SCIENTIFIC ARTICLE

Comparative Analysis of Intramedullary Nail Fixation Versus Casting for Treatment of Distal Radius Fractures

Virak Tan, MD, Walter Bratchenko, MS, Ali Nourbakhsh, MD, John Capo, MD

Purpose Intramedullary fixation is one treatment option for distal radius fractures. Our purpose was to compare the outcomes of intramedullary nailing to those of casting for these injuries.

Methods From 2006 to 2009, we reviewed 63 adult patients with isolated distal radius fractures. Thirty-one patients had surgical fixation with an intramedullary device (IMN group) within 4 weeks of the injury, and 32 (cast group) had casting as definitive treatment of the fracture. Clinical outcomes (grip strength; Disabilities of the Arm, Shoulder, and Hand scores; active wrist range of motion; and complications) and radiographic indices (radial inclination, radial height, ulnar variance, and tilt) of both groups were analyzed for the 1-, 2-, 4-, 6-, and 12-month follow-up periods.

Results The flexion–extension arc was significantly higher in the IMN group than in the cast group at 2-, 6-, and 12-month follow-up. The IMN group exhibited significantly greater grip strength and lower DASH scores throughout the follow-up period. At final follow-up, all radiographic indices were significantly better in the IMN group than in the cast group. There was no significant difference between the initial reduction to final position in the IMN group, but the cast group showed an increase in ulnar variance and a significant change in dorsal–volar tilt. In addition, the cast group experienced more clinical complications in the delayed period compared to the IMN group.

Conclusions Intramedullary nail fixation, as compared to casting, results in less functional disability, not only in the early postoperative period but also up to a year after treatment. On the basis of our data, intramedullary fixation should be considered for patients with unstable extra-articular or simple intra-articular distal radius fractures. *(J Hand Surg 2012;37A:460–468.*

Type of study/level of evidence Prognostic II.

Key words Cast, distal radius fracture, early motion, intramedullary nail, wrist.

Additional material is available online.

CLOSED REDUCTION AND casting remains the standard of care for most distal radius fractures (DRFs) with minimal comminution or articular stepoff.[1] Over the last decade, open reduction and internal fixation using locked plating systems has been the mainstay of surgical treatment of displaced intra-articular or unstable extra-articular fractures in adults.[2] More recently, intramedullary fixation has also emerged as a viable treatment.[3–5]

Even though DRFs are among the most common orthopedic injuries, the optimal treatment remains a topic of debate. It is generally agreed that stable fractures can be managed nonsurgically with satisfactory outcomes. Some have suggested that unstable DRFs in the elderly can be treated with casting alone because alignment is not associated with functional outcomes, as it is in younger patients.[6,7] Others recommend open reduction and internal fixation.[8–11] The controversy

From the Department of Orthopedics, University of Medicine and Dentistry of New Jersey, New Jersey Medical School, Newark, NJ.

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Corresponding author: Virak Tan, MD, University of Medicine and Dentistry of New Jersey, New Jersey Medical School, Department of Orthopedics, ACC D1626, 140 Bergen St., Newark, NJ 07103; e-mail: tanvi@umdnj.edu.

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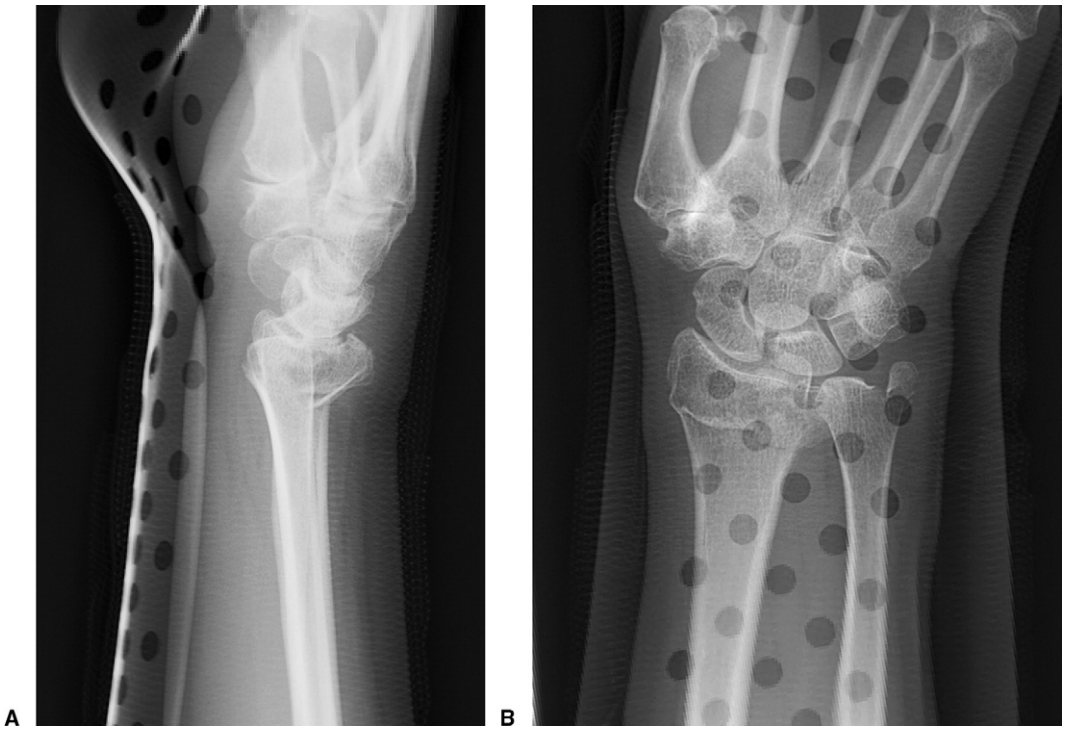

