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ORIGINAL RESEARCH

Distraction Plating for the Treatment of Highly Comminuted Distal Radius Fractures in Elderly Patients

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ABSTRACT

Purpose: To evaluate the use of internal distraction plating for the management of comminuted, intra-articular distal radius fractures in patients over 60 years of age at two level one trauma centers. Our hypothesis was that distraction plating of comminuted distal radius fractures in the elderly would result in acceptable outcomes regarding range of motion, disabilities of the arm, shoulder and hand (DASH) score, and radiographic parameters and would thereby provide the upper extremity surgeon with another option for the treatment of these fractures.

Materials and methods: A retrospective review was performed on 33 patients over 60 years of age with comminuted distal radius fractures treated by internal distraction plating at two level 1 trauma centers. Patients were treated with internal distraction plating across the radiocarpal joint. At the time of final follow-up, radiographs were evaluated for ulnar variance, radial inclination, and palmar tilt. Range of motion, complications and DASH scores were also obtained.

Results: Thirty-three patients with a mean age of 70 years were treated with distraction plating for comminuted distal radius fractures. At final follow-up, all fractures had healed and radiographs demonstrated mean palmar tilt of 5° and mean positive ulnar variance of 0.6 mm. Mean radial inclination was 20°. Mean values for wrist flexion and extension were 46° and 50° respectively. Mean pronation and supination were 79° and 77° respectively. At the final follow-up, the mean DASH score was 32.

Conclusion: In the elderly, distraction plating is an effective method of treatment for comminuted, osteoporotic distal radius fractures.

Level of evidence: Therapeutic, Level IV (Retrospective case series).

Keywords: Distal radius fracture, ORIF, Bride plate, Spanning fixation.

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INTRODUCTION

Distal radius fractures are the most common fracture of the upper extremity, representing one-sixth of all fractures treated in emergency departments.[1] Approximately 10% of women in the United States above the age of 65 will sustain a distal radius fracture during the remainder of their lifetime.[2] These fractures are particularly difficult to treat because of the poor bone quality and the often considerable comminution. Recently, a direct correlation between bone mineral density and the severity of distal radius fractures has been established.[3] Furthermore, distal radius fractures in these patients result in higher rates of carpal malalignment and malunion.[4]

The optimal treatment of these fractures remains controversial, but several authors agree that restoration of anatomical alignment leads to better chances for functional recovery.[5] There has been advancement in the treatment of distal radius fractures with the advent of the volar distal radius locking plate, yet standard open reduction and internal fixation with nonspanning plates can be challenging for comminuted fractures with poor bone quality.[6,7]

One treatment option for complex distal radius fractures is distraction plating. The distraction plate is an internal fixator taking advantage of ligamentotaxis to help obtain fracture reduction.[8] The reduction at the fracture site is further optimized by making a 2 cm incision at the Lister tubercle. The extensor pollicis longus tendon is exposed and freed from the groove around the Lister tubercle. This permits exposure of the fracture for both articular reduction and placement of bone graft into the metaphyseal defect as needed. While the plate takes advantage of ligamentotaxis for indirect fracture reduction, it also provides a direct buttress of the comminuted bone dorsally and helps prevent dorsal tilt and subsidence of the fracture. It also allows for early functional use of the injured extremity and has few reported complications.[8,9] Previously, distraction plating for distal radius fractures with metaphyseal and diaphyseal comminution has been reported to have good results in younger patients with polytrauma.[9]

This technique uses a dorsally placed 3.5 mm dynamic compression plate (Synthes,West Chester, PA) or 2.4 mm distal radius bridge plate (Synthes) from the radial diaphysis to the metacarpal that spans the radiocarpal joint. The plates used have nonlocking and locking screw capability. Traditionally, a nonlocking screw is placed first in the metacarpal, then a nonlocking screw is placed in the proximal hole in the diaphysis of the radius while manually distracting the fracture. This effectively lags the plate onto the bones. Overdistraction, as indicated by a radiocarpal space in excess of 5 mm[2], should be avoided in order to prevent loss of digital motion. The digits are assessed to confirm full passive flexion in order to avoid extrinsic extensor tightness. The remaining screw holes in the

