Effectiveness of Non-Operative Treatment vs. Operative Treatment of Unstable Distal Radius Fractures in the Elderly

Shannon Donegan
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Abstract

Background

There has been an ongoing debate on how to treat patients over 65 with unstable distal radius fractures. The purpose of this systematic analysis is to review the literature and determine if nonoperative care in the form of casting vs. operative care can be as effective in this specific population.

Methods

An exhaustive search of available medical literature using the following databases: MEDLINE-Ovid, CINAHL, Web of Science and Clinical Key using search terms fracture fixation, radius fracture, aged, non-operative and unstable was undertaken. Outcomes of interest included Disabilities of the Arm, Shoulder, and Hand (DASH) scores and Patient related Wrist Evaluation (PRWE) to determine functionality, wrist range-of-motion (ROM), pain, grip strength, and radiographic findings. The purpose was to determine outcomes of these various factors comparing the nonoperative vs. operative approaches in those patients over 65 years old. GRADE was utilized in assessing the quality of evidence.

Results

One prospective randomized study\(^6\) and two retrospective studies\(^{7,4}\) were analyzed. The prospective study demonstrated that there was no difference in functionality of the fractured wrist between the operative and conservatively managed groups at one year after sustaining unstable distal radius fracture. Both of the retrospective studies also concluded that at one year after the initial fracture there was no difference in functional status between the groups. Complications occurred less frequently in the conservatively managed patients across all three studies\(^{6,7,4}\) whereas grip strength and radiographic findings were improved in the operative group.

Conclusion

At one year follow up examination of the non-operative group vs. operative group in the treatment of unstable distal radius fractures, grip strength and radiographic findings were better in the operative group. Functionality based on DASH scores, ROM and pain in those over age 65 showed no significant differences. Therefore, since functionality is similar with either intervention, in patients where surgical risks are high, the non-operative approach can be considered. Given the growing elderly population, the social-economic impact of this injury and the morbidities associated with putting an elderly patient through surgery it is a reasonable decision to choose non-operative management in those over 65 with unstable distal radius fractures. Of course, patient lifestyle, activity level and daily routine would play a significant role in the decision to have surgery vs. elect conservative management. It is assuring to note that no matter what the decision, conservative management does not change functional outcome of the fracture at one-year post injury.

Degree Type

Capstone Project
Degree Name
Master of Science in Physician Assistant Studies

Keywords
terms fracture fixation, radius fracture, aged, non-operative and unstable

This capstone project is available at CommonKnowledge: https://commons.pacificu.edu/pa/634
Effectiveness of Non-Operative Treatment vs. Operative Treatment of Unstable Distal Radius Fractures in the Elderly

Shannon Donegan
Biography

Shannon Donegan is from Denver, Colorado and received her Bachelors of Science Degree in Business Marketing and Spanish from Montana State University. After working in orthopedic device sales she decided to choose a career in patient centered care. She then worked as a medical assistant at an orthopedic practice in Denver. After which she enrolled in the Physician Assistant program at Pacific University in Hillsboro, Oregon. Main areas of interest in medicine include orthopedics, women’s health, and integrative health care.
Abstract

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Acknowledgements

To Professor Sommers: Thank you for sacrificing so much of yourself for our success. Your patience with me is greatly appreciated as it was a struggle to get to this point. You never gave up and we finally found a great topic with meaning. Your passion is evident in this project and it is obvious you pour your heart and soul into this. You are an invaluable part of this program and to each of us as future clinicians.

To my mom: Thank you for listening to me as I tirelessly called you while coming up with an idea for this project. You supported me in coming up with a “bright idea”, and because of your advice to return to my passion for orthopedics, I found this topic.
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List of Abbreviations

ROM- Range of motion
AROM- Active range of motion
PRWE- Patient-Related Wrist Evaluation
DASH- Disabilities of the Arm, Shoulder and Hand
DRF- Distal radius fracture
ORIF- Open reduction and internal fixation
VAS- Visual analog scale
LCP- Locking compression plate
DRP- Distal radius plate
C. D. – Clinical decision support
Treating unstable distal radius fractures in the elderly

