

ORIGINAL RESEARCH

Correction of deformity following distal radius non-union with bone grafting and plating

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Abstract:

10 patients with malaligned fractures of the distal radius that demonstrated either delayed healing or the development of an atrophic or synovial nonunion on standard radiographs were treated with surgical realignment, stable internal fixation, and autogenous iliac crest bone grafting. All 10 fractures healed with acceptable radiologic alignment within 6 months of the index procedure. After an average follow-up period of 3 years (range, 2 years to 5 years) patients had an average of 90° wrist flexion and extension, 150° forearm rotation, and 70% grip strength compared with the opposite limb. In the treatment of malaligned, non-united fractures of the distal radius, specific techniques and implants must be tailored to the deformity of the distal radius and the shape of the distal fragment. A stable, well-aligned wrist with preservation of at least 50° mobility in flexion and extension was achieved in every patient, but the final result was compromised by associated problems in 2 patients.

Key words: Distal radius, wrist, nonunion, bone graft, internal fixation.

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INTRODUCTION

Nonunion of a distal radius fracture is extremely uncommon. Healing problems in the distal radius seem to be related to unstable situations, such as concomitant fracture of the distal radius and ulna, and to an inadequate period of immobilization. The nonunion of the distal radius may result in shortening, radial impaction, volar angulation, dorsal displacement or rotatory deformity. Nonunion should be suspected if there is continuing pain after remobilization of the wrist in combination with a progressing deformity. The diagnosis may be confirmed by showing movement at the fracture site on lateral radiographs of the wrist in flexion and extension. When associated with deformity, surgical correction of a nonunited fracture of the distal radius can be problematic (due to a small, osteopenic distal fragment, associated soft tissue contracture, and atrophic status at the site of delayed healing). But improvements in the implants and surgical techniques for the fixation of small, periarticular fractures have made these goals more realistic. Failure to achieve union can be salvaged with total wrist arthrodesis. For restoration, the anatomy and kinematics of the distal radioulnar joint and the triangular fibrocartilaginous complex (TFCC) are of importance. Because of the rarity of distal radius fracture nonunion, it is not surprising that there is no

consensus on the optimum mode of operative treatment. The most common operation that has proved to be effective is osteotomy of the radius, insertion of a trapezoidal bone graft in place, and internal fixation with a dorsal or volar plate. We review our experience with delayed union or nonunion and malalignment of fractures of the distal radius treated by debridement, bony alignment, internal fixation, and autogenous bone grafting. Based on our experience with reconstruction surgery in 10 patients, we think that most nonunions of the distal radius are amenable to attempts to realign and heal the fracture even when the distal fragment is small. Therefore, surgeons should try to preserve even a small amount of wrist motion and reserve wrist fusion as a final resort.

MATERIALS AND METHODS

We have included 10 patients that were presented to New Civil Hospital, Surat for treatment of nonunion distal end radius. This study includes all patients that were treated conservatively as well as operatively. This study includes adult age group (Range 20 to 70 years) excluding those who were unfit for surgery due to other comorbidities and those who were not willing for surgery. Diagnosis is made when a metaphyseal fracture of the distal radius in a healthy patient shows no signs of progressive healing within last 3 months

on standard radiographs. Patients with limited radiographic evidence of healing 4 months after the injury were considered to have delayed healing and patients with limited radiographic evidence 6 months after the fractures were considered to have fracture nonunion. The diagnosis was confirmed by showing movement at the fracture site on lateral radiographs with the wrist in flexion and extension. If there was any doubt regarding the radiographic signs of fracture union (bony trabeculae crossing the fracture site), a CT scan was recommended. All patients were investigated for preoperative evaluation and anesthetic fitness was taken for each patient before operation. Standard biplanar radiographs of both wrists were taken for adequate for planning the operative treatment of most patients. Comparison with the uninjured wrist is crucial to the understanding of carpal alignment, ulnar variance, and inclination of the distal radial articular surface in the sagittal plane. Computed tomography scanning can be used to evaluate the size of the distal fragment to imagine what kind of implants can be applied and to evaluate instability or incongruence of the distal radioulnar joint. Preoperative consent taken for Bone grafting and possible future wrist arthrodesis (if fracture fails to unite even after current surgical correction). All patients were operated under regional anesthesia with supplemental anaesthesia at time of bone grafting. All patients were operated under tourniquet control. 9 of our 10 patients were treated through a palmar approach, 1 patient was treated through a dorsal approach.