Fig. 1: PA and lateral radiographs and coronal and sagittal CT scan of a 67-year-old woman who sustained a comminuted distal radius fracture in a fall

Fig. 2: Immediate postoperative PA and lateral radiographs that demonstrate placement of 14 hole small fragment locking compression plate. Note that three bicortical screws were placed in the radial diaphysis and three bicortical screws were placed into the third metacarpal

Fig. 3: PA and lateral X-rays taken 1 year after the original surgery. The dorsal plate has been removed

Fig. 4: PA and lateral radiographs of a 60-year-old woman who sustained a comminuted distal radius fracture in a fall

Fig. 5: Immediate PA and lateral postoperative radiographs that demonstrate dorsal placement of a 14 hole small fragment locking compression plate. Note that three bicortical screws were placed in the proximal radial diaphysis and three bicortical screws were placed into the third metacarpal. For further supplemental fixation, two locking screws we placed in the distal radius

Fig. 6: PA and lateral X-rays taken 1 year status post the original surgery. The dorsal plate has been removed

metacarpal and radius are secured with bicortical locking screws in the cases where there is concern about bone quality, with a minimum of 3 screws used at either end of the plate. In cases where bone quality appears to be reasonable, only 3.5 mm nonlocking cortical screws or 2.4 mm cortical screws are used for the 3.5 or 2.4 mm plate respectively. When placing screws in the metacarpal we are careful to place them centrally in the bone and not to perforate the radial or ulnar margin of the metacarpal, which would risk an iatrogenic fracture. The plate is removed after fracture consolidation, and wrist motion is then initiated. See Figures 1 to 6, which demonstrate the technique for two patients in the study.

MATERIALS AND METHODS

A retrospective review was performed for 33 patients over 60 years old with comminuted distal radius fractures treated by distraction plating at two level 1 trauma centers. Surgeries were performed by hand-fellowship-trained orthopaedic surgeons. Inclusion criteria were patients greater than 60 years old with C-2 or C-3 distal radius fractures by the AO classification. Patients had to be treated with distraction plating for inclusion. Institutional review board approval and informed consent were obtained, and data were collected according to the approved protocols.

Patients were treated with internal distraction plating across the radiocarpal joint using a 3.5 or 2.4 mm dynamic compression plate, placed dorsally from the radial diaphysis to the metacarpal. In 21 patients, the plate was affixed to the third metacarpal, and in 12 patients the plate was secured to the second metacarpal. This difference came from the fact that certain surgeons were accustomed to routinely using the second metacarpal, while others were more familiar with using the third metacarpal for distal plate fixation. Yet their underlying goal of spanning the fracture site for distraction plating remained the same. The surgical technique, which has been well described in previous papers, used 3 incisions to place the plate.[8,9] A 4 cm incision was made over the shaft of the metacarpal where the extensor tendon was retracted. At the dorsal aspect of the distal radius a second 4 cm incision was made opening the third compartment. The extensor pollicis longus tendon was transposed, and the fourth compartment was elevated to allow passage of the plate. A third incision was then made at the dorsal radial aspect of the radius at least 4 cm proximal to the fracture. This was typically at the same region of the radius where external fixation pins would be placed. The radius was exposed between the brachioradialis and the second dorsal compartment. The plate was then passed from the distal incision at the metacarpal and advanced proximally under the fourth extensor compartment along the dorsal aspect of the radius, or the plate was passed from proximal to distal along the radial diaphysis to the dorsal surface of the metacarpal. It was secured in standard fashion as described by Ruch et al and Hanel et al.[8,9] Care was taken to assess passive digital flexion prior to plate fixation to prevent overdistraction.

Supplemental fixation with Kirschner wires was used to secure and support the articular fragments in 7 cases according to surgeon discretion. Postoperatively, patients were placed into a short splint for comfort until suture removal. Digit motion was initiated immediately postoperatively, and patients were placed on a 2 kg lifting restriction with the affected extremity. This lifting restriction was intended to avoid fracture through the site of plate fixation at the metacarpal and radius and also to avoid screw pullout and loss of fracture reduction. If concomitant injuries required assistive ambulatory devices, patients were allowed to weight-bear through the forearm. Serial clinical examinations and radiographs were obtained at approximately 2, 6 and 12 weeks postoperatively. Once fracture consolidation was demonstrated, the plate was removed as an outpatient procedure an average of 119 days (range: 70-280 days) following injury.