FIGURE 1: A Lateral and **B** posteroanterior injury radiographs of a 60-year-old woman with an AO/ASIF type C2 fracture.

might, in part, lie in the paucity of studies directly comparing surgical to nonsurgical treatment of DRFs. To date, only a few studies have examined surgical fixation versus closed treatment of DRFs[12–14]; therefore, the question, "Does surgical treatment have better results than casting?" remains.

The purpose of the current study was to compare the outcomes of intramedullary nailing (IMN) to casting for DRFs. We sought to answer the following questions: (1) Can open reduction with intramedullary fixation give better results than casting? (2) Are there radiographic differences between these groups? (3) Are there noteworthy complications from the treatments?

MATERIALS AND METHODS

From 2006 to 2009, we conducted an institutional review board–approved, retrospective study on prospectively collected data in patients with DRFs. The study consisted of 2 groups: the IMN group—patients who had surgical fixation with an intramedullary device (Micronail, Wright Medical Technology, Inc, Arlington, TN) within 4 weeks of the injury (Figs. 1, 2), and the cast group—patients who had casting as definitive treatment of the fracture. Patients who initially were treated by immobilization but went on to surgery due to redisplacement of the fracture were excluded from the cast group, but they were included in the IMN group if they had intramedullary fixation. Other exclusion criteria included multi-extremity injuries, complex intra-articular fracture (AO/ASIF C3), and age younger than 18 years. Patients who had other forms of treatment for DRFs or who had less than 1-year follow-up were also excluded.

In total, 63 patients were included in this study, with an average follow-up time of 13 months. All fractures were classified according to the AO/ASIF classification system[15] (Table 1). At initial presentation, all patients had a reduction maneuver of the fracture under a hematoma block and were placed into a sugar-tong splint. Radiographs were used to assess the fracture alignment after manipulation. For patients in whom the reduction could not be achieved after 2 attempts (dorsal tilt $> 20°$, shortening ≥ 3 mm, or articular stepoff ≥ 2 mm), surgical treatment was advised.[16] In the post-reduction period, patients were followed up weekly for 4 weeks with serial radiographs. Those who lost reduction (defined earlier) during this timeframe were advised to have surgery.

Surgical treatment protocol—IMN group

During the study period, the senior author (V.T.) operated on 84 isolated DRFs. Of these 84 DRFs, 52 had intramedullary fixation, 23 had locked volar plating, 5 had percutaneous pinning, 3 had locked volar plating and external fixation, and 1 had screw fixation alone. Initial assessment of whether the fracture pattern was amenable to IMN was done before surgery, based on radiographs. For all extra-articular and simple intra-articular fractures, intramedul-

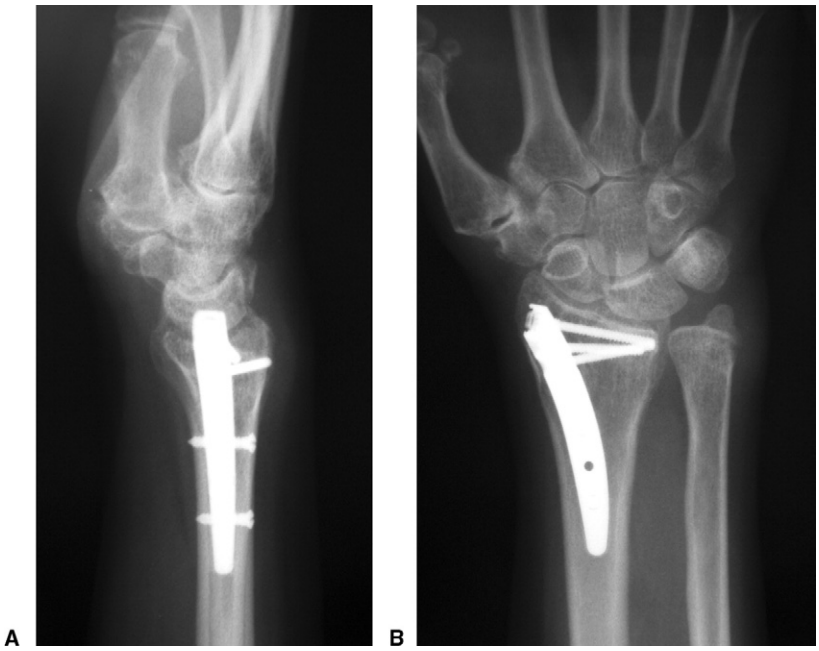

FIGURE 2: A Lateral and **B** posteroanterior postoperative radiographs of the patient in Figure 1.

lary fixation was the device of choice. For fractures with small and comminuted articular fragments, open reduction and locked volar plating was typically chosen. The final decision for the mode of fixation was made during surgery. If the fracture could be reduced by closed or percutaneous means, IMN was performed.

