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Original Research

# Clinical and Radiographic Outcomes Following Volar-Locked Plating Versus Dorsal Bridge Plating for Distal Radius Factures

Thomas John Carroll, MD, [*] Akhil Dondapati, MD, [*] Michaela Malin, BS, [*] Constantinos Ketonis, MD PhD, [*] Warren Hammert, MD DDS, [†] Ronald Gonzalez, DO [*]

[*] Department of Orthopaedic Surgery, University of Rochester School, University of Rochester, Rochester, NY
[†] Department of Orthopaedic Surgery, Duke University School of Medicine, Durham, NC

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*Purpose:* Distal radius fractures (DRFs) indicated for operative intervention are most commonly treated with volar-locked plating (VLP); however, dorsal bridge plating (DBP) has been used as an alternative fixation method. The purpose of this study was to use a propensity score to match and compare the radiographic and clinical outcomes of patients undergoing isolated VLP or DBP for DRFs.
*Methods:* We performed a retrospective, propensity score-matched analysis of patients undergoing isolated VLP or DBP treatment for isolated DRFs from 2015 to 2022 at a single level-1 trauma center. Patients were propensity score-matched by a total of eight demographic and comorbidity factors, AO Foundation/Orthopedic Trauma Association classification, and preoperative Patient-Reported Outcomes Measurement Information System (PROMIS) scores. Our primary outcomes included postoperative complications, wrist and forearm range of motion (ROM), grip strength, and radiographic measurements, including radial height, radial inclination, volar tilt, and articular step-off.
*Results:* Overall, 415 DBP and 2075 VLP were successfully propensity score-matched and included in this study. Grip strength and ROM measurements at the 6-month follow-up, including wrist flexion, wrist extension, forearm pronation, forearm supination, radial deviation, and ulnar deviation, were increased in the VLP compared with DBP ($P < .05$). Complication rates among both the groups were relatively low; however, the rates of malunion and nonunion were significantly higher among the DBP group ($P < .05$). Radial height, radial inclination, and articular step-off were improved in the VLP group compared with the DBP group ($P < .05$); however, volar tilt was similar between groups. PROMIS upper extremity and physical function were significantly higher among the VLP group ($P < .05$). No significant difference was noted in PROMIS pain interference between the groups.
*Conclusions:* When compared with DBP, patients undergoing VLP are more likely to have improved clinical and radiographic outcomes. Although improvement in wrist and forearm ROM and radiographic parameters is statistically significant, it may not be clinically relevant.
*Type of study/level of evidence:* Therapeutic III.



Distal radius fractures (DRFs) are one of the most common orthopedic injuries seen in the United States, with an incidence of approximately 640,000 cases per year.[1] The incidence of DRFs has been increasing both in the United States and internationally.[2] Higher-energy injuries, more commonly in younger patients, tend to lead to intra-articular and comminuted fractures, whereas lower-energy injuries, typically seen in elderly patients with osteoporosis, often result in mildly displaced extra-articular fractures—although this cohort can also be associated with comminuted fracture patterns, given the poor bone quality.[3] Conservative treatment versus surgical intervention is ultimately dependent on shared decision making with the patient, family, and surgical team. Historically, most extra-articular and lower-energy DRFs can be treated nonsurgically with closed reduction and splint or cast immobilization. Operative

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**Corresponding author:** Thomas John Carroll, MD, 6 Laureldale Drive, Pittsford, NY 14534.

*E-mail addresses:* thomasj_carroll@urmc.rochester.edu (T.J. Carroll), akhil_dondapati@urmc.rochester.edu (A. Dondapati).