BACKGROUND

Introduction

Distal radius fractures affecting those with osteoporotic bone is a common problem. In fact, distal radius fractures account for approximately 18% of all fractures in the elderly population.¹ The incidence of sustaining a distal radius fracture has significant social-economic implications. In older women, the risk of hip fracture increases 1.4 to 1.8 fold if there was a previous wrist fracture. In older men, the risk of hip fracture increases 2.3 to 2.7 fold.² If surgery is warranted in this population, there are additional repercussions to consider. Undergoing surgery leads to increased financial burden, risk of potential infection, complications due to comorbid conditions and increased risk of mortality. It is also important to recognize that the elderly population is increasing. According to the Administration for Community Living, people 65 and over accounted for 14.5% of the population in the latest census data of 2014. This number is projected to increase to 21.7% of the population by 2040.³

Due to the residual social-economic consequences, such as risks of surgical intervention, cost of surgery, and the increasing elderly population, the treatment surrounding distal radius fractures in the elderly is of growing importance. The purpose of this systematic review is to compare outcomes of elderly patients who have unstable distal radius fractures who were treated conservatively vs. with surgical intervention. The outcomes analyzed include functionality measured by Disabilities of the Arm, Shoulder and Hand (DASH) scores and, Patient Related Wrist Evaluation (PRWE) range-of-motion (ROM), pain, grip strength and radiographic findings up to 12 months after the fracture.
METHODS

An exhaustive literature search was conducted using various databases including MEDLINE-Ovid, CINAHL, Web of Science, Clinical key and Google scholar. MEDLINE-Ovid was searched using the 5 terms: fracture fixation, radius fracture, aged, non-operative and unstable. Both CINAHL and The Web of Science were searched using the 3 terms: distal radius fracture, unstable, and elderly. The Clinical Key database along with Google Scholar were searched by typing in “nonoperative unstable fracture of distal end of radius in elderly” into the search line with only full text articles.

Inclusion criteria included studies in which outcomes such as functionality, pain, ROM and grip strength were analyzed between operative treatment vs. conservative following a distal radius fracture. The patients had to be over 65 years of age. Other criteria included full text articles in English. These articles were also evaluated using Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group guidelines. 5

RESULTS

The initial search yielded 179 articles for review. The MEDLINE-Ovid yield was 8 studies. CINAHL included 8 potential articles. Google Scholar yielded 10 possible articles. Web of Science included 53 and Clinical Key included 100 articles. After eliminating duplicates the search was refined to 166 articles. The 166 articles were screened and 149 were removed. Next 17 full text articles were assessed for eligibility and 14 were excluded based on the inclusion and exclusion parameters. The 3 remaining articles are included in this review. These articles included 1 randomized control trial6 and 2 cohort trials4,7 (See Table 1). For a summary flow diagram of the methods please refer to Figure 1.
The prospective randomized control trial\textsuperscript{6} was conducted at the Department of Trauma Surgery and Sports Medicine Medical University Innsbruck Austria from 2005-2008. Initially there were 90 participants after inclusion criteria was met to include patients over 65 with unstable dorsally displaced distal radius fractures. These patients were randomized with 45 in the operative group and 45 in the non-operative group. Of these, 4 in the operative group and 2 in the non-operative group were lost to death due to causes outside of the fracture. Within the operative group 5 were lost to follow-up and 6 were lost to follow-up in the non-operative group. Therefore, 73 patients participated in this study and met the inclusion criteria; 36 in the operative group and 37 in the non-operative group. The median age of the participants was 76.7 years old.

Within the operative group all patients were treated with an open reduction and internal fixation (ORIF) using a palmar approach along the flexor carpi radialis muscle. The devices used were determined by the experienced hand surgeon with a “Synthes Volar- fixed angle plate 2.4-mm Locking compression plate (LCP) and Distal radius plate (DRP) or DVR\textsuperscript{®} plate from Hand Innovations.” The wrist was then immobilized in a below the elbow splint for 1 week until sutures were removed. The patients were transitioned into a removable wrist brace and began physical therapy for hand and wrist ROM.

The non-operative group fractures were not remanipulated after the initial closed reduction. The patients were placed in a short arm cast for 5 weeks. While in the cast active digit ROM was encouraged and after cast removal the patients began physical therapy. The patients were followed up by an unblinded outside examiner. The examiner was not blinded
secondary to the evidence of the palmar scars in the operative group. Approximate median follow up time was at 6 weeks, 12 weeks, 6 months and 12 months respectively.