Progressive wrist motion was initiated after plate removal under the supervision of a hand therapist, and patients were allowed active, active assisted, and passive wrist and finger motion without restriction. Most patients achieved maximal motion at an average of 3 months after plate removal. At the time of final follow-up, which averaged 47 weeks, radiographs were evaluated for radial length, radial inclination, and palmar tilt. Clinical evaluation of wrist and forearm motion and digital range of motion was performed. Complications were documented and the disabilities of the arm, shoulder and hand (DASH) instrument was used. This instrument quantifies disabilities related to the upper extremity with a score ranging from 0 points (no disability) to 100 points (maximum disability).

Statistical Methods

The results of the clinical and radiographic variables were recorded at final follow-up. The mean and standard deviation was calculated for the variables. The arc of wrist flexion/extension was achieved by adding together active wrist flexion and extension, as has been used in prior studies.[10,11] Supination and pronation were summated to achieve the arc of forearm rotation.

RESULTS

Thirty-three patients with a mean age of 70 years were treated with distraction plating for comminuted distal radius fractures. For a list of demographic results, refer to Table 1.

During follow-up all fractures demonstrated union. Standard posteroanterior, lateral and oblique radiographs evaluated palmar tilt, radial length and radial inclination. The mean palmar tilt was 5° with two patients demonstrating dorsal tilt. The mean positive ulnar variance was 0.6 mm. The radial inclination was 20° at final follow-up. In 30 wrists, the distal radius articular surface was restored to a congruous position (<2 mm of articular step-off). See Table 2 for a summary of outcomes.

Digital stiffness, noted in 10 patients during the postoperative course, was demonstrated by difficulty in flexing digits to the distal palmar crease. One patient required a tenolysis, which was performed at the time of plate removal. These adhesions occurred at the extensor tendons to the index finger in a patient whose plate had been secured to the index metacarpal. One patient noted transient superficial radial neuritis, one patient developed complex regional pain syndrome, and one patient with an open fracture developed an infection with poor wound healing that required a skin graft. There were no cases of tendon ruptures.

Table 1: Patient demographic information

Number of patients included in the study	33
Average age	70
Sex	
Male	10
Female	23
Mechanism of injury	
Fall	23
MVC	8
Crush	1
Car *vs* Ped	1
Fracture	
Open	7
Closed	26
Supplemental K-wire fixation	7
Average follow-up duration (weeks)	47
Average time of plate removal (days)	119

Table 2: Outcome data

	Mean value at final follow-up
Radiographic outcomes	
Palmar tilt (degrees)	5 (SD: 6.2)
Ulnar variance (mm)	1 (SD: 1.8)
Radial inclination (degrees)	20 (SD: 4.9)
Motion (degrees)	
Flexion	46 (SD: 19.2)
Extension	50 (SD: 25.4)
Pronation	79 (SD: 17.6)
Supination	77 (SD: 17.8)
DASH score	32

DISCUSSION

As elderly patients remain active, surgeons are likely to see an increase in the incidence of distal radius fractures and an increased desire for patients to maintain their independence. Treatment goals remain directed toward achieving functional outcomes. Several authors have demonstrated good functional results after operative management of displaced distal radius fractures in elderly patients.[12-19] Jupiter et al achieved good or excellent results in 18 of 20 patients treated with plate fixation.[20] Other authors have demonstrated similar results with volar plating, but appropriate patient selection is emphasized as complications of these plating systems become recognized.[5]

Several studies have documented the inverse relationship between bone mineral density and incidence of distal radius fracture in the elderly.[1,21,22] Recently, Clayton et al reported that decreased bone mineral density correlated directly with fracture severity in this age group.[3] Though the advances in volar plate technology have been substantial, fractures with extensive comminution and extension into the diaphysis may be difficult to treat with volar plate fixation.[8,9] As fracture severity increases, surgical management becomes more challenging and requires a broadening of the skill set available to the surgeon caring for these patients.