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indications vary depending on age, patient functional status, mechanism of injury, and fracture characteristics. However, surgical intervention is typically indicated in open fractures, comminuted or intra-articular fractures, concurrent neurovascular compromise, and fractures with radiographic findings indicative of instabilitiy.[4] Operative fixation is typically accomplished with open reduction and internal fixation (ORIF); however, the exact technique may vary based on fracture pattern, bone quality, patient age or activity level, and other associated injuries, particularly those affecting weight-bearing status. Today, two commonly used methods for ORIF include volar-locking plating (VLP) and dorsal bridge plating (DBP).[5]

Volar-locking plate fixation has become the most common fixation method for the surgical treatment of DRFs. Therefore, ORIF with VLP can be used for various DRF patterns and allows for an early range of motion (ROM).[6] Additionally, surgical fixation with a volar approach allows for concomitant carpal tunnel release, either through a separate incision or with an extended flexor carpi radialis approach.[7] Potential complications of VLP fixation include iatrogenic tendon injury, intra-articular screw placement, neurovascular injury, and inadequate fixation for highly comminuted fractures.[8–11]

Dorsal bridge plating, on the other hand, has historically been used for injuries with significant soft tissue injury, severe comminution, or polytrauma patients. In higher-energy and severely comminuted DRFs, a VLP may not adequately stabilize the fracture site.[12] External fixators have historically been used to address these fracture patterns but have high complication rates relating to pin site infections, stiffness, and malreduction.[13–15] The advent of DBP allowed for the benefit of a spanning fixation construct with a lower complication profile that is better tolerated by patients.[16] The DBP acts similar to an external fixator with potentially superior biomechanical properties.[17] Bridge plating also has the benefit of allowing partial early weight-bearing, which is especially helpful in patients who require assistive devices for ambulation or in polytraumatized patients.[18] Due to the aforementioned benefits, the indications of DBP have been expanding. Drawbacks of this fixation method include reliance on indirect reduction and the need for a secondary hardware removal procedure.[19] However, DBP remains fairly uncommon compared with VLP, and large-scale comparisons are difficult to perform.

A number of studies looking at perioperative and postoperative outcomes after VLP and dorsal locking plate fixation of DRFs exist. However, studies directly comparing VLP and DBP are lacking in the literature. The purpose of this study was to use a propensity score to match and compare the radiographic and clinical outcomes of patients undergoing VLP or DBP for DRFs. Our primary hypothesis was that patients undergoing VLP, compared with DBP, would demonstrate better postoperative ROM, radiographic outcomes, and patient-reported outcome scores with lower complication rates. Our secondary hypothesis was that patients older than the age of 65 years and those with higher-energy fracture patterns would independently demonstrate worse clinical and radiographic outcomes, compared with the cohort of those aged 65 years and younger.

## Materials and Methods

### *Patient selection*

The institutional review board approved the study and granted a waiver of consent. This was a retrospective evaluation of a database at a single, urban level 1 trauma center and academic medical center in the Northeast United States. Patients included in this study were identified using current procedural terminology codes 25607, 25608, and 25609. Operative technique was determined using a chart review. Inclusion criteria included patients aged 18–90 years old and those who underwent operative treatment of DRFs between October 1, 2015 and October 1, 2022. Exclusion criteria included the cases of revision surgery, ages outside the above range, polytraumatized patients, previous wrist surgery, and patients without at least 6 months of follow-up. Patients who underwent VLP with supplemental DBP and open reduction with DBP or the use of bone graft/substitute were also excluded. These data were deidentified and securely stored within the hospital network. After exclusion, 521 DBP and 2463 VLP patients were eligible for matching (Fig. 1).