Shortening of the radius in relation to the ulna was treated with lengthening. An opening wedge procedure reorients the distal fragment in the sagittal and the frontal planes. The defect created by the procedure included debridement of the nonunion site, including any synovial membrane and avascular bone, realignment of the fragments, bone grafting, and stabilization of the site of the fracture this approach was filled with a contoured corticocancellous autogenous iliac crest bone graft. 9 patients had a lengthening and opening-wedge procedure combined with a bone grafting of the radius. 8 patients had a corticocancellous bone graft from the iliac crest and 1 patient had iliac crest cancellous bone graft. A small skeletal distractor (Lamina spreader) was used to realign the fracture. Complete tenotomy or Z-lengthening of the brachioradialis tendon was done to help to gain length when a deformity is characterized by extreme radial deviation and shortening.

Post-operative protocol included active-assisted motion of the hand and elbow was encouraged the morning after surgery. A wrist splint is used to help support the wrist for 4–6 days after surgery. Active-assisted wrist motion was allowed once pain and swelling has subsided. Sutures were removed after 15 days postoperatively. Strengthening exercises were restricted until radiographic healing was

established. Patients were followed on 6, 12 and 24 weeks with xrayson each follow-up and final follow up was made after 1 year of index surgery.

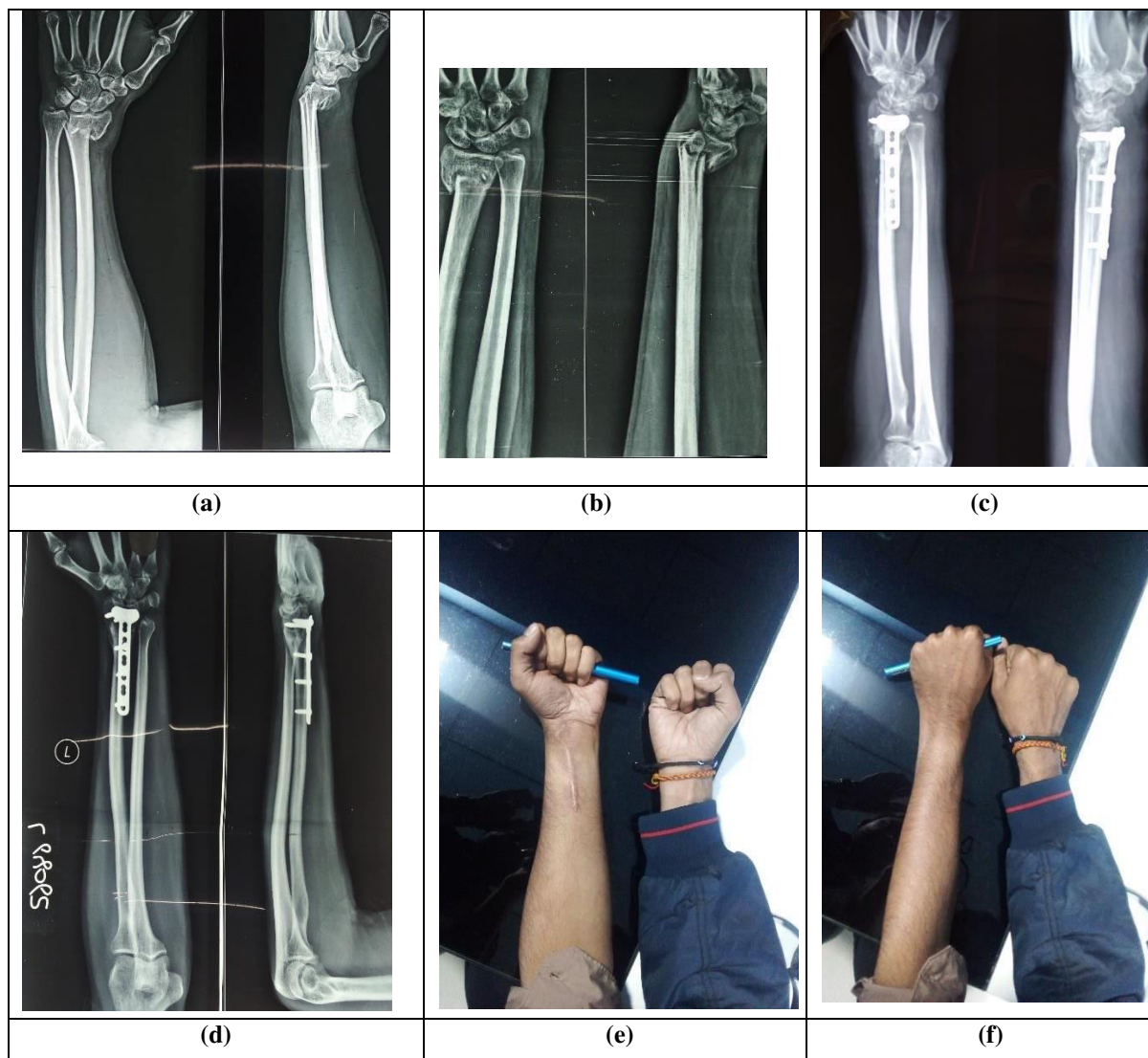
RESULTS

Segalman and Clark(14) treated 12 nonunions of the distal radius in 11 patients during a 24-year period. Nine non-united fractures (eight patients) had less than 5 mm of metaphyseal subchondral bone beneath the articular surface, an amount considered insufficient for open reduction and internal fixation by the authors. Of these nine fractures, three were treated without additional surgery.

