Nonbridging external fixation for fractures of the distal radius

Drew A. Bednar, MD; Hamad Al-Harran, MD

Objective: To assess the feasibility of using standard components from the small AO external fixator set to support fractures of the distal radius with a construct incorporating distal fixation in the perarticular radius fragment that would allow for primary mobilization of the wrist joint during fracture healing. Methods: In a prospective pilot study of a nonbridging external fixator in early 2001, 6 consecutive cases of fracture in the distal radius presenting at a tertiary care centre, the Hamilton General Division of Hamilton Health Sciences, were compared with 6 historical controls treated with a standard bridging construct immobilizing the wrist. Both groups were or had been treated with closed reduction and external fixation of the distal radius under fluoroscopic control. Fracture alignment was measured on radiographs after healing and removal of the fixation devices; additional (secondary) outcome measures were pin-tract sepsis and implant loosening (treatment failure). Results: Compared radiographically with controls, alignments after fracture healing were improved (and virtually anatomic) with use of the nonbridging external fixator. The incidence of pin-tract sepsis was similar in the 2 groups, neither of which included any treatment failures. Conclusions: Nonbridging external fixation of comminuted distal radius fractures can be accomplished safely and effectively. The results of this pilot study suggest that improved radiographic alignment may be achieved with this technique.

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Although the first description of an external fixator in the treatment of forearm fractures by Ombrédanne in 1929 was of a nonbridging device, standard technique involves and current texts describe bridging constructs that cross and necessarily immobilize the wrist during the bony healing process.

Nonbridging constructs offer a potential benefit in accelerating rehabilitation by allowing primary wrist mobilization with the fixator in situ; yet, they are infrequently used and in fact go unmentioned in the most recent instructional course lecture from the American Academy of Orthopaedic Surgeons. There may be a clinical concern that compromised bone stock in the distal radius fragment (as is commonly encountered, either from osteoporosis in the geriatric patient or by virtue of fracture comminution in the higher-energy injuries seen in younger patients) may preclude definitive fixation with this technique.

We have applied this technique in a small group of patients, confirming the feasibility of this treatment.

Methods

All 6 consecutive cases, without exception, of comminuted displaced fracture in the distal radius without volar displacement of the distal fragment (as would require buttress plating) presenting to the senior author (D.A.B.) in the first 6 months of 2001 were treated with nonbridging external fixation (Fig. 1). The previous 6 consecutive comminuted distal radius fractures treated by the senior author in late 2000 were analyzed as historical controls (Fig. 2).

All preoperative radiographs were analyzed for fracture classification according to the AO system and to define relevant radiographic parameters of alignment: the height of the radial styloid (radial height in Fig. 3), radial inclination (Fig. 3) and the volar tilt (Fig. 4). Immediate postoperative films were similarly analyzed to quantify improvement in radial inclination and height and volar tilt. Late postoperative films were analyzed for maintenance or potential deterioration of these parameters. Preoperative, immediately postoperative and late images of the 6 immediately preceding cases treated by the senior author with bridging fixator constructs were similarly analyzed for comparison.

All surgeries were performed by the senior author in the operating room under general anesthesia, with standard surgical preparation and free draping of the limb.

All fixations were performed under fluoroscopic guidance with components from the standard AO small external fixator set. The pins used generally were of 4.0 mm diameter with a 20-mm thread length; 2.5-mm pins with 15 mm of thread were used in the metacarpals of smaller patients. They were inserted through small incisions (5–10 mm) just large enough to reveal the bone without use of retractors. The radius was then predrilled with a 2.0-mm drill working through a protective drill-guide. All pins used were short-threaded so as to optimize purchase of the screw shank through the proximal cortex, and inserted with bicortical purchase.

Preliminary and usually incomplete fracture reduction was performed under fluoroscopy. Next, a proximal pin was inserted into the intact radial shaft 2–4 cm proximal to the fracture.