**Functional assessment**

At each of the time intervals functional outcomes based on DASH and PRWE scores were recorded. Early in the study at 6 and 12 weeks the operative group had lower DASH score and PRWE scores, which indicated better wrist function in the operative group. At 6 months and 12 months, however, there was no significant difference between the operative and non-operative groups (p value of 0.34 for DASH and p value of 0.73 for PRWE both greater than 0.05).

**Range of Motion and Pain**

Active ROM to include; extension, flexion, pronation, supination, radial deviation and ulnar deviation were measured with a goniometer. The study demonstrated no functional differences between the operative and operative groups regarding ROM (see p values in Table 2). Pain was measured based upon the visual analog score. The operative group pain was 0.1 ± 0.3 and the non-operative group pain was measured as 0.1 ± 0.5 for a p value of 0.80. Between the two groups at one year, there was no significant difference in pain.

**Grip Strength and Radiographic findings**

Grip Strength was measured using a dynamometer. Throughout the process grip strength was better in the operative group. P value of significant significance 0.02. Radiographic findings were performed by an assessor of radiographic outcome included measurements of palmar tilt, radial inclination, step off and ulnar variance. These images were obtained at 1 week, 6 weeks, 12 weeks, 6 months and 12 months. This assessor was blinded to
the functional outcomes but not the method of treatment. The results were better in the operative group with a significantly significant p value in every respective category (see Table 3).\(^6\)

**Complications**

The complications were significantly higher in the operative group (13 compared with 5).\(^6\) Complications of the 13 operative group patients included extensor and flexor tenosynovitis, carpal tunnel syndrome and complex regional pain syndrome. The 5 patients in the non-operative group all developed complications of complex regional pain syndrome. Complications of both the operative and non-operative groups resolved with outpatient physical therapy and oral analgesia.

**Arora et al Cohort**

The retrospective clinical study\(^7\) was also performed at the Department of Trauma Surgery and Sports Medicine Medical University Innsbruck Austria between 2000 and 2005.\(^7\) There were 150 patients that met the inclusion criteria. Of these 5 were lost to death and 11 were lost to follow up. After exclusion criteria had been met 114 patients participated in the study: 53 in the operative group and 61 in the non-operative group. Of those that participated in the study the median age was 79 years old.

The group that elected to have surgery underwent ORIF of the distal radius using a volar-fixed angle plate 2.4-mm Locking compression plate (LCP) and Distal radius plate (DVR) from Hand Innovations.\(^7\) A palmar approach was used along the flexor carpi radialis muscle. After surgery, the patients were placed in a below the elbow splint for approximately 2 weeks.\(^7\) Active digit ROM was encouraged, sutures were removed by 10 days and the patients were
transitioned into a removable wrist splint for an additional week. The patients then began both passive and active ROM in physical therapy.

Patients who elected conservative treatment were transitioned into a short arm cast at 1 or 2 weeks after the injury. Then into another short arm cast for an additional 6 weeks. After 6 weeks these patients began assisted AROM and grip strengthening in physical therapy.

Functional assessment was performed by an orthopedic physiotherapist who was not blinded secondary to the obvious palmar scar.

**Functional assessment**

This assessment included DASH and PRWE scores to measure functional status. There results showed no significant difference in either group (p values DASH score of .90 and p value of .21 PRWE score). (Refer to Table 2.)

**Range of motion and Grip strength**

ROM measurements using a goniometer measured extension, flexion, pronation, supination, radial deviation and ulnar deviation. Grip strength was measured using a dynamometer. Both the ROM in all planes and grip strength between the two groups showed no statically significant difference (P> 0.05). (refer to table 2)

**Pain and Radiographic findings**

Pain using the VAS scoring scale showed a statically significant difference between the two groups. Pain scores of the operative group were reported to be 1.7 ± 1.4 and pain scores of the non-operative group were 0.7 ± 1.4 which yielded a p value of 0.03 indicating less pain in the non-operative group.
Radiographic findings were analyzed by a clinical decision support (C. D.) who was not a member of the surgical team at 2, 6 and 12 weeks and at final follow up. He was blinded to the outcomes but not to the treatment. At the final follow up the ORIF (operative) group showed significantly better results when compared to the (CAST) non-operative group with a (P < 0.05). (refer to table 2)

**Complications**

There were 13% of patients in the operative group who suffered from complications and 11% of the patients that had the initial surgery required a second surgery in the form of hardware removal and one carpal tunnel release. There were 8% of patients in the non-operative group who suffered complications in the form of complex regional pain syndrome which all resolved with conservative management in the form of physical therapy and oral analgesia.

