Dual Radial Styloid and Volar Plating for Unstable Fractures of the Distal Radius

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Author Affiliation | Disclosures

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Acknowledgment: The authors would like to convey that this article is in dedication and in tribute to the life and career of Dean G. Lorich, MD.

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Take-Home Points

- Radial column fixation can be used as a reduction tool in unstable distal radius fractures.
- Radial column fixation can help maintain reduction until union in unstable distal radius fractures when combined with volar plating.
- When operating without an assistant, radial column plating can assist in reduction maintenance when other techniques are not successful and holding a reduction manually is not possible.
- Acceptable clinical and radiographic outcomes can be achieved with the use of dual radial styloid and volar plating for unstable distal radius fractures.
- The effects of increased dissection during radial column fixation in distal radius fractures with regard to scar formation and wrist ROM is currently not known.
Distal radius fractures are among the most common orthopedic injuries encountered; their reported incidence is >640,000 annually and is estimated to increase.\textsuperscript{1-4} The management of these injuries has evolved from closed reduction and casting to percutaneous pinning and internal fixation, as the importance of achieving and maintaining an anatomic reduction has become more apparent.\textsuperscript{5-7} More recently, volar locking plates have emerged as a way to prevent complications associated with dorsal plating. Most authors agree that volar locked plating achieves stable fixation and allows for early postoperative wrist range of motion (ROM).\textsuperscript{5,8-11} However, a volar approach to a dorsally unstable fracture creates difficulty with regard to reduction at the time of surgery and several reports have noted mechanical failure with utilization of locked volar plating alone.\textsuperscript{12-15}

Dual plating of unstable distal radius fractures with a volar locking plate and a radial column plate has been described in the past in the setting of severely comminuted fractures or in patterns with a large radial styloid fragment that was not addressed with a volar locking plate alone.\textsuperscript{16-19} The purpose of this study is to present the use of the radial column plate as a tool that allows a surgeon to achieve and maintain reduction during open reduction and internal fixation (ORIF) of an unstable distal radius fracture.

**Operative Technique**

Patients for whom ORIF is indicated include those with unstable distal radius fractures, with or without intra-articular extension and involvement of both the intermediate and lateral columns.

The patient is positioned supine on the operating table with the operative hand placed palm-up on a radiolucent hand table. A volar approach to the distal radius is undertaken, utilizing the interval between the flexor carpi radialis (FCR) tendon and the radial artery. The floor of the FCR sheath is incised, and a self-retaining retractor with blunt tips can be placed to permit visualization. The pronator quadratus (PQ) is sharply reflected off the radial border of the distal radius and approximately 1 mm to 2 mm proximal to the radiocarpal joint with an L-shaped incision for fracture site exposure. The brachioradialis is then identified and tenotomized with a scalpel (Figure 1).

A preliminary reduction is then performed using a combination of axial traction and palmar translation of the carpus. The surgeon should not be concerned with radial height or inclination at this point; however, volar tilt should be established as best as possible. A rolled towel is placed dorsal to the metacarpals, holding the wrist in a flexed position as it is placed back onto the radiolucent hand table.

A 7 to 8 hole 2.0-mm reconstruction plate (DePuy Synthes) is bent to the shape of the radial border of the distal radius. Undercontouring of the plate is necessary to allow for its use as a reduction tool. The plate is then applied to the radial column ensuring that the distal aspect of the plate engages the distal fracture fragment(s) (Figure 2). A single 2.4-mm fully threaded cortical screw in the radial to ulnar direction is then placed bicortically in the proximal fragment in the hole nearest the fracture site. As the screw is tightened, the plate will push the distal fragment(s) due to its undercontoured shape, and in doing so, will restore radial height and inclination (Figure 3). As this screw is being used as a “working screw,” it will be longer than needed after final tightening. A second screw is then placed proximally to prevent rotation of the plate, and the initial screw can be replaced if its length is of concern. If it is the intention of the surgeon to remove the plate prior to wound closure, the second screw is typically not necessary, and there is no indication for exchanging the first screw if it is long.