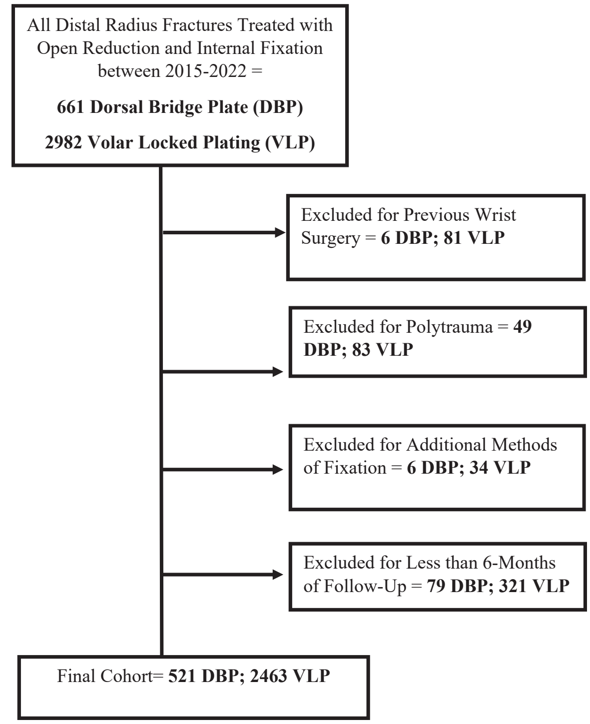


**Figure 1.** The sample-selection flow diagram illustrating patients who underwent volar-locked plating or DBP included in this study.

### *Matching*

Patients who met the inclusion and exclusion criteria were propensity score-matched with a ratio of 1:5. Propensity scores were generated using logistic regression modeling, which incorporated baseline PROMIS scores, age, body mass index (BMI), sex, race, and AO Foundation/Orthopedic Trauma Association (AO/OTA) classification (A, B, or C), and comorbidities, including tobacco use, diabetes, hypothyroidism, and rheumatoid arthritis, were included as covariates. Therefore, BMI categorical ranges included less than 20, 20–25, 25–30, 30–35, and 35–40 and greater than 40 kg/m$^2$. Race was grouped as Black or African American, White, or other. Matching was completed using a greedy, nearest-neighbor algorithm, with a 1:5 ratio of DBP to VLP, without replacement. To eliminate the risk of making bad matches, a caliper was specified for acceptable matches. The caliper was set as 0.2—the standard deviation of the logit of the propensity scores for the collective group.[20,21] Using this matching algorithm, the resulting groups included 415 DBP patients and 2075 VLP.

*Surgical technique*

Most of the surgical procedures were performed by either a fellowship-trained hand or orthopedic trauma surgeon, with the remainder treated by those on call at a tertiary level 1 trauma center. In total, 17 surgeons were included. Volar-locked plate fixation and dorsal bridge fixation were performed using one of several available implant designs. The decision to perform VLP versus DBP was determined by surgeon preference. Dorsal bridge plating patients included in this study underwent closed reduction without bone grafting and involved fixation to the second or third metacarpal shaft based on surgeon preference. All patients were placed into a volar slab splint postoperatively for 2–4 weeks followed by a removable wrist brace. Plate removal for the DBP group was performed as part of standard practice at approximately 3–4 months at the surgeon's discretion. Rehabilitation was started at the surgeon's discretion in the VLP cohort between 1 and 6 weeks after surgery and the dorsal bridge plate cohort began therapy after plate removal. All patients were instructed to begin finger ROM exercises at home and elevation for edema control. Once rehabilitation had been started, all patients underwent similar postoperative rehabilitation protocols with hand therapists.

*Radiographic evaluation*

Plain radiographs preoperatively and postoperatively were independently assessed by three orthopedic physicians. The three physicians were blinded in assessing the preoperative radiographs. For patients with advanced imaging available, only the plain films were analyzed. Therefore, AO/OTA classification was determined preoperatively. Patients were assigned AO/OTA 23-A, 23-B, or 23-C. Radial height, radial inclination, and articular step-off were calculated on the posteroanterior radiographs. Volar tilt was calculated using the lateral radiograph. Lateral and posteroanterior radiographs were available for all patients included in this study.

*Clinical outcomes assessment*

Chart review within the electronic medical records was used to identify patient demographics including age, sex, BMI, and race. Comorbidities including tobacco use, diabetes, hypothyroidism, and rheumatoid arthritis were identified through chart review. Therefore, PROMIS physical function (PF) (v1.2/2.0), upper extremity (UE) (v2.0), and pain inference (PI) (v1.1) instruments using computer adaptive tests were collected at routine clinic visits between October 1, 2015 and October 1, 2022 on iPad tablets. Additionally, PROMIS scores were collected routinely at the preoperative 6-month follow-up with a final completion of 73%. Surgical complications, including the need for revision surgery, malunion, nonunion, superficial or deep infection, and tendon rupture, were determined through a chart review of the clinical notes and operative reports. Asymptomatic and symptomatic nonunion/malunion were combined for the purposes of this study. Malunion was defined as radial inclination of 15° or less, dorsal tilt of 10° or greater, and/or ulnar variance of 3 mm or greater.