In the study group, 2 pins were then inserted to the distal fragment, 1 on each side of Lister's tubercle so as to preserve the extensor pollicis longus pulley there. These pins were inserted under lateral fluoroscopic control into immediately subchondral bone. The pins were cross-linked with a short connecting rod. Any residual volar tilt was then corrected, likewise under lateral fluoroscopy. A longitudinal rod was used to connect the distal construct to the proximal pin. A fourth pin was then inserted to the radius 2–3 cm proximal to the first pin and connected to the longi-
Finally, a second longitudinal rod was connected to complete the assembly (Fig. 1).

After surgery, radiographs of both the operated and unoperated wrist were taken to allow the determination of the normal radiographic parameters for each patient.

In the control group, distal pins were inserted to the second metacarpal shaft and incremental longitudinal traction applied to optimize reduction before connection of the 2 longitudinal rods. A fifth pin was then inserted to the periarticular radius fragment and used as a joystick to reduce residual volar tilt before being connected to one of the longitudinal rods to hold that reduction (Fig. 2). Biplane fluoroscopic assessment was then used to confirm the adequacy of fracture reduction.

In all 12 patients, any skin tethering around the pins was incised for release and any gaping of skin around the pins was loosely approximated with 3-0 nylon suture. Two-inch (~5 cm square) Kling gauze was then loosely wrapped around the bases of the pins to protect the pin–skin interface.

Afterward, patients used a simple sling for comfort for 1–2 weeks, without wrist splints. Pin-site care included maintaining the gauze dressings in place until any bleeding or fluid discharge had stopped, at which point dressings were removed; pins were left exposed to the air and not purposefully disturbed. Active range-of-motion exercises of the fingers (and the wrist, in the study group) were encouraged, but physiotherapy was not immediately prescribed.

When the fractures were judged radiographically to be healed (mean 8 wk; range 6–10 wk), the fixators were removed in the clinic and physiotherapist-supervised exercises initiated. Follow-up lasted until patients were comfortable and the injured hand and wrist fully functional, at which time they were discharged for active care (mean follow-up 21 wk; range 16–28 wk). No patient was recalled to the clinic specifically for study purposes.

**Results**

All distal-radius fractures presenting to the senior author in the study period were treated with this technique, including those with comminution and/or articular disruption.

The study group consisted of 3 men and 3 women with a mean age of 55 years (range 42–72 yr). Five were injured in simple falls; 1 had a high-energy fracture resulting from a fall from a height. The control group also consisted of 3 men and 3 women, of mean age 58 years (range 31–88 yr). Five were injured in simple falls, and 1 had a high-energy injury caused by a motor vehicle crash. Demographics and mechanism of injury are accordingly similar between groups.

**Complications**

Two cases of pin-site infection developed, 1 in each group. Both occurred at proximal pins inserted into the intact radial shaft within the first 3 weeks of treatment, and both resolved rapidly with oral antibiotic therapy (cloxacillin). There were no infections involving the more distal pins inserted into distal/periarticular fragments.

No case could be considered as a failure of therapy, as no patients displayed premature implant loosening or infection that might have required early removal of the fixators.

One control patient had mild carpal-tunnel symptoms perioperatively, which resolved within days. One patient in the study group had fracture through the proximal pin site on the radial shaft after a fall.

**Table 1**

<table>
<thead>
<tr>
<th>AO Subtype</th>
<th>Study Group</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>C3</td>
<td>2</td>
<td>0</td>
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</table>
some 2 weeks after surgery. This was treated with ORIF (open reduction with internal fixation) using a small-fragment dynamic compression plate. The nonbridging external fixator was left in place. Both fractures subsequently did well.

Discussion

The aim of treatment of fracture of the distal radius is the restoration and maintenance of normal anatomical alignment at the wrist. Radiological and clinical results correlate well.6

Taleisinik and Watson10 described symptomatic midcarpal instability caused by malunited fracture of the distal radius, and showed that loss of volar tilt can put the cap in a position causing dorsal collapse.

Bringing external fixators produce fracture reduction primarily by ligamentotaxis across the radiocarpal joint. Less-than-perfect reconstitution of volar tilt can result because volar radiocarpal ligaments are much stronger than the dorsal complex. For this reason, the senior author has routinely inserted a fifth pin into the periarticular distal radius fragment and used it as a derotation joystick to improve volar tilt in his standard bridging construct.