Of the 52 patients who had IMN, 31 patients (2 men, 29 women) with a mean age of 65 years (range, 27–89; SD, 15) met criteria for inclusion in the study. The AO/ASIF fracture patterns are reported in Table 1. Four of the injuries were open.

All surgical procedures were performed under general or regional anesthesia, using the technique as previously described.[3] No bone grafting was used. In addition to the IMN, 1 patient with an open distal radioulnar joint (DRUJ) dislocation had capsular repair. Five of the 13 fractures with associated distal ulnar (styloid, 4; neck, 1) fractures also had ulnar fixation.

After surgery, the wrist was not immobilized unless the distal ulna fracture also had fixation or the DRUJ was unstable, in which case these patients were immobilized with sugar-tong splints. The average time of immobilization was 5 days (range, 0–31; SD, 9.2) for the entire group. For the 6 patients who had postoperative immobilization, the average was 23 days. Patients who were not immobilized were allowed immediate forearm, wrist, and finger motion. Formal therapy was individualized. Average follow-up time was 13 months (range, 12–17 mo).

Nonsurgical treatment protocol— cast group

The demographics of the 32 patients in the cast group and their injury patterns are reported in Table 1. Active and passive finger motion was encouraged immediately. These patients were seen weekly for serial radiographs. No repeat manipulation was done.

There were 4 patients (in addition to the 32 in the cast group) who had re-displacement of the fracture. These patients were converted to IMN and were included in the IMN group for analysis.

At the 2-week mark, the splint was changed to a Muenster cast. Then a short-arm cast was placed at 4 weeks. The duration of casting was based on clinical and radiographic evidence of healing of the fracture. Immobilization averaged 35 days (range, 21–51 d; SD, 8.8). Formal therapy was individualized. Average follow-up time was 14 months (range, 11–23 mo).

Functional assessment

A physician assistant (W.B.) who was not involved in the initial assessment or treatment obtained the functional outcome measures. Assessment included active wrist flexion–extension, radial–ulnar deviation, and forearm rotation using a goniometer. Grip strength was measured on the second position of a hand dynamometer (Jamar, Irvington, NY) with the patient seated, shoulder adducted, elbow flexed 90°, and forearm in neutral position. The average of 3 measurements was

TABLE 1. Demographics and Fracture Patterns

	IMN	Cast	*P* Value
Number of patients	31	32	
Age	65 ± 15 y	63 ± 18 y	.618
Gender			
M	2 (6%)	3 (9%)	
F	29 (94%)	29 (91%)	.886
Hand dominance			
R	29 (94%)	31 (97%)	
L	2 (6%)	1 (3%)	.787
Dominant extremity fractured	20 (65%)	22 (69%)	
AO/ASIF classification			
A2	8 (26%)	17 (53%)	
A3	10 (32%)	2 (6%)	
B1	0	1 (3%)	
B3	1 (3%)	0	.015
C1	7 (23%)	10 (31%)	
C2	5 (16%)	2 (6%)	
Associated distal ulnar injury			
Fracture	13 (42%)	3 (9%)	.002
DRUJ dislocation	1 (3%)	0	
Mechanism of injury			
Low energy*	25 (81%)	26 (81%)	
High energy†	6 (9%)	5 (16%)	
Assault	0	1 (3%)	

*Low-energy injury—simple fall.
†High-energy injury—fall from height, motor vehicle accident, or work- or sport-related accident.

TABLE 2. Active Arcs of Motion

	IMN (°)	Cast (°)	*P* Value
2 mo			
F-E	95 ± 24 (n = 28)	71 ± 27 (n = 26)	<.001
R-U	43 ± 14 (n = 30)	30 ± 11 (n = 25)	<.001
S-P	155 ± 21 (n = 30)	139 ± 37 (n = 26)	.05
4 mo			
F-E	107 ± 23 (n = 29)	94 ± 30 (n = 23)	.07
R-U	45 ± 12 (n = 29)	42 ± 13 (n = 23)	.46
S-P	155 ± 25 (n = 29)	160 ± 20 (n = 23)	.42
6 mo			
F-E	130 ± 21 (n = 29)	98 ± 21 (n = 26)	<.001
R-U	48 ± 11 (n = 29)	42 ± 11 (n = 26)	.05
S-P	163 ± 16 (n = 29)	162 ± 15 (n = 26)	.89
12 mo			
F-E	125 ± 19 (n = 31)	102 ± 25 (n = 29)	<.001
R-U	51 ± 9 (n = 31)	45 ± 13 (n = 29)	.06
S-P	165 ± 16 (n = 31)	166 ± 17 (n = 29)	.94

F-E, flexion-extension; R-U, radial-ulnar deviation; S-P, supination-pronation.

recorded for grip. The Disabilities of the Arm, Shoulder, and Hand (DASH) scores were recorded.