Calculated ROM and strength measurements included wrist flexion, wrist extension, forearm pronation, forearm supination, radial deviation, ulnar deviation, and grip strength. However, ROM measurements and grip strength measurements were calculated by a combination of the dedicated hand therapist and the included hand surgeons. All measurements were calculated with the use of a goniometer and a calibrated hydraulic hand dynamometer. Therefore, ROM and grip strength measurements were calculated at 6 months after the final surgical procedure including the index procedure for the VLP group and the dorsal bridge plate removal date for the DBP plate. All calculations were also included for 6 months after the initial surgical procedure, regardless of the plate removal date.

*Statistical analysis*

Included descriptive statistics were determined and expressed as the mean and standard deviation. Univariate analysis was used to compare baseline demographics and fracture classification and determine the matching balance between the groups. Clinical outcomes were analyzed with a combination of chi-square tests, pooled and unpooled *t* test, and two-proportion z-test. Standardized mean differences were used in comparing the matched cohort characteristics. Differences in the duration of follow-ups were accounted for using mixed-effects regression modeling. An alpha level of 0.05 was used for all tests. Statistical analysis was conducted using statistical software, R (version 4.3.0; R Foundation for Statistical Computing).

## Results

A total of 521 DBP and 2463 VLP patients were eligible for matching after application of inclusion and exclusion criteria (Fig. 1). Among the unmatched cohort, the patients in the VLP group were older ($P < .05$) and were more likely to be white ($P < .05$). The VLP group was less likely to be diabetic ($P < .05$) and use tobacco ($P < .05$). The VLP also had disproportionally fewer extra-articular DRFs defined as AO/OTA 23-A. The complete unmatched cohort characteristic analysis can be found in Table 1.

After propensity score matching, 415 DBP patients were successfully matched to 2075 VLP patients. Matching achieved acceptable balancing on all prespecified covariates. The complete matched cohort characteristic analysis and balancing can be found in Table 2.

Patients were followed up for an average of 13.4 months in the VLP group (SD 5.3 months) compared with 13.9 months in the DBP group (SD 4.9 months; $P = .08$). The dorsal bridge plate was removed at an average of 112 days (SD: 21 days). Grip strength and ROM measurements at the 6-month follow-up (including wrist flexion, wrist extension, forearm pronation, forearm supination, radial deviation, and ulnar deviation) were increased in the VLP compared with DBP ($P < .05$). Therefore, PROMIS UE and PF were significantly higher among the VLP group ($P < .05$). No significant difference was observed in PROMIS PI between the groups at 6 months from the final procedure was greater in the VLP group at 6 months from index procedure. Complication rates among both the groups were relatively low; however, the rate of malunion and nonunion was significantly ($P < .05$) higher among the DBP group (Table 3).

Among the radiographic variables analyzed, radial height, radial inclination, and articular step-off were within acceptable limits (less than 5 mm radial height shortening, less than a 5° difference of radial deviation, less than 2 mm of articular step-off, and less than 5° of dorsal angulation) among both the groups but statistically superior in the VLP group compared with the DBP group. Volar tilt, however, was similar between the groups. Radiographic analysis results can be found in Table 4.

A subgroup analysis of the matched cohort separated by AO/OTA classification and age was conducted. Predictably, the higher-energy fracture patterns (AO/OTA 23-C and 23-B) and older patients (≥65 years old) demonstrated decreased ROM and grip strength ($P < .05$; Table 5).