At this point, final changes to the reduction can still be performed, as the distal fragment(s) has no fixation except for a buttress plate on its radial border. However, the pressure applied by this plate is still typically adequate to maintain a reduction without the use of percutaneous pins or an assistant holding the reduction. Volar fixation is
then applied and positioned under both direct visualization and fluoroscopic aid, and cortical and locking screws are inserted as needed (Figure 4). The radial styloid plate can then be removed; however, it is our preference to leave it in place, as we have not seen any postoperative issues that we can attribute to this technique. The PQ is then repaired over the volar locking plate directly to the radial column plate.

At our institution, patients are maintained in a plaster volar-based wrist splint for a period of 2 weeks postoperatively. After splint and suture removal, active and passive ROM exercises of the wrist and hand are initiated, and a custom thermoplast volar wrist splint is manufactured. This splint is to be worn at all times except during physical therapy. At the 6-week postoperative visit, all restrictions are lifted, assuming there are no complications or unexpected issues. Patients are then seen for follow-up at 3 and 6 months postoperatively. Continued follow-up is indicated if patients are following an abnormal clinical or radiographic course.

Materials and Methods

After Institutional Review Board approval was obtained, a clinical outcomes registry was queried to identify all patients treated operatively by the senior author (DGL) for a distal radius fracture at our Level 1 trauma center between August 2002 and December 2013. Adult (age >18 years) patients with isolated distal radius fractures treated with a radial styloid plate were included for initial review (N = 261). Patients for whom 6-month clinical or radiographic outcomes were unknown were then excluded (n = 225).

Patient demographics were recorded from the existing database along with visual analog scale, Quick Disabilities of the Arm, Shoulder and Hand (DASH), and short form 36 (SF-36) physical component scores (PCS) and mental component scores (MCS) from the final follow-up visit. Injury and intraoperative and final radiographs were assessed by a single reviewer (MRG) using calibrated radiographs on our institution’s picture archiving and communication system. Radial height, radial inclination, and volar tilt were documented for each time point except for radial height, which was not recorded on intraoperative films due to the use of fluoroscopy, which is not calibrated at our institution. Intra-articular extension was noted on injury films. Wound complications, the presence of a deep or superficial infection, and removal of implants after union were recorded.

Results

Thirty-six patients met the inclusion criteria and were therefore included in the study. The average age at the time of surgery was 60.6 years (range, 25-87 years), 27 patients (75%) were female, and 21 (58%) had left-sided injuries. Patient comorbidities can be seen in Table 1. Twenty-six fractures (72.2%) had intra-articular extension. Average follow-up was 15.6 months (range, 6-53.9 months).

Radiographic measurements at the time of injury, surgery, and final follow-up can be seen in Table 2. As previously noted, radial height could not be recorded on intraoperative films due to the use of fluoroscopy, which is not calibrated at our institution. The average changes in radial inclination and volar tilt from the time of surgery (intraoperative fluoroscopy) to final follow-up were 0.46° (range, −4.4°-4.3°) and 0.24° (range, −10.6°-9.6°), respectively. All patients had acceptable radial height, radial inclination, and volar tilt at final follow-up. Clinical outcomes were obtained at a mean of 15.6 months (range, 6-54 months) and were generally good, with a mean DASH score of 20.7 (range, 0-57.5), SF-36 PCS of 45.4 (range, 22.7-68.0), and SF-36 MCS of 50.5 (range, 22.3-64.1) (Table 3). Of the 36 patients with 6-month outcome scores, 13 (36.1%) elected for implant removal after fracture union at a mean of 7.6 months after index surgery (range, 3.2-49.8 months). No infections or wound complications were noted.
Discussion

In this article, we described the use of a radial column plate as a tool to achieve and maintain a reduction during the surgical fixation of an unstable distal radius fracture with a volar locking plate. We have further presented a series of 36 patients treated in this manner and their clinical and radiographic outcomes. This technique permits the maintenance of coronal alignment, thereby limiting the use of percutaneous techniques or the need to manually hold fracture fragments in a reduced position, which may be valuable to the surgeon who is operating without a surgical assistant.