Wrist arthrodeses were done successfully in six fractures (five patients). Four of these healed after one operation, one required three attempts before union occurred after 12 months despite a postoperative infection, and one obtained a successful radiocarpal fusion. The time to union ranged from 3 to 12 months. Of the three fractures with sufficient subchondral bone for restoration of the distal radius, two were treated with internal fixation and iliac bone graft; one of the two fractures also had an external fixator placed. Both fractures healed within 4 months. The third fracture was treated with distraction lengthening and delayed bone grafting. The first bone graft was from the iliac crest; a bone substitute was used 4 months later when there were no signs of union. This fracture healed within 7 months.

Smith and Wright(17) treated five patients with nonunion of the distal radius. Four patients had open reduction, bone grafting, and internal fixation. One patient was treated with open reduction, bone grafting, and an external fixator. Three of the four patients treated with internal fixation healed although one required an additional operation to achieve union. One patient, who had five procedures at the wrist before he was treated by the authors and four subsequent procedures, ultimately obtained union after a total wrist fusion. The patient who was treated with open reduction, bone grafting, and an external fixator required salvage with a total wrist fusion because of a persisting nonunion. One patient reported being very satisfied with the final outcome, two patients were somewhat satisfied, one patient was not satisfied, and the outcome in one patient was unknown.

We had analysed 10 patients with a nonunion of the distal radius in whom the distal fragment had more than 5 mm of subchondral bone supporting the articular surface distal to the site of the nonunion. All patients had reconstruction of the distal radius in an attempt to gain bony union with preservation of some wrist motion. In our 10 patients, the reconstruction of the distal radius was done as one-stage procedure. Simultaneous to the reconstruction of the distal radius, 1 of our patients had Darrach procedure of the distal ulna. Arthrolysis of the DRUJ was done in two patients in an attempt to help restore functional motion.



(a) Immediate x-ray after trauma; (b) After 3 months of conservative treatment-including 1 and half months of cast; (c) Immediate postop-Debridement of fracture site with tricortical Iliac crest graft with plating; (d) At 6 months follow-up; (e) & (f) Final movements.