**Table 1**
Unmatched Cohort Characteristics

| Characteristic | Volar-Locked Plating ($n = 2,463$) | Dorsal Bridge Plating ($n = 521$) | *P* Value |
|---|---|---|---|
| Demographics | | | |
| Age, y (mean; SD) | 57.4 (7.2) | 62.3 (8.1) | ***P* < .001** |
| BMI >40 kg/m$^2$ (%) | 139 (5.6) | 34 (6.5) | .43 |
| Female (%) | 1521 (62) | 301 (58) | .09 |
| Race (%) | | | |
| Black or African American | 150 (6.1) | 39 (7.5) | .23 |
| White | 2185 (89) | 441 (85) | **.009** |
| Other | 128 (5.2) | 41 (7.9) | ***P* < .001** |
| Comorbidities (%) | | | |
| Tobacco use | 739 (30) | 214 (41) | ***P* < .001** |
| Diabetes | 394 (16) | 104 (20) | **.027** |
| Rheumatoid arthritis | 126 (5.1) | 33 (6.3) | .26 |
| Hypothyroidism | 139 (5.6) | 38 (7.3) | .15 |
| AO/OTA classification (%) | | | |
| 23-A | 431 (17) | 145 (28) | ***P* < .001** |
| 23-B | 899 (37) | 175 (34) | .21 |
| 23-C | 1,133 (46) | 201 (38) | .51 |

Bolded values indicate statistical signifcance ($P < .05$).

**Table 2**
Propensity Score-Matched Cohort Characteristics

| Characteristic | Volar-Locked Plating ($n = 2,075$) | Dorsal Bridge Plating ($n = 415$) | Standardized Difference |
|---|---|---|---|
| Demographics | | | |
| Age (mean; y) | 57.6 | 57.9 | 0.04 |
| BMI >40 kg/m$^2$ (%) | 110 (5.3) | 25 (6.0) | 0.03 |
| Female (%) | 1349 (65) | 274 (66) | 0.01 |
| Race (%) | | | |
| Black or African American | 127 (6.1) | 27 (6.5) | 0.02 |
| White | 1847 (89) | 361 (87) | 0.03 |
| Other | 101 (4.9) | 27 (6.5) | 0.05 |
| Comorbidities (%) | | | |
| Tobacco use | 706 (34) | 133 (32) | 0.04 |
| Diabetes | 374 (18) | 71 (17) | 0.02 |
| Rheumatoid arthritis | 120 (5.8) | 24 (5.8) | 0 |
| Hypothyroidism | 131 (6.3) | 27 (6.5) | 0.02 |
| AO/OTA classification (%) | | | |
| 23-A | 355 (17) | 71 (17) | 0 |
| 23-B | 790 (38) | 158 (38) | 0 |
| 23-C | 930 (55) | 186 (55) | 0 |

**Table 3**
Propensity Score-Matched Differences in Postoperative Clinical Outcomes at 6-Month Follow-Up From Final Surgical Procedure

| Outcome | Volar-Locked Plating ($n = 2,075$) | Dorsal Bridge Plating ($n = 415$) | *P* Value |
|---|---|---|---|
| Follow-up in mo (SD) | 13.4 (5.3) | 13.9 (4.9) | .08 |
| Range of motion in degrees (SD) | | | |
| Wrist flexion | 64.1 (4.2)_ | 57.8 (5.3) | ***P* < .001** |
| Wrist extension | 68.8 (4.7) | 63.9 (5.0) | ***P* < .001** |
| Forearm pronation | 84.8 (0.9) | 83.3 (1.3) | ***P* < .001** |
| Forearm supination | 84.4 (0.6) | 82.9 (1.1) | ***P* < .001** |
| Wrist radial deviation | 17.9 (1.8) | 17.3 (2.2) | ***P* < .001** |
| Wrist ulnar deviation | 24.9 (2.1) | 23.9 (2.5) | ***P* < .001** |
| Grip strength (lb) | 74.9 (12.8) | 62.3 (13.4) | ***P* < .001** |
| Patient-reported outcomes | | | |
| PROMIS UE | 35.8 (3.9) | 33.8 (3.8) | ***P* < .001** |
| PROMIS PF | 47.2 (3.1) | 43.4 (3.4) | ***P* < .001** |
| PROMIS PI | 52.1 (3.7) | 52.3 (4.2) | .32 |
| Complications | | | |
| Need for revision surgery | 98 (4.7) | 28 (6.7) | .078 |
| Malunion | 44 (2.1) | 16 (3.9) | **.032** |
| Nonunion | 37 (1.8) | 20 (4.8) | ***P* < .001** |
| Superficial infection | 108 (5.2) | 13 (3.1) | .075 |
| Deep infection | 73 (3.5) | 18 (4.3) | .39 |
| Tendon rupture | 58 (2.8) | 8 (1.9) | .31 |

Bolded values indicate statistical signifcance ($P < .05$).