In addition to its value as a reduction tool, unlike traditional temporary k-wire fixation, we believe that the utilization of a radial styloid plate allows for increased stability until fracture union is achieved. Biomechanical studies have demonstrated favorable results with the use of a radial column plate. Grindel and colleagues evaluated dual radial styloid and volar radius plating vs volar plating alone in their biomechanical comparison of 8 cadaveric matched hand and forearm pairs. Specimens were fixated with a volar locking plate, and a 1-cm wedge osteotomy was created dorsally approximately 2 cm from the articular margin. The distal fragment was then osteotomized longitudinally between the 2 ulnar and 2 radial distal locking screws to create a fracture pattern that mimics a dorsally unstable injury with intra-articular extension. Half of the specimens then underwent radial styloid plating with 2 screws securing the construct proximally, and load-to-failure testing was performed. The authors found that utilization of both the volar and radial styloid plates resulted in 50% increased stiffness and 76% increased force-to-failure as compared with radial styloid plating alone. Similar, although not statistically significant, results were found by Blythe and colleagues. In their cadaveric study, dorsal and volar plating with an additional radial column plate resulted in improved stiffness with axial loading compared to volar or dorsal plating alone.

Two prior studies have presented outcome data after fixation of distal radius fractures with radial column and volar radius dual plating. Tang and colleagues described this technique and presented postoperative outcomes in 8 patients followed for an average of 35 weeks. They reported a 100% union rate, no loss of reduction, and a mean DASH score of 19.9. Jacobi and colleagues also described this technique in their 2010 report. In their cohort of 10 patients treated by multiple surgeons, they found a mean of 39° of flexion, 49° of extension, 75° of pronation, and 75° of supination at 24 months postoperatively. Eight patients were rated as “excellent,” 1 as “good,” and 1 as “fair” according to the Gartland and Werley score, with all 10 cases achieving bony union. No cases demonstrated loss of volar tilt, radial length, or radial inclination. In both studies, however, the use of the radial column plate was advocated as a fragment-specific fixation tool and not as a reduction tool.

Although 1-year DASH scores for volar plating alone have been shown in the literature to be consistently within 6 and 13, 3-month and 6-month scores have historically been >18. Our short-term clinical results (Table 3) are comparable to these historic controls. Further, within our cohort there were no cases of nonunion, postoperative infection, or wound complications, and radiographic measures show maintenance of reduction at final follow-up (Table 2).

We do recognize that 36.1% (13/36) of our cohort had their distal radius implants removed. Although this incidence is high, it stems from the fact that patients who elect for implant removal are more likely to have had an atypical postoperative course and are therefore followed for longer than 6 months. Those who do not elect for removal are typically discharged from care after their 3-month postoperative visit, and were therefore not eligible for inclusion in this study. Overall, a total of 261 patients have been treated with this technique by the senior surgeon. Of those patients, only 28 (10.7%) underwent removal of surgical implants. If the remaining patients had been followed for the full 6 months, it is likely that outcome scores would have been skewed in a more favorable
Surgeons electing to utilize radial styloid plating for displaced distal radius fractures should recognize that the required increased surgical dissection might lead to increased scar formation and postoperative stiffness. A limitation of this study is the lack of quantitative wrist ROM data. Future studies may compare final clinical outcomes and ROM for patients treated with and without radial column fixation.

**Conclusion**

We advocate for the use of a radial column plate as a tool to help achieve and maintain fracture reduction in the setting of an unstable distal radius fracture being treated with ORIF. This technique may be particularly useful when a surgical assistant is not available. Surgeons can expect clinical and radiographic results that are similar to those of volar locked plating alone.