Fracture stabilization techniques involving direct manipulative control of and stable fixation to the distal radius fragment offer potentially optimal results.11-13 In our control patients as well as our study subjects, volar tilt was increased with fifth-pin manipulation of the fragment (as illustrated in Fig. 2) to optimize distal radius alignment. Although unproven, this technique may have biased the control group toward improved reduction and thereby create concern that our controls may not be equivalent to the classical bridging fixator method, in which the periarticular distal-radius fragment is not directly instrumented.

There has historically been concern that deficient bone stock in the distal radius fragment, either by virtue of osteoporosis in the elderly or fracture comminution in higher-energy injuries as commonly seen in younger patients, would not allow for sufficiently secure and stable fixation without “bridging” the fixator and securing to the metacarpals distally.

Oddly, despite the current standard of practice involving bridging devices,7 the first report of distal radial external fixation by Ombredanne7 in 1929 described the use of a nonbridging device. Several authors have more recently presented small series of cases treated with this technique: Meléndez and colleagues14 reported good results in 13 cases; Krishnan and associates15 obtained good functional results in 22 patients with intra-articular fractures; and Fischer and coauthors16 had good results in 17 patients.

Our pilot study is admittedly limited in size but represents the only controlled series in the literature to date. We cannot pretend to present well-objectified functional status information in these cases, but can confirm the feasibility of the nonbridging technique. The “fifth pin” technique used in the control series might tend to improve the quality of reduction in our controls, which would increase the apparent importance of our observation that this small pilot study generated improved quality of reduction in the nonbridging group with statistical significance.

Hopefully this report may inspire others to pursue the nonbridging technique. Only a prospective and controlled multicentre trial will be able to define any potential benefit to functional outcomes. Recognizing the statistical limitations imposed by our small numbers (n = 6), we incidentally present what may be improved fracture realignment obtained this way.

One concern with this technique is the possibility of pin-tract sepsis contaminating the wrist joint. To date, this has not occurred, with both of our pin-tract infections involving proximal pins.

Our data not only confirm that nonbridging external fixation of distal radius fractures can be accomplished effectively, but also strongly suggest that significantly improved volar tilt can be restored with this technique as compared with a bridging fixator, even where volar tilt in the bridging construct is optimized through use of a derotation pin in the periarticular fragment.

Conclusion

Nonbridging external fixation of comminuted distal radius fractures can be accomplished safely and effectively. The results of this pilot study suggest that improved radiographic alignment may be achieved with this technique.

Table 2

<table>
<thead>
<tr>
<th>Alignment measure</th>
<th>Study pts</th>
<th>Controls</th>
<th>Study pts</th>
<th>Controls</th>
<th>Study pts</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial height, mm</td>
<td>4 (5)</td>
<td>3 (4)</td>
<td>15 (2)</td>
<td>13 (5)</td>
<td>14 (2)</td>
<td>13 (5)</td>
</tr>
<tr>
<td>Radial inclination, °</td>
<td>—</td>
<td>—</td>
<td>28 (6)</td>
<td>27 (4)</td>
<td>25 (7)</td>
<td>27 (6)</td>
</tr>
<tr>
<td>Volar tilt, °</td>
<td>-22 (12)</td>
<td>-29 (16)</td>
<td>15 (5)</td>
<td>5 (11)*</td>
<td>17 (6)†</td>
<td>6 (13)†</td>
</tr>
</tbody>
</table>

*11 Postoperative between-group differences were both statistically significant at p < 0.03.
Immed postop = measurements taken immediately after surgery; pts = patients

Table 3

<table>
<thead>
<tr>
<th>Alignment measure</th>
<th>Injured wrist</th>
<th>Normal side</th>
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</thead>
<tbody>
<tr>
<td>Radial height, mm</td>
<td>28 (6)</td>
<td>26 (4)</td>
</tr>
<tr>
<td>Radial inclination, °</td>
<td>15 (2)</td>
<td>14 (1)</td>
</tr>
<tr>
<td>Volar tilt, °</td>
<td>15 (5)</td>
<td>15 (3)</td>
</tr>
</tbody>
</table>

No comparison was significant (all p > 0.05). SD = standard deviation

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*2003 CMA Physician Resource Questionnaire.