**Egol et al Cohort**

This cohort study was performed at New York University Hospital for Joint diseases and Jamaica Hospital Medical Center Jamaica New York from 2004 to 2008. After the inclusion criteria was met there were 156 patients; 82 in the operative group and 74 in the non-operative group. The patients who had an open fracture, those with inherently unstable fracture pattern, a shear fracture or a fracture dislocation of the wrist or other exclusion criteria unquestionably underwent surgery. There were also patients who met radiographic criteria for surgery; they however, chose conservative care. Therefore, this study was not randomized. In the operative group 32 were lost to follow up. In the non-operative group there were 17 lost to follow up. After accounting for the loss, 9 patients met the exclusion criteria which included 44 in the
operative group and 46 in the non-operative group. The median age for this study was 76 years old.

The operative group was treated either with Volar locking plate or bridging external fixation with supplemental Kirschner wires. The ORIF was accomplished using the extended flexor carpi radialis approach. Those patients who underwent fixation with the volar locking plate were released with a volar splint with early transition to a removable cock up wrist splint with freedom for active range of motion (AROM). The group who underwent external fixator application were encouraged to perform digit ROM and the fixator remained in place for 6 weeks. Both operative groups transitioned to outpatient physical therapy for ROM and grip strengthening.

The non-operative group underwent treatment with casting. Although patients were followed by their surgeon the functional data was collected by an independent trained researcher. Blinding of outcomes assessments was not clearly addressed. Approximate median follow up time was 1 week, 6 weeks, 3 months, 6 months and 12 months.

*Functional Assessment*

Outcomes were measured by the independent researcher at each visit. Functional outcomes were measure using DASH scores but not PRWE scores. Based upon the post hoc power analysis used by the researches, it was determined that if there was a 15-point difference between the operative and non-operative groups that would account for a functional difference. The DASH scores revealed no statically significant difference. However, based on the findings in this study “the lack of difference in DASH scores at 3, 6 and 12 months was not real due to insufficient study power.”
**Pain and Grip strength**

Pain was measured based on the VAS sale. Pain scores of the operative group were reported to be $1.5 \pm 2.1$ and pain scores of the non-operative group were $1.2 \pm 1.7$ at 12 months which yielded a not statically significant $p$ value. (refer to table 2). Grip strength was measured with a dynamometer and was better in the operative group with a $p$ value of 0.005.

**Range of Motion**

At 24 weeks into the study ROM was better in the operative group. At 1 year, all ROM planes except for supination showed no significant differences between the two groups. Supination was favorable in the operative group with a $p$ value of 0.03. (refer to table 2)

**Radiographic findings**

Radiographic findings were obtained at the same time intervals and were performed by a trained research associate under the direction of the treating surgeon. Measurements included volar tilt showing a $p$ value of <0.0001, Radial inclination of 0.0001, radial length of 0.0008 and ulnar variance of 0.007 respectively. This indicates significantly better radiographic outcomes in the operative group. (refer to table 2)

**Complications**

Both the operative and nonoperative groups developed similar rates of carpal tunnel syndrome 3 (7) and tendinitis 1 (2). The operative group developed severe finger stiffness, severe ulnar sided wrist pain and prominent hardware 1 (2) in each complication respectively. 4
DISCUSSION

Treatment course

The articles\textsuperscript{6,7,4} included in this literature review are based on patients over 65 years old who sustained a distal radius fracture after a fall from a standing height. Initial treatment of all patients who were neurovascularily intact with an unstable fracture included initial radiographs of the injured wrist followed by closed reduction and application of a sugar tong or similar splint. Within 1 week of the injury all patients included in each study were reevaluated radiographically and clinically to determine course of treatment. Each study included different inclusion and exclusion criteria for determining operative vs. conservative care. In the RCT study\textsuperscript{6} this decision was randomized and the other two cohort studies\textsuperscript{7,4} were based upon retrospective review of decisions made. Patients were followed for 12 months or more and outcomes were obtained comparing the operative group to the non-operative group.