**Key Info**

**Figures/Tables**

Figures / Tables:

**Table 1. Comorbidities of Patients Treated with Radial Column Plating**

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>No. of Patients</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Total No. of patients</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>2</td>
<td>5.6%</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>7</td>
<td>19.4%</td>
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<tr>
<td>Hypertension</td>
<td>11</td>
<td>30.6%</td>
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<tr>
<td>Current smoker</td>
<td>4</td>
<td>11.1%</td>
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<tr>
<td>Current alcohol abuse</td>
<td>1</td>
<td>2.8%</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>0</td>
<td>0.0%</td>
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<tr>
<td>Mean body mass index</td>
<td>27.0</td>
<td>Range: 19-34.5</td>
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**Table 2. Radiographic Measurements for Patients Treated with Radial Column Plating**

<table>
<thead>
<tr>
<th>Injury radiographs</th>
<th>Mean Measurement</th>
<th>Range</th>
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<tbody>
<tr>
<td>Radial inclination (degrees)</td>
<td>7.3</td>
<td>−22.9-22</td>
</tr>
<tr>
<td>Radial height (mm)</td>
<td>3.3</td>
<td>−14.9-11.5</td>
</tr>
<tr>
<td>Volar tilt (degrees)</td>
<td>−10.4</td>
<td>−49.2-33.9</td>
</tr>
</tbody>
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Intraoperative fluoroscopy

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<table>
<thead>
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<tbody>
<tr>
<td>Radial inclination (deg)</td>
<td>21.1</td>
<td>13.1-26.6</td>
</tr>
<tr>
<td>Volar tilt (deg)</td>
<td>6.2</td>
<td>-3.6-12.2</td>
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</tbody>
</table>

Final radiographs

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<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Radial inclination (deg)</td>
<td>21.5</td>
<td>14.5-29.2</td>
</tr>
<tr>
<td>Radial height (mm)</td>
<td>11.0</td>
<td>7.6-14.6</td>
</tr>
<tr>
<td>Volar tilt (deg)</td>
<td>6.8</td>
<td>-12.4-18.8</td>
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</tbody>
</table>

**Table 3.** Clinical Outcome Scores at Final Follow-Up for Patients Treated with Radial Column Plating

<table>
<thead>
<tr>
<th>Outcome Score</th>
<th>Mean Score</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS</td>
<td>1.4</td>
<td>0-7.5</td>
</tr>
<tr>
<td>DASH</td>
<td>20.7</td>
<td>0-57.5</td>
</tr>
<tr>
<td>PCS</td>
<td>45.4</td>
<td>22.7-68</td>
</tr>
<tr>
<td>MCS</td>
<td>50.5</td>
<td>22.3-64.1</td>
</tr>
</tbody>
</table>

Abbreviations: DASH, Quick Disabilities of the Arm, Shoulder and Hand; MCS, mental component scores; PCS, physical component scores; VAS, visual analog scale.

garner0318_f1.jpg

*Figure 1.* Clinical image of brachioradialis tenotomy using a scalpel during exposure of the distal radius.
**garner0318_f2.jpg**

*Figure 2.* Clinical image showing the initial application of a radial column plate.

**garner0318_f3.jpg**

*Figure 3.* Anteroposterior fluoroscopic images showing the restoration of radial height and the inclination after pushing fracture fragments with a radial column plate.
References

References


6. McQueen M, Caspers J. Colles fracture: Does the anatomical result affect the final function? *J Bone*


**Multimedia**

**Product Guide**

- **STRATAFIX™ Symmetric PDS™ Plus Knotless Tissue Control Device**
- **STRATAFIX™ Spiral Knotless Tissue Control Device**
- **BioComposite SwiveLock Anchor**
- **BioComposite SwiveLock C, with White/Black TigerTape™ Loop**

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