**Table 4**
Propensity Score-Matched Differences in Postoperative Radiographic Outcomes at 6 Months From Initial Surgery

| Parameter (SD) | Volar-Locked Plating ($n = 2,075$) | Dorsal Bridge Plating ($n = 415$) | *P* Value |
|---|---|---|---|
| Radial height (mm) | 11.8 (1.9) | 11.4 (2.0) | ***P* < .001** |
| Radial inclination (degrees) | 21.1 (3.1) | 20.3 (3.5) | ***P* < .001** |
| Volar tilt (degrees) | 6.9 (1.4) | 7.0 (1.5) | .19 |
| Articular step-off (mm) | 0.54 (0.2) | 0.82 (0.2) | ***P* < .001** |

Bolded values indicate statistical signifcance ($P < .05$).

## Discussion

Our study demonstrates improved clinical and radiographic outcomes among patients undergoing VLP compared with DBP. Although statistically significant, the improvement in measured outcomes may not represent clinically important differences. When deciding between VLP and DBP among these patients, it is important to consider the expected outcomes and clinical relevance of the outcome's differential.

With an increase in the annual incidence of DRFs, growing interest has been noted in maximizing both biomechanical fixation strategies and clinical outcomes.[2] Locked-plating technology has advanced to lower profile implants with better longevity and options for incorporating fragment-specific fixation.[6,7] External fixation devices may still be used in cases of open fracture, polytrauma, and infection; however, this method is declining in popularity.[13–15] The development of DBP allows for early partial weight-bearing and can be technically less demanding than VLP. This is especially true for cases of severe articular comminution when direct reduction of the joint surface is challenging through a volar approach.[12] Suggesting that the results of DBP are within a minimum clinically important difference in patient-reported outcomes might encourage increased use of DBP.

Volar-locked plating produced better outcomes compared with DBP in wrist flexion, extension, radial and ulnar deviation, forearm pronation and supination, and grip strength. Previously, ROM and grip strength of VLP versus DBP have not been directly compared. However, other studies comparing VLP with external fixation and VLP alone have demonstrated average ROM and grip strength at 6 months are superior in the VLP group.[22,23] Minimum clinically important differences (MCID) in various ROM measurements have not been well established in the setting of DRFs. The MCID for wrist motion, defined as the sum of total wrist flexion and extension, has been suggested to be between 79% and 95% of the uninjured side.[24,25] Similarly, MCID for grip strength, has been defined as 59% to 65% of the uninjured side.[24,25] Within our cohort, an average final wrist ROM of 135°–140° in both groups with an average grip strength of 62–75 lb was observed. This represents greater than 95% arc ROM and 65% grip strength compared with national averages.[24,25] The differences in the measured ROM or grip strength metrics, therefore, are likely not clinically relevant between VLP and DBP, despite statistical significance.

To our knowledge, no studies directly compare PROMIS UE, PF, or PI between DBP and VLP patients. The MCID for PROMIS PF and PI