Outcomes measured

Functionality was measured according to the Disabilities of the Arm, Shoulder and Hand (DASH) scores in all three studies. DASH scores range from 0-100 points 0 representing no function to 100 representing perfect function. The Patient-Rated Wrist Evaluation (PRWE) was evaluated in one of the cohorts and the RTC which also uses the 100 point scale. Grip strength was measured using a dynamometer in all 3 studies. ROM in all studies included wrist extension, wrist flexion, pronation, supination, ulnar and radial deviation using a goniometer by an independent, trained researcher or examiner. Pain was measured in all studies using a visual analog scale (VAS) rating of 0-10 zero representing no pain and 10 being the worst pain imaginable. Radiographic findings evaluated palmar/volar tilt or dorsal tilt, radial inclination,
radial length, and ulnar variance. All functional outcomes were compared between the operative and non-operative groups.

The results from the comparison of the three studies shows that for patients over 65 years old there is no significant evidence to support surgical intervention over non-operative casting care in regard to functional outcomes, pain, ROM and complications in this specific patient population. (Refer to Table 2 and 3.)

**Clinical relevance**

The three studies each had a patient sample size of 90-114 patients with an average of 44 patients in the operative group and an average of 48 patients in the non-operative group. The median age across the three studies was 77 years old. Here the various outcomes will be discussed between the three studies.

**Functional Assessment**

The DASH scoring system was used in all three studies. The RCT showed the p value to be 0.34, the cohort was 0.9 and the cohort performed by Egol et al showed a non-significant DASH score. Based on the results of DASH scores there was no functional differences between the operative group and nonoperative group across the three studies. When addressing the PRWE p value score measured in the RCT was 0.73 and the Arora et al cohort was 0.73 again demonstrating no statically significant differences in functional outcomes.

**Range of Motion**

The extension, flexion, pronation, supination, radial and ulnar deviation of the wrist were measured across all three studies. Between each ROM between the operative and non-operative groups there were no statistically significant differences with the exception of
supination in the Egol et al \(^4\) study finding that supination was slightly better in the operative group. This means that overall, ROM at 1 year was very similar whether the patients underwent surgery or had casting treatment. Please see Table 2 for further data of the various ROM degrees.

**Pain**

All three studies\(^6,7,4\) used the same scale of measurement in the VAS scoring system. The RCT performed by Arora et al \(^6\) showed minimal difference in pain between the 2 groups at 1 year. Arora et al cohort \(^7\) showed that the non-operative group had less pain than the operative group. The second cohort performed by Egol et al \(^4\) demonstrated slightly less pain in the operative group over the non-operative group. Across the three studies, however, the pain between the two groups was not statistically significant. (See Table 1 and 2)

**Grip strength**

The RCT from Arora et al \(^6\) in addition to the cohort from Egol et al \(^4\) did show a statistically significant difference between the operative and non-operative groups favoring the operative group. The other cohort from Arora et al \(^7\) did not show any statistically significant difference between the groups in regard to grip strength. Although this finding favors operative treatment it is a less weighted factor in overall function of the patient.

**Radiographic findings**

Radiographically each study used a researcher who was not involved in the procedure and was blinded to the outcomes but not the method of treatment. Across the board in all three studies\(^6,7,4\) when examining volar tilt, radial inclination, radial length and ulnar variance the operative group had favorable outcomes. Although the radiographs do support the surgical
treatment for operative intervention, it is more important to consider the overall function of the patient and how they feel as opposed to simply how their film looks.