Data were obtained at 1 month (3–5 wk), 2 months (7–10 wk), 4 months (14–18 wk), 6 months (22–26 wk), and 1 year (11 mo or greater). The range of motion and grip strength data at the 1-month follow-up were not included in the analysis because patients in the cast group were still in or just recently out of immobilization. At the 2-month follow-up, grip and range of motion were recorded only if patients had been out of immobilization for a minimum of 2 weeks. Grip strength was determined as a percentage of the uninjured side, with a 10% adjustment for hand dominance.[17]

Radiographic assessment

Standard posteroanterior and lateral radiographs were obtained as clinically indicated during the treatment period and at the 1-year mark. Radiographic measurements from initial and 1-, 2-, 4-, 6-, and 12-month follow-ups were recorded and analyzed. The following parameters were measured: tilt, radial inclination, radial height, and ulnar variance. The tilt was measured on the lateral view and expressed as the number of degrees from the neutral position[18] (positive indicates dorsal tilt and negative indicates volar tilt). Posttraumatic arthritis at follow-up was classified using the Knirk and Jupiter classification system.[19]

Complications

Complications were categorized into minor (requiring no surgery) or major (requiring surgery), and early (occurring within 2 months) or delayed (occurring after 2 months). In the early timeframe, finger stiffness was defined as inability to touch the palm with the fingertips. In the delayed period, stiffness was defined as inability to touch the distal palmar crease.

Statistical methods

See the Appendix, which can be viewed on the *Journal's* Web site at www.jhandsurg.org.

RESULTS

Clinical results

The mean active arcs of motion are given in Table 2. The flexion–extension (F-E) arc was significantly

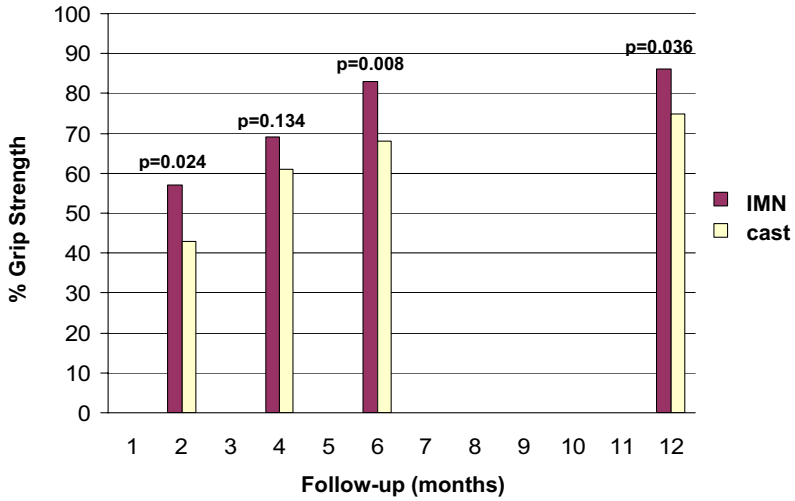

FIGURE 3: Graph showing the percentage mean grip strength of the injured hand (compared to the uninjured side) in the IMN and cast groups.

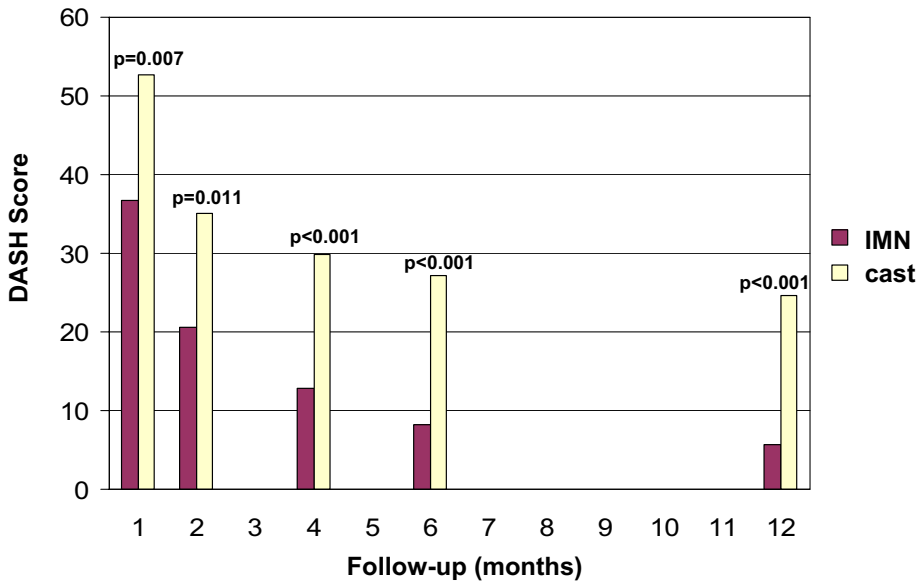

FIGURE 4: Graph of the mean DASH scores in the IMN and cast groups.

higher in the IMN group than in the cast group at the 2-, 6-, and 12-month follow-ups. The radial–ulnar (R-U) deviation was better in the IMN group at 2 and 6 months; however, there was no difference at the final follow-up. Except at the 2-month follow-up, there was no statistically significant difference for supination–pronation (S-P) arc between the groups.