Our hypothesis was that distraction plating of comminuted distal radius fractures in the elderly would provide the upper extremity surgeon with another option in the treatment of these complex fractures. We formulated this hypothesis based on our prior studies involving a population of younger polytraumatized patients treated with bridge plates. Our prior studies revealed functionally acceptable results in 20 of 22 patients and 100% fracture healing, maintenance of radial length, radial inclination, palmar tilt, and no articular gaps or step-offs greater than 2 mm in 62 out of 62 patients.[8,9]

In our current study fracture healing was universal. Final radiographs demonstrated a mean palmar tilt of 5° and positive mean ulnar variance of 0.6 mm. This is important considering that closed reduction may not adequately restore anatomic alignment and that at least 50% of the fractures treated with closed reduction lead to malunion.[23,24]

Several authors have reported on the ability of external fixation to restore anatomy of the distal radius. In many ways the distraction plate acts like an internal external fixator. The cadaveric study by Chhabra et al using acrylic rods demonstrated favorable results in plates over external fixation by showing resistance to loss of reduction in the axial plane and maintenance of palmar tilt due to the buttress effect of the plate.[25] Bridge plates have favorable biomechanics compared with external fixation by minimizing the bone-to-bar distance. Behrens et al demonstrated that the rigidity of external fixation was directly proportional to how close the longitudinal fixator bar is to the bone and fracture. A bridge plate rests directly against the radius proximally and metacarpals distally, making it a strong construct.[26]

Another advantage of the bridge plate over the external fixator relates to complication rates. Szabo and Weber reported a 50% complication rate, especially pin track infections, when using external fixation alone.[27] McQueen et al showed high complication rates and poor functional outcomes with external fixation involving pin track infections, fracture subsidence, prolonged distraction and digital stiffness.[28] Because the bridge plate is subcutaneous, there is no need for pin track care. One disadvantage of bridge plate fixation is that it requires removal in the operating room. We acknowledge that a second operation in an older patient who may be infirm is a risk factor that needs to be kept in mind and discussed with the patient before employing this technique.

Previous studies have concluded that functional range of motion varies between flexion of 5 and 40° and extension of 30 to 40° accompanied by functional forearm supination of 50° and pronation of 50°.[29-31] In our study, the use of the bridge plate allowed for values that exceeded these norms. It does not appear that restricting wrist motion with a bridge plate during the time of fracture healing compromises the eventual motion of the wrist. This appears consistent with the findings of Lozano-Calderon et al who studied wrist mobilization following volar plate fixation of distal radius fractures, and noted that beginning wrist motion at 6 weeks did not lead to decreased wrist motion at 6 months compared with patients who started wrist motion within 2 weeks of surgery.[32] Though we have found that patients ultimately have a functional outcome in terms of wrist motion after plate removal, we acknowledge the fact that older patients may find the time period when the plate is applied to be disabling since they may not be as capable of adapting to the immobilization and loss of motion brought on by the plate compared with a younger patient.

Digital stiffness was noted in 10 patients, and one patient required extensor tenolysis. We postulate that the cause for digital stiffness was subsequent to the fracture itself, in the sense that the pain, swelling, and tissue trauma from the injury lead to a period of decreased digital motion in the immediate postinjury period. We acknowledge the possibility of an iatrogenic cause to digital stiffness, since overdistraction during plate placement can create extrinsic tightness and limit flexion. We attempted to avoid this by confirming on fluoroscopy that the radiocarpal joint was not distracted greater than 5 mm and that the patients had full digital flexion and extension in the operating room after the plate was applied. Though patients seem to have acceptable results clinically and radiographically after surgery in this study, at final follow-up, the mean score on the DASH questionnaire was 32, which is higher than the normative value for the general population, which Hunsaker et al found to be 10.[33]

The use of distraction plating is not a panacea for the treatment of distal radius fractures, but rather it should be thought of as a treatment option. Distraction plating appears to provide acceptable results based on the ability to restore functional range of motion and achieve acceptable radiographic outcomes. A general weakness of our study was that there is no control group. Since we did not directly compare distraction plating with other forms of fixation we have no intention to suggest that distraction plating is superior for the treatment of C2 or C3 radius fractures. Indeed other operative techniques, such as volar plating and external fixation may be viable options and be a more familiar technique for many surgeons. Perhaps future studies could more directly compare distraction plating with other forms of fixation of distal radius fractures.

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