**Complications**

Post-operative complication is an important factor to consider when surgery is in question especially in the elderly population. Arora et al\(^6\) and Arora et al cohort\(^7\) demonstrated that complications were significantly higher in the operative group 13 compared with 5\(^6\) and 13% to 8%.\(^7\) Egol et al\(^4\) also established lower complications in the non-operative group. Complications across all three studies evaluated\(^6,7,4\) exhibited post-operative complications such as extensor and flexor tenosynovitis, carpal tunnel syndrome and complex regional pain syndrome, need for second surgery and extreme stiffness. The major complication demonstrated in the non-operative groups across the three studies\(^6,7,4\) was complex regional pain syndrome and tendonitis. With that said however, these complications occurred less frequently and all resolved with oral analgesia and additional physical therapy. When considering those patients over 65 with unstable distal radius fracture it is significant to note that the complications are less in those who elected conservative management.

**Limitations**

Of the three studies\(^6,7,4\) there was mention that no source of outside funding was used. Two of the studies\(^6,7\) were performed at the same clinic in Austria. Thus it would be beneficial to see the results of studies performed in the US. The researchers measuring the functional outcome data along with the radiologist were not blinded between the groups based on the presence of the volar scar. This could have been easily corrected by having each patient cover the palmar wrist with a wrap whether they had surgery or not and that would remove the potential bias.
Across the studies there was not significant variability even between the operative groups. All three studies provide sound evidence and are reliable. There were no serious limitations and each section had either a moderate or low quality of evidence. Please note that in analyzing GRADE complications was considered a low-quality analysis due to the minute number of adverse effects. Please refer to Table 1 for detailed quality assessment.³

CONCLUSION

Grip strength and radiographic evidence support operative management for unstable displaced distal radius fractures. However, more importantly, weighted factors for long term outcome of the patient such as functional status, complications, pain and ROM are of paramount importance to consider when treating those over 65 with an unstable distal radius fracture. Across the three studies⁶,⁷,⁴ in this systematic review it was demonstrated that there was no statistically significant difference between functional scores, pain or ROM. Given the growing elderly population, the social-economic impact of this injury and the morbidities associated with putting an elderly patient through surgery it is a reasonable decision to choose non-operative management in those over 65 with unstable distal radius fractures. Of course, patient lifestyle, activity level and daily routine would play a significant role in the decision to have surgery vs. elect conservative management. However, it would be assuring to note that no matter what the decision, conservative management does not change functional outcome of the fracture at one year post injury.
References


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* Due to scar from surgery, blinding of the assessor was difficult to maintain. Pain was assessed using the visual analogy scale. Arora et al (cohort) showed no difference in the groups.

b Imprecision due to small number of adverse events.