The mean grip strength is shown in Figure 3. The IMN group exhibited significantly greater grip strength at 2 months, 6 months, and 12 months, but not at 4 months.

The mean DASH scores are presented in Figure 4. Patients in the IMN group reported significantly less disability for all time periods. The difference observed was at least 14 points. For the AO/ASIF type A fractures (Table 3), there were significant differences in F-E and R-U at 2 months, in DASH at 4 months, in F-E and R-U at 6 months, and in F-E and percent grip at 12 months.

For the AO/ASIF type C fractures (Table 4), there were significant differences in R-U at 2 months; in DASH at 4 months; in F-E, percent grip, and DASH at 6 months; and in F-E and DASH at 12 months. Analysis of AO/ASIF type B fractures was not performed because there were only 2 patients in this category.

In general, duration of immobilization negatively affected motion and grip. In addition, longer immobilization

TABLE 3. Clinical Outcome Measures for AO/ASIF Type A Fractures

	IMN	Cast	*P* Value
2 mo			
F-E (°)	96 ± 18	73 ± 32	.028
R-U (°)	41 ± 12	29 ± 13	.016
S-P (°)	151 ± 25	140 ± 36	ns
% Grip	62 ± 19	47 ± 27	ns
DASH	19 ± 13	32 ± 24	ns
4 mo			
F-E (°)	113 ± 20	99 ± 32	ns
R-U (°)	43 ± 11	42 ± 13	ns
S-P (°)	153 ± 23	160 ± 16	ns
% Grip	77 ± 17	70 ± 17	ns
DASH	13 ± 13	25 ± 15	.046
6 mo			
F-E (°)	124 ± 18	106 ± 17	.014
R-U (°)	50 ± 8	41 ± 11	.027
S-P (°)	164 ± 12	159 ± 13	ns
% Grip	90 ± 21	82 ± 16	ns
DASH	10 ± 13	22 ± 21	ns
12 mo			
F-E (°)	128 ± 20	106 ± 25	.011
R-U (°)	50 ± 7	46 ± 13	ns
S-P (°)	161 ± 21	168 ± 13	ns
% Grip	94 ± 16	82 ± 16	.036
DASH	8 ± 10	21 ± 23	ns

F-E, flexion-extension arc; R-U, radial-ulnar deviation arc; S-P, supination-pronation arc; ns, not significant.

TABLE 4. Clinical Outcome Measures for AO/ASIF Type C Fractures

	IMN	Cast	*P* Value
2 mo			
F-E (°)	91 ± 25	69 ± 20	ns
R-U (°)	52 ± 6	29 ± 7	<.001
S-P (°)	159 ± 13	141 ± 37	ns
% Grip	54 ± 21	38 ± 22	ns
DASH	26 ± 20	42 ± 24	ns
4 mo			
F-E (°)	103 ± 25	90 ± 28	ns
R-U (°)	51 ± 12	41 ± 14	ns
S-P (°)	155 ± 32	148 ± 20	ns
% Grip	68 ± 25	66 ± 30	ns
DASH	11 ± 13	40 ± 22	.003
6 mo			
F-E (°)	121 ± 19	81 ± 21	<.001
R-U (°)	50 ± 11	41 ± 10	ns
S-P (°)	160 ± 21	159 ± 17	ns
% Grip	84 ± 17	61 ± 29	.049
DASH	8 ± 11	36 ± 24	.003
12 mo			
F-E (°)	121 ± 15	94 ± 26	.010
R-U (°)	51 ± 9	43 ± 12	ns
S-P (°)	170 ± 8	161 ± 22	ns
% Grip	83 ± 19	73 ± 33	ns
DASH	5 ± 8	33 ± 25	.024

F-E, flexion-extension arc; R-U, radial-ulnar deviation arc; S-P, supination-pronation arc; ns, not significant.

led to higher DASH scores, indicating more disability. These relationships were significant at 12 months for all clinical parameters except for S-P (Table 5).

Radiographic results

Overall, there was no difference in initial post-reduction radiographs between the IMN and cast groups, except for radial height (11.8 ± 1.5 mm vs 10.5 ± 2.4 mm, respectively; Table 6). At final follow-up, tilt, radial inclination, radial height, and ulnar variance were significantly better in the IMN group than in the cast group (Table 6).

When comparing the initial post-reduction position to final position within each treatment group, no significant differences were seen for the IMN group, but significant differences in ulnar variance and tilt existed for the cast group, showing statistically significant worsening ulnar variance and loss of volar tilt (Table 7).