**Table 5**
Subgroup Analysis of Matched Cohort by Age and Fracture Pattern at 6 Months from Final Surgical Procedure

| | | Wrist Flexion* (SD) | Wrist Extension* (SD) | Forearm Pronation* (SD) | Forearm Supination* (SD) | Wrist Radial Deviation* (SD) | Wrist Ulnar Deviation* (SD) | Grip Strength ** (SD) |
|---|---|---|---|---|---|---|---|---|
| OTA-A | VLP ($n = 355$) | 68.9 (3.8) | 74.1 (3.9) | 87.1 (0.9) | 85.9 (0.5) | 18.2 (1.8) | 25.0 (2.0) | 80.1 (10.7) |
| | DBP ($n = 71$) | 62.3 (4.7) | 69.8 (4.1) | 84.9 (1.0) | 84.3 (0.9) | 17.5 (1.9) | 24.1 (2.6) | 74.9 (12.1) |
| | *P* value | **< .001** | **< .001** | **< .001** | **< .001** | **.0023** | **< .001** | **< .001** |
| OTA-B | VLP ($n = 790$) | 67.7 (4.1) | 70.3 (5.2) | 85.7 (0.8) | 85.5 (0.6) | 18.3 (1.7) | 25.1 (2.1) | 78.5 (12.5) |
| | DBP ($n = 158$) | 58.5 (5.0) | 69.4 (4.9) | 85.4 (1.1) | 85.8 (1.0) | 17.7 (2.1) | 24.1 (2.3) | 64.2 (13.0) |
| | *P* value | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** |
| OTA-C | VLP ($n = 930$) | 59.2 (5.1) | 65.0 (6.8) | 83.0 (1.2) | 82.9 (0.8) | 17.5 (2.0) | 24.7 (2.2) | 69.8 (14.0) |
| | DBP ($n = 186$) | 55.5 (6.0) | 56.9 (5.7) | 80.9 (1.6) | 79.9 (1.5) | 16.9 (2.5) | 23.6 (2.7) | 55.9 (15.1) |
| | *P* value | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** |
| Age (y) ≥65 | VLP ($n = 1,195$) | 61.7 (4.1) | 64.9 (5.1) | 83.9 (1.3) | 83.1 (0.7) | 17.6 (2.1) | 24.7 (2.1) | 70.1 (13.1) |
| | DBP ($n = 239$) | 56.0 (4.9) | 58.3 (5.6) | 81.3 (1.5) | 80.3 (1.4) | 17.0 (2.3) | 23.8 (2.6) | 59.1 (14.9) |
| | *P* value | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** | **< .001** |
| Age (y) <65 | VLP ($n = 880$) | 67.4 (4.5) | 74.3 (4.2) | 86.1 (0.7) | 86.2 (0.6) | 18.3 (1.6) | 25.2 (2.1) | 81.7 (12.5) |
| | DBP ($n= 176$) | 60.2 (5.5) | 71.5 (4.4) | 86.0 (1.1) | 86.4 (0.8) | 17.7 (1.9) | 24.0 (2.5) | 66.6 (12.3) |
| | *P* value | **< .001** | **< .001** | .12 | **< .001** | **< .001** | **< .001** | **< .001** |

Bolded calculations indicated statistical significance at $P < .05$. OTA: Orthopedic Trauma Association Fracture Classification; * indicates measurements in degrees; ** indicates percentage of uninjured side. Range of motion measurements includes active range of motion only.
Bolded values indicate statistical signifcance ($P < .05$).

**Table 6**
Propensity Score-Matched Differences in Postoperative Clinical Outcomes at 6-Month Follow-Up From Initial Surgical Procedure

| Outcome | Volar-Locked Plating ($n = 2,075$) | Dorsal Bridge Plating ($n = 415$) | *P* Value |
|---|---|---|---|
| Range of motion (degrees) | | | |
| Wrist flexion | 64.1 (4.2)_ | 54.1 (4.9) | ***P* < .001** |
| Wrist extension | 68.8 (4.7) | 62.1 (5.1) | ***P* < .001** |
| Forearm pronation | 84.8 (0.9) | 83.2 (1.5) | ***P* < .001** |
| Forearm supination | 84.4 (0.6) | 83.0 (1.1) | ***P* < .001** |
| Wrist radial deviation | 17.9 (1.8) | 17.1 (2.4) | ***P* < .001** |
| Wrist ulnar deviation | 24.9 (2.1) | 23.5 (2.4) | ***P* < .001** |
| Grip strength (lb) | 74.9 (12.8) | 61.9 (12.8) | ***P* < .001** |
| Patient-reported outcomes | | | |
| PROMIS UE | 35.8 (3.9) | 34.2 (4.2) | ***P* < .001** |
| PROMIS PF | 47.2 (3.1) | 43.6 (3.9) | ***P* < .001** |
| PROMIS PI | 52.1 (3.7) | 53.0 (3.8) | ***P* < .001** |

Bolded values indicate statistical signifcance ($P < .05$).

after DRFs have been defined as 5.2 and 6.8, respectively.[26] By this standard, VLP and DBP final PROMIS scores did not demonstrate any clinically significant differences.