*Obs- Observational, No.-Number
<table>
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<tr>
<td>PRWE</td>
<td>12.8 ± 23.2</td>
<td>14.6 ± 22.8</td>
<td>0.73</td>
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<tr>
<td></td>
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<td>Nonoperative</td>
<td>P Value</td>
</tr>
<tr>
<td>Extension</td>
<td>57 ± 11.6</td>
<td>59.8 ± 7.0</td>
<td>0.23</td>
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<tr>
<td>Flexion</td>
<td>44.6 ± 10.4</td>
<td>49.6 ± 9.8</td>
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<tr>
<td>Pronation</td>
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<td>81.4 ± 8.6</td>
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<tr>
<td>Supination</td>
<td>83 ± 9.9</td>
<td>82.5 ± 6.8</td>
<td>0.83</td>
</tr>
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<td>Radial Deviation</td>
<td>20.6 ± 8.6</td>
<td>21.2 ± 8.4</td>
<td>0.68</td>
</tr>
<tr>
<td>Ulnar Deviation</td>
<td>38.0 ± 9.4</td>
<td>36.4 ± 9.2</td>
<td>0.72</td>
</tr>
<tr>
<td>Grip strength</td>
<td>19.4 ± 6.0</td>
<td>21.1 ± 7.0</td>
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</tr>
<tr>
<td>Pain</td>
<td>1.7 ± 1.4</td>
<td>0.7 ± 1.4</td>
<td>0.03</td>
</tr>
<tr>
<td>DASH</td>
<td>11.1 (0-17.4)</td>
<td>11.6 (0-18.1)</td>
<td>0.9</td>
</tr>
<tr>
<td>PRWE</td>
<td>9.3 (0-12.6)</td>
<td>16.9 (0-16.3)</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Operative</td>
<td>Nonoperative</td>
<td>P Value</td>
</tr>
<tr>
<td>Extension</td>
<td>54.6 ± 14.9</td>
<td>54.8 ± 18.7</td>
<td>NS</td>
</tr>
<tr>
<td>Flexion</td>
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<td>47.8 ± 13.1</td>
<td>NS</td>
</tr>
<tr>
<td>Pronation</td>
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<td>82.9 ± 6.8</td>
<td>NS</td>
</tr>
<tr>
<td>Supination</td>
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<td>0.03</td>
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<td>NS</td>
</tr>
<tr>
<td>Ulnar Deviation</td>
<td>30.3 ± 7.1</td>
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<td>NS</td>
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<td>Grip strength</td>
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<td>39.0 ± 16.1</td>
<td>0.005</td>
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<td>1.2 ± 1.7</td>
<td>NS</td>
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<td>DASH</td>
<td>12.1 ± 29.6</td>
<td>10.0 ± 20.3</td>
<td>NS</td>
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<tr>
<td>Table 3</td>
<td>Radiographic Outcomes at Final Follow Up</td>
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<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Arora et al</strong>&lt;sup&gt;6&lt;/sup&gt;</td>
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<tr>
<td>Palmar Tilt</td>
<td><strong>Operative</strong> 3.0 ± 7.2</td>
<td><strong>Non-operative</strong> -10.4 ± 19.1</td>
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<tr>
<td>Radial Inclination</td>
<td>21.2 ± 2.6</td>
<td>15.9 ± 9.0</td>
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<td>step off</td>
<td>0.2 ± 0.5</td>
<td>0.6 ± 1.1</td>
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<tr>
<td>Ulnar Variance</td>
<td>0.7 ± 1.8</td>
<td>3.2 ± 2.9</td>
<td>0.00</td>
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<tr>
<td><strong>Arora et al Cohort</strong>&lt;sup&gt;7&lt;/sup&gt;</td>
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<tr>
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<td><strong>Intra-articular Fracture</strong></td>
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<tr>
<td>Dorsal Tilt</td>
<td><strong>Operative</strong> -1.4 ± 3.8</td>
<td><strong>Non-operative</strong> -23.9 ± 16.4</td>
<td>0.0001</td>
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<td>Radial Inclination</td>
<td>24.3 ± 4.2</td>
<td>18.3 ± 9.3</td>
<td>0.04</td>
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<td>Radial Length</td>
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<td>-</td>
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</tr>
<tr>
<td>Ulnar Variance</td>
<td>1.7 ± 1.5</td>
<td>4.1 ± 3.0</td>
<td>0.0001</td>
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<tr>
<td></td>
<td><strong>Extra-articular Fracture</strong></td>
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<tr>
<td>Dorsal Tilt*</td>
<td>1.3 ± 9.2</td>
<td>-24.9 ± 7.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Radial Inclination</td>
<td>23.0 ± 3.4</td>
<td>20.1 ± 3.6</td>
<td>0.04</td>
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<tr>
<td>Radial Length</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ulnar Variance</td>
<td>1.4 ± 2.3</td>
<td>3.7 ± 2.3</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Egol et al Cohort</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
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<tr>
<td>Volar Tilt</td>
<td><strong>Operative</strong> -5.8 ± 10.4</td>
<td><strong>Non-operative</strong> 6.2 ± 9.2</td>
<td>&lt;0.0001</td>
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<td>Radial Inclination</td>
<td>18.0 ± 4.0</td>
<td>22.3 ± 4.7</td>
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<td>Radial Length</td>
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<td>Ulnar Variance</td>
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<td>1.5 ± 2.2</td>
<td>0.007</td>
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</table>

This study measured the dorsal tilt and further divided the fracture types into intra-articular and extra-articular.
Figure 1: PRISMA Flow Diagram

- Records identified through database searching (n = 179)
- Additional records identified through other sources (n = 2)
- Records after duplicates removed (n = 166)
- Records screened (n = MEDLINE-Ovid 8, CINAHL 8, Google Scholar 10, Web of Science 53, Clinical Key 100)
- Records excluded (n = 149)
- Full-text articles assessed for eligibility (n = 17)
- Full-text articles excluded, with reasons (n = 14 did not fully meet the inclusion criteria)
- Studies included in qualitative synthesis (n = 3)