Fracture union was achieved in all patients. At final follow-up, 1 patient in the IMN group and 7 patients in the cast group showed radiographic evidence of radiocarpal arthritis ($P = .053$).

Complications

The IMN group: In the early period, 7 patients had minor complications, and none had a major complication. The 3 patients with radial sensory nerve neuritis had resolution of symptoms by the 4-month follow-up. The patient who developed complex regional pain syndrome required 6 months of hand therapy before the symptoms abated. In the delayed period (ie, after 2 mo), there were no complications in the IMN group.

There was no tendon or soft tissue irritation, no screw penetration into the joint, or wound healing problem in either time period. No hardware removal was required in the follow-up period (Table 8).

TABLE 5. Spearman Rank Order Correlation Coefficients Between Duration of Immobilization and Clinical Outcome Parameters

	IMN	Cast	IMN Plus Cast*
2 mo			
F-E	−0.246	−0.322	−0.426 (.005)
R-U	−0.058	−0.207	−0.468 (.001)
S-P	0.087	−0.412 (.036)	−0.221
% Grip	−0.296	−0.496 (.010)	−0.288
DASH	−0.009	0.236	−0.171
4 mo			
F-E	−0.283	−0.243	−0.312 (.035)
R-U	−0.275	−0.098	−0.183
S-P	−0.416 (.031)	0.074	−0.181
% Grip	−0.379	−0.080	−0.241
DASH	0.035	−0.057	0.376 (.013)
6 mo			
F-E	−0.485 (.008)	−0.033	−0.530 (<.001)
R-U	−0.215	0.003	−0.370 (.008)
S-P	−0.202	−0.083	−0.202
% Grip	−0.132	−0.210	−0.084
DASH	0.042	0.174	0.365 (.010)
12 mo			
F-E	−0.482 (.011)	−0.067	−0.489 (<.001)
R-U	−0.235	−0.208	−0.354 (.007)
S-P	−0.358	−0.094	−0.040
% Grip	−0.084	−0.328	−0.276 (.034)
DASH	−0.174	0.111	0.325 (.013)

F-E, flexion-extension arc; R-U, radial-ulnar deviation arc; S-P, supination-pronation arc.
*Significant *P* values are given in parentheses.

TABLE 6. Radiographic Indices Between the Groups at Initial Reduction and Final Follow-Up

Indices	IMN	Cast	*P* Value
Initial reduction			
UV (mm)	−0.3 ± 1.3	0.0 ± 1.7	.528
RI (°)	22.9 ± 3.1	22.1 ± 4.6	.414
RH (mm)	11.8 ± 1.5	10.5 ± 2.4	.019
Tilt (°)	−6.8 ± 5.1	−4.0 ± 7.0	.083
Final follow-up			
UV (mm)	0.3 ± 1.5	1.7 ± 2.2	.004
RI (°)	23.3 ± 3.1	19.8 ± 4.9	.002
RH (mm)	11.1 ± 1.5	10.0 ± 2.3	.028
Tilt (°)	−8.9 ± 5.2	2.2 ± 11.8	<.001

UV, ulnar variance; RI, radial inclination; RH, radial height; Tilt, lateral alignment.

TABLE 7. Radiographic Indices at Initial Reduction Compared to Final Follow-Up for the Groups

Indices	Initial Reduction	Final Follow-Up	*P* Value
IMN			
UV (mm)	−0.3 ± 1.5	0.3 ± 1.5	.153
RI (°)	22.8 ± 3.1	23.3 ± 3.1	.525
RH (mm)	11.8 ± 1.6	11.1 ± 1.1	.106
Tilt (°)	−7.5 ± 5.0	−8.9 ± 5.2	.281
Cast			
UV (mm)	0.0 ± 1.7	1.7 ± 2.2	.010
RI (°)	22.1 ± 4.6	19.8 ± 4.9	.073
RH (mm)	10.5 ± 2.4	10.0 ± 2.3	.387
Tilt (°)	−4.0 ± 7.0	2.2 ± 11.8	.017

UV, ulnar variance; RI, radial inclination; RH, radial height; Tilt, lateral alignment.

The cast group: For this group, 10 patients developed minor complications, and no patient had a major complication in the early timeframe. In the delayed period, 5 patients had minor complications, and another 5 had major complications (Table 8).