The follow up was averaging 30 months. Bony union was achieved in 8 patients. All union patients resulted in approximately an 90° flexion and extension arc, a 40° ulnar and radial deviation arc, and a 150° supination and pronation arc. Grip strength averaged 70% compared with the opposite limb. There were few complications attributable to the surgical treatment. One obese patient had a superficial infection in the wound used to access the iliac crest. This was treated with debridement and parenteral antibiotics followed by oral antibiotics. One patient had deep infection in the wound on the distal radius. The infection was treated with debridement and parenteral antibiotics, but not controlled. Finally implant removal with debridement and JESS fixator done but that patient lost follow up later on. One patient did not have union and required a salvage procedure with a total wrist fusion.

DISCUSSION

Although healing problems at the distal radius have historically been considered rare, some investigators have speculated that delay in healing of a fracture of the distal radius may have become more common since the advent of surgical techniques that restore the length of the fractured distal radius and thus create a bony gap in the metaphysis that may delay healing. Healing problems in the distal radius also seem to be related to unstable situations, such as concomitant fracture of the distal radius and ulna, as well as to an inadequate period of immobilization, inadequate fixation during open reduction and excessive distraction during application of an external fixator. Some medical conditions and some drugs may disturb the bone metabolism and, therefore, may delay or even prevent fracture healing. Such comorbid medical conditions are diabetes mellitus,

peripheral vascular disease, peripheral neuropathy, and psychiatric disorders, alcoholism, hypothyroidism, morbid obesity, and scleroderma. Tobacco previously has been implicated in an increase in the nonunion rate in patients having spinal fusion and limited intercarpal arthrodeses. Alcoholism may negatively affect compliance of the patients during fracture treatment. Patients with delayed union or nonunion of the distal radius may have dysfunction related to pain and instability, but many problems arise from the associated malalignment.

Nonoperative treatment is appropriate only in patients with limited functional demands (such as the elderly) in whom symptoms can sometimes be managed in a splint. In the case of a stable fibrous nonunion, the indication for surgery relates more to dysfunction associated with malalignment of the fracture fragments in an active person. Further immobilization to encourage fracture healing would only prolong and exacerbate this dysfunction and would not address the malalignment; such care would be appropriate only in patients with limited functional demands. In active patients, intervention is indicated as soon as dysfunction and limited healing become apparent.

A small, osteoporotic distal fragment, associated soft tissue contracture with radial deviation of the carpus and hand, and atrophic status at the site of the nonunion are features that can make surgical correction of a distal radial nonunion difficult and has led some authors to recommend total wrist fusion. Several series describe surgical attempts to gain union. Segalman and Clark (14) advised the extent of the metaphyseal subchondral bone supporting the articular surface distal to the site of the nonunion as a criterion to determine the appropriate treatment. They suggested that surgical attempts to gain bony union are worthwhile when at least 5 mm of subchondral bone beneath the lunate facet of the distal radius is available for application of implants. For nonunions with less than 5 mm of subchondral bone supporting the articular surface distal to the nonunion site, they recommend total wrist arthrodesis. We have shown the results of reconstruction of distal radial fracture nonunions in 10 patients in whom the distal fragment had more than 5 mm of subchondral bone supporting the articular surface distal to the site of the nonunion.

When the wrist is stiff, particularly in the presence of a synovial nonunion, incision of the (7-Fernandez, Ring, and Jupiter / Nonunion of the Distal Radius) dorsal radiocarpal and/or volar distal radioulnar joint capsule should be considered. Arthrosis, deformity, or incongruity of the distal radioulnar joint must be addressed. Wrist motion facilitates positioning of the hand in space, enhances strength and precision of the digits, and provides important proprioceptive feedback. It is therefore preferable to preserve even a small amount of wrist motion. We think that an attempt to maintain functional mobility of the wrist by obtaining anatomic

realignment of the distal fragment and union of the fracture seems warranted. Total wrist arthrodesis should be reserved as a final resort. Based on our experience, we favor resection of the distal ulna (Darrach procedure), particularly when there is severe shortening of the distal radius that cannot be overcome. Our experience suggests that most nonunited fractures of the distal radius are amenable to attempts to realign and heal the fracture.

SUMMARY

Distal radius nonunion is less commonly recognized. The success of operative treatment to gain union seems to have improved along with improvements in operative fixation of fractures of the distal radius. Operative treatment to gain union or arthrodesis of the wrist can improve function and comfort with relatively few complications.

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