We found that radial height, radial inclination, and articular step-off were within acceptable criteria among both groups. These radiographic parameters for the VLP group were marginally superior compared with the DBP group, whereas volar tilt was similar between groups. Comparative radiographic outcomes following VLP versus DBP have not been well established. Several studies have analyzed DBP alone and found that the radiographic outcomes in more comminuted fracture patterns (AO/OTA 23-C) treated with DBP are inferior compared with lower-energy patterns treated with VLP.[22,27,28] Our study supports these established findings, demonstrating that radial height, radial inclination, and articular step-off were statistically, although marginally, superior in the VLP group. However, the difference between measurements for all studied parameters is less than one degree/one millimeter. The clinical relevance of a difference this size has yet to be established.

The complication rates among both groups were relatively low; however, the rate of malunion and nonunion was significantly higher among the DBP group. The overall complication rate after DBP has been reported to be 13% compared with VLP (4% to 27%).[5,29] The rate of nonunion and malunion was higher in the DBP group, which is consistent with previously reported data demonstrating a symptomatic nonunion and malunion rate of 3%.[5] The overall rate of infection, tendon rupture, and revision surgery was similar to previous studies.[5]

Among the subgroup analysis, higher-energy fracture patterns and older patients predicably demonstrated worse ROM and grip strength. Evidence from this study and future similar prospective studies can be used to better predict expected ROM and grip strength between treatment modalities depending on AO/OTA classification and age. Ultimately, this will allow for a more informed, shared decision making process for patients needing surgical fixation. It is important to note, however, that DBP does require a second surgery for plate removal, which adds to the overall cost of treatment, particularly if performed in the operating room.

This study has several notable limitations. The presence of concurrent carpal tunnel release during surgery was not analyzed or controlled for. This may have affected the outcomes between groups and should be accounted for in future studies. The ROM and strength measurements were collected by a combination of surgeons and hand therapists. Although the measurement devices used were calibrated, multiple observers could have impacted the inter-rater reliability. If we followed the cohorts to a later time point, such as 12 or 24 months, the differences between groups may have disappeared. Radiographic measurements were performed on plain films, and the measurements of articular gap and step are not as precise as CT scans. Nonetheless, we believe that this is consistent with routine clinical care. Included comorbidities were determined through a meticulous chart review, and thus, there could be other comorbidities that were not captured and possible that our data underreported the true comorbidities of the study population. In addition, we did not analyze the cost between groups and when two procedures provide similar outcomes, the one with the lower cost is often the preferred treatment.

Our study is further limited through the exclusion of polytraumatized patients. Dorsal bridge plating is often indicated in the case of polytraumatized patients, and therefore, a substantial number of patients were excluded from this group. However, it was thought that the inclusion of polytraumatized patients, often with ipsilateral extremity injuries, may impact the outcomes analysis. Our radiographic and physical examination measurements only included the operative extremity. Measurements of the contralateral side were not routinely available among the study population. Inclusion of contralateral measurements could have provided a more accurate assessment of the change in ROM, strength, and radiographic outcomes. Due to the fact that the DBP needed a secondary procedure, postoperative clinical outcomes are difficult to compare directly. We included calculations for 6 months from the index and final procedures to help delineate these differences. Finally, the decision for DBP versus VLP was made on surgeon preference, which would have added selection bias.

## Conclusion

Patients undergoing VLP, when compared with DBP, are more likely to have improved clinical and radiographic outcomes. Although the improvement in various ROM and radiographic parameters is statistically significant, this difference may not be clinically relevant. Overall, DBP may be a fixation modality that can offer clinically equivocal results compared with VLP with the downside of requiring a second surgery. Prospective analysis including comparison to the contralateral extremity is warranted to better understand the expected outcomes of VLP versus DBP.

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