DISCUSSION

Initial results of the Micronail fixation have been previously published,[3–5] but those studies contained relatively few patients, short follow-up periods, and/or no comparison group. The present study examined the differences between DRFs managed with closed treatment and open reduction with intramedullary fixation with follow-up of at least 1 year. Our null hypothesis was that there would be no significant differences in any outcome between the 2 groups at any point in time. However, we found that, in the early postoperative period, patients who had been managed with IMN generally had better active wrist flexion–extension arc, grip strength, and lower DASH scores than those who had been treated with casting. These differences were also present for AO/ASIF types A and C fractures and were maintained even at the final follow-up, which is in contrast to other studies.[8,12,21]

The reasons for better outcomes in our surgery group might include less pain, early wrist motion, and confidence in the injured limb, which allowed patients to rapidly incorporate the limb into the activities of daily

TABLE 8. Complications

Complications	IMN (n)	Cast (n)	*P* Value
Early			
Minor	Transient radial sensory neuritis (3) Trigger finger (1) Finger stiffness (1) Ulnar fixation hardware irritation (1) Complex regional pain syndrome (1)	CTS (2) CTS and finger stiffness (2) Finger stiffness (6)	.572
Major	None (0)	None (0)	
Delayed			
Minor	None (0)	de Quervain and CTS (2) CTS (1) Finger stiffness (2)	<.001
Major	None (0)	Malunion repair (2) Ulnar shortening (2) de Quervain release (1)	

CTS, carpal tunnel syndrome.

living. We identified that duration of immobilization had negative correlations with active range of motion and grip strength and correlated with more disability (ie, higher DASH scores). Our supposition on the benefits of early wrist motion seems to contradict the findings of Lozano-Calderon et al,[22] who suggested that 6 weeks of postoperative wrist immobilization does not compromise wrist function and DASH scores. The current study and the Lozano-Calderon et al study differ in several ways. First, Lozano-Calderon et al studied patients who had volar plate fixation with randomization between late and early wrist motion. They did not report on immobilization in the setting of closed treatment of DRF with casting, as we did. Second, the authors made no attempt to confirm or verify that their patients adhered to the recommended motion protocols. Therefore, patients in the late motion group could have removed their thermoplastic splints and started earlier motion than advised and vice versa, thereby narrowing any difference that might have otherwise existed. Our closed treatment patients were maintained in a cast for duration of treatment, which guaranteed 100% compliance with immobilization. By the same token, our IMN group patients (except for the ones with distal ulna fixation) were mobilized immediately without any splinting. Third, all patients in the Lozano-Calderon et al study were immobilized in a volar plaster splint for 2 weeks after the surgery, again narrowing any difference that might otherwise exist between the late and early motion groups.

Arora et al[14] performed a retrospective study in an elderly patient population treated with volar plating versus casting. At final follow-up, they found no significant difference in mean ranges of motion, grip strength, DASH score, Patient-Rated Wrist Evaluation score, and Green and O'Brien score. The discrepancies between our results and theirs might be attributed to the differences in the methods of internal fixation, the mean final follow-up periods, and the patients' ages.

The only other recent study comparing surgical to conservative treatment for DRFs was a Cochrane review by Handoll et al.[12] They examined external fixation versus cast immobilization and concluded that there was some evidence to support external fixation because it prevented late collapse and malunion. However, there was insufficient evidence to confirm better functional outcome in the surgically treated patients. Similar to Handoll et al[12] and others[14,21] who concluded that surgery resulted in better radiographic parameters at healing, we also found this to be true for DRFs treated with IMN. However, unlike those of Handoll et al,[12] our surgically treated patients had better clinical functional outcomes than the patients who were casted.

We found no difference in the rates of complications between the surgically and nonsurgically treated patients in the early timeframe. All delayed complications occurred in the cast group, with no delayed complications occurring in the IMN group. In the cast group, 5 patients had minor complications, and another 5 had major complications requiring surgery on the injured wrists. The rate of secondary procedures in the cast group was high when compared to that of Arora et al,[14] who reported none, but it is in line with that of Handoll

et al,[12] who reported a 15% (51/338) rate of secondary treatment as a result of re-displacement.

Ilyas and Thoder[4] reported on 10 patients with AO/ASIF types A and C DRFs who had Micronail fixation. The average age of the group was 55 years, and average follow-up was 21 months. Overall, our results are similar to theirs in range of motion, grip strength, and DASH score. However, we did not observe any noteworthy change in alignment of the distal radius from immediately after surgery to final follow-up. In addition, we did not note any screw penetration into the DRUJ. Ilyas and Thoder[4] seemingly attributed DRUJ symptoms in 3 of their patients to "apparent penetration of the subchondral screws into the distal radioulnar joint," but they did not confirm this by computed tomography scan or perform surgery to remove the offending screws.

There are several limitations of the present study. First, it is a retrospective review with inherent limitations. It might also be argued that the cast group was not comparable to the IMN group because fractures in the former group are, by definition, more inherently stable. Patients in the cast group, in fact, were younger, had less severe fracture patterns (more A2 and C1), and had fewer associated distal ulnar injuries. Despite the differences between the groups, we felt that the cast group served a useful purpose for comparison because (1) casting is the most common form of treatment for DRFs, especially in the elderly,[23] and (2) we wanted to compare the treatment to the best-case scenario. Another limitation is that the outcome measures were obtained by an orthopedic physician assistant who is employed by the senior surgeon (V.T.), which could have led to bias.

Despite these shortcomings, the present study suggests that intramedullary nail fixation, as compared to casting, results in less functional disability, not only in the early postoperative period but also up to a year after treatment. On the basis of our data, we conclude that intramedullary fixation should be considered over casting for patients with extra-articular or simple intra-articular DRFs.

