fixation was scheduled three days after the accident. The fracture was approached through a volar incision and was fixed after reduction with a 3.5 T-type Locking Compression Plate (LCP) (Mathys Medical Ltd, Bettlach, Switzerland). Angle-stable locking screws were used proximally as well as distally. Postoperatively, the forearm was immobilised in a plaster cast. The postoperative radiographs showed radial shortening, 10° palmar inclination and discontinuity in the anterior cortical alignment at the fracture site. The plate was not in contact with the anterior cortex (fig 2).

After two weeks the plaster cast was replaced by a removable splint allowing gentle mobilisation. Six weeks after surgery, the splint was removed and a rehabilitation program under supervision of a physiotherapist was started.

At this stage only mobilisation of the wrist and hand was allowed without strengthening exercises. One month later functional improvement was good but the patient reported some pain during and after

effort. The radiographs showed a slight posterior collapse of the fracture site (fig 3), due to slight bending of the plate without screw loosening. Rehabilitation was continued.

Fourteen weeks after the operation the pain had significantly increased. The patient reported a painful event during a rehabilitation session, a few days earlier. Thereafter, when leaning on the wrist, she heard a cracking. Clinical examination revealed shortening and radial displacement at the fracture site. Radiographs showed a broken plate at the original fracture site. This breakage occurred through an empty screw hole and the distal radius was displaced dorsally and radially (fig 4).

Five days later the patient was re-operated and the plate and screws were removed. The non-union was fixed with a similar plate in conjunction with a posterior bone graft. As iliac crest harvesting would have been difficult due to the morbid obesity of the patient, the nonunion site was grafted with demineralised bone matrix (Allomatrix, Wright Medical Corporation) (fig 5). Locking screws were used distally but this time classical bicortical non-locking screws were used for proximal fixation of the plate, giving compression at the non-union site.



Fig. 2. — Postoperative radiographs : View after fracture fixation with an anterior LCP-plate. A : Anteroposterior view ; B : Lateral view.

After the surgery the forearm was again immobilised in a plaster cast and the patient left the hospital three days later.

Although the peroperative fluoroscopic images taken with the C-arm were reassuring, the radiograph a few days after the intervention showed an intra-articular positioning of one of the two distal screws. It was decided to leave this screw in place and remove it after fracture healing. This time the plate was in close contact with the anterior cortex (fig 6).

The plaster cast was removed at 7 weeks and replaced by a removable splint and physiotherapy was begun. Complete fracture consolidation was obtained 8 months after the initial trauma : the fracture line disappeared and there was no pain on palpation of the fracture or mobilisation of the wrist (fig 6). The Disability of Arm, Shoulder and Hand (DASH) score at the time of healing was 56.2 (normal value : 50 ; standard deviation : 10) (6).

DISCUSSION

Non-union of the distal radius is very rare but cases have been reported in association with diabetes mellitus and obesity (11). These non-unions are usually symptomatic (5,7) and can be treated by rigid internal fixation and iliac crest bone grafting (2). Routine bone grafting of unstable fractures of the distal radius has even been suggested by several authors to promote fracture healing (3,12). Angular stability of the LCP-plate is reported to maintain fragments in place in distal radius fractures that might have been at risk of tilting, without opening the fracture site for grafting, although osteoporosis is known to be a risk factor for failure of the LCP-system (12).

It has been demonstrated that the transmission of forces to the proximal radius is greater through the volar LCP-system than through a conventional volar or dorsal compression plate (9). In such an



Fig. 3. — Radiographs at 10 weeks : Dorsal impaction of the fracture site with plate bending. A : Anteroposterior view ; B : Lateral view.



Fig. 4. — Radiographs at 14 weeks : Breakage of the plate with secondary displacement of the fracture. A : Anteroposterior view ; B : Lateral view.



Fig. 5. — CT-scan 3 months after the second operation, showing the demineralised bone matrix graft in the metaphyseal bone area.

osteosynthesis, the plate is exposed to high bending forces, particularly because there is no bony support from the opposite cortex.

Non-union in our case was probably caused by several factors. The reduced capillary vascularity associated with diabetes and the surgical periosteal devascularisation created a biological situation which was unfavourable for fracture healing. Mechanical weaknesses were the lack of continuity of the anterior cortex as well as the poor contact of the plate with the anterior cortex. In combination with the dorsal fracture comminution this gave an unstable construct that went on to failure. This is evidenced by the change in the angulation between the plate and the distal screws on early postoperative radiographs (fig 2) and radiographs at 10 weeks (fig 3). As shown by the lateral radiographs (figs 2, 3), all the forces were transmitted through the distal part of the plate, acting as an internal fixator without cortical contact. Initial bone grafting to support the posterior cortex might have been indicated in this situation. Radiographs 2.5 months after initial surgery showed a slight posterior collapse of the fracture site (fig 3). The plate was submitted to prolonged high bending forces and ultimately broke.



Fig. 6. — Radiographs 8 months after the second operation, showing bony healing. A : Anteroposterior view ; B : Lateral view.

The stability of the locking screw system is demonstrated by the fact that none of the screws had loosened or pulled out when the plate broke (fig 4).

Fracture union was obtained after posterior bone grafting and revision of the osteosynthesis with a plate that was in close contact with the anterior cortex.

Moreover in the proximal part of the plate, bicortical screws without angular stability were used to allow a progressive transmission of load between the plate and the bone (fig 6). These bicortical screws have a longer working length, which enables them to withstand axial and bending forces over a longer time (4).

We found one similar report of failure of the LCP-system in the distal radius : it was a case of cut out of the epiphyseal screws in the distal fragment because of insufficient fixation in osteoporotic bone, combined with anterior instability through fracture comminution and lack of contact between the anterior cortex and the plate (12). This failure however went on to fracture healing without plate breakage ; besides, the patient in our case showed no osteoporosis as confirmed by a bone mineral density measurement 7 months after the initial trauma.

CONCLUSION

The great variety of possibilities offered by the LCP-system requires a good biomechanical analysis of the lesion and careful surgical technique. In our case restoration of length and reduction of the anterior cortex of the distal radius was insufficient and the construct was too weak to withstand the forces transmitted through it and that is why the osteosynthesis went on to failure. Initial bone grafting would probably have been better as well to avoid non-union in this patient.

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