REFERENCES

1. Simic PM, Weiland AJ. Fractures of the distal aspect of the radius: changes in treatment over the past two decades. Instr Course Lect 2003;52:185–195.
2. Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. J Orthop Trauma 2007;21:316–322.
3. Tan V, Capo J, Warburton M. Distal radius fracture fixation with an intramedullary nail. Tech Hand Up Extrem Surg 2005;9:195–201.
4. Ilyas AM, Thoder JJ. Intramedullary fixation of displaced distal radius fractures: a preliminary report. J Hand Surg 2008;33A:1706–1715.
5. Brooks KR, Capo JT, Warburton M, Tan V. Internal fixation of distal radius fractures with novel intramedullary implants. Clin Orthop Relat Res 2006;445:42–50.
6. Beumer A, McQueen MM. Fractures of the distal radius in low-demand elderly patients: closed reduction of no value in 53 of 60 wrists. Acta Orthop Scand 2003;74:98–100.
7. Young BT, Rayan GM. Outcome following nonoperative treatment of displaced distal radius fractures in low-demand patients older than 60 years. J Hand Surg 2000;25A:19–28.
8. Arora R, Lutz M, Fritz D, Zimmermann R, Oberladstatter J, Gabl M. Palmar locking plate for treatment of unstable dorsal dislocated distal radius fractures. Arch Orthop Trauma Surg 2005;125:399–404.
9. Beharrie AW, Beredjiklian PK, Bozentka DJ. Functional outcomes after open reduction and internal fixation for treatment of displaced distal radius fractures in patients over 60 years of age. J Orthop Trauma 2004;18:680–686.
10. Orbay JL, Fernandez DL. Volar fixed-angle plate fixation for unstable distal radius fractures in the elderly patient. J Hand Surg 2004;29A:96–102.
11. Ring D, Jupiter JB. Treatment of osteoporotic is distal radius fractures. Osteoporosis Int 2005;16 Suppl 2:S80–84.
12. Handoll HH, Huntley JS, Madhok R. External fixation versus conservative treatment for distal radial fractures in adults. Cochrane Database Syst Rev 2007:CD006194.
13. Rozental TD, Blazar PE. Functional outcome and complications after volar plating for dorsally displaced, unstable fractures of the distal radius. J Hand Surg 2006;31A:359–365.
14. Arora R, Gabl M, Gschwentner M, Deml C, Krappinger D, Lutz M. A comparative study of clinical and radiologic outcomes of unstable Colles type distal radius fractures in patients older than 70 years: nonoperative treatment versus volar locking plating. J Orthop Trauma 2009;23:237–242.
15. Müller ME. Appendix A, The comprehensive classification of fractures of long bones. In: Müller ME, Allgöwer M, Schneider R, Willenegger H, eds. Manual of internal fixation. 3rd ed. New York: Springer-Verlag, 1991:134–135.
16. Trumble TE, Schmitt SR, Vedder NB. Factors affecting functional outcome of displaced intra-articular distal radius fractures. J Hand Surg 1994;19A:325–340.
17. Petersen P, Petrick M, Connor H, Conklin D. Grip strength and hand dominance: challenging the 10% rule. Am J Occup Ther 1989;43:444–447.
18. van der Linden W, Ericson R. Colles' fracture. How should its displacement be measured and how should it be immobilized? J Bone Joint Surg 1981;63A:1285–1288.
19. Knirk JL, Jupiter JB. Intra-articular fractures of the distal end of the radius in young adults. J Bone Joint Surg 1986;68A:647–659.
20. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. BMC Musculoskelet Disord 2003;4:11.
21. Figl M, Weninger P, Jurkowitsch J, Hofbauer M, Schauer J, Leixnering M. Unstable distal radius fractures in the elderly patient—volar fixed-angle plate osteosynthesis prevents secondary loss of reduction. J Trauma 2010;68:992–998.
22. Lozano-Calderon SA, Souer S, Mudgal C, Jupiter JB, Ring D. Wrist immobilization following volar plate fixation of fractures of the distal part of the radius. J Bone Joint Surg 2008;90A:1297–1304.
23. Chung KC, Shauver MJ, Birkmeyer JD. Trends in the United States in the treatment of distal radial fractures in the elderly. J Bone Joint Surg 2009;91A:1868–1873.

APPENDIX

This study was designed to determine a 10-point mean difference in the DASH scores between the 2 groups, with a standard deviation of 10 points (for an effect size of 1.0).[20] A power analysis indicated that a sample size of 23 patients in each group would provide 90% power to detect this effect size between the groups ($\alpha = 0.05$, $\beta = 0.10$) with an unpaired Student's *t*-test.

Chi-square or Fisher exact tests were used to compare the nonparametric measures between the groups. The DASH scores, grip strengths, arcs of motion, and radiographic assessments were analyzed using analysis of variance at different intervals between the 2 groups and between baseline and 12 months within each group. Correlations between time of immobilization and the clinical outcome parameters were determined by Spearman rank correlation coefficients. Significance was reported as $P < .05$.