

## Assessment of the Subjective, Objective and Radiographic Outcome of the Different Treatment Approaches for the Management of Radius and Ulna Fractures in Adults

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### Abstract

**Aim:** To determine relationship of the subjective, objective and radiographic method of treatment. **Material and methods:** A prospective study were conducted in the Department of Orthopaedics Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India. for 1 year. Three different treatment approaches were utilized: open reduction and internal fixation (ORIF), closed reduction and casting (CR), and external skeletal fixation with pins-in-plaster (PIP). The method of treatment was chosen by the attending surgeon based upon his experience and the type of injury. **Results:** Overall, 82 percent of patients reported no pain, with no difference between patients with open and those with closed fractures. While 85 percent of patients treated with ORIF were pain free at their last examination, only 55 percent treated with CR and 50 percent treated with PIP were painless. There was no significant difference in the loss of forearm rotation between closed and open fractures: 67 percent of each group lost less than thirty degrees of forearm rotation. 75 percent of patients treated with ORIF lost less than thirty degrees of forearm rotation, while only 48 percent treated by CR and 27 percent by PIP lost less than thirty degrees. Union occurred in 91 percent of radius fractures and 94 percent of ulna fractures, with an average time to union of 15.1 weeks for the radius and 16.5 weeks for the ulna. Union was more frequent after closed than after open fractures. This difference was most apparent in radius fractures where 14 percent of open fractures developed nonunion, compared to only 3 percent of closed injuries ( $p = 0.142$ ). Also, the average time to union was 17 percent longer for open than for closed fractures of the radius ( $p = 0.035$ ), and 33 percent longer for open fractures of the ulna ( $p = 0.014$ ). Neither the frequency of nor the time to union varied significantly with the method of treatment. The amount of forearm rotation lost was directly proportional to the loss of normal alignment, reaching a mean of 38 degrees when the combined malalignment of the radius and ulna exceeded thirty degrees ( $p = 0.06$ ). 80 percent of patients treated with ORIF had less than twenty-degree combined malalignment of the radius and ulna on the final radiographs, a result seen in only 55 percent and 11 percent of patients treated with CR and PIP respectively. **Conclusion:** The results of open and closed fractures were somewhat similar, with the exception of a longer period to union and a higher infection

risk. A weakened end outcome was strongly predicted by the occurrence of subsequent casualties.

**Keywords:** Fracture radius, ulna, factors affecting, and outcome.

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## Introduction

Since the radius travels around the ulna in pronation and supination motions, achieving an optimum result for mid shaft fractures of the radius and ulna in adults requires union with natural anatomical reconstruction. Open reduction and plate fixing are used to accomplish these goals. Other experiments have paid no attention to outcome measures other than union, and the inclusion of single-bone fractures with fractures of both bones (radius and ulna) cannot be comparable.[1-3] Forearm fractures are one of the most common fractures. Mechanisms of injury of these fractures are generally high energy accidents, direct trauma, fall from height etc. It's not rare to have open wounds and a neurovascular deficit. Based on the level and displacement of the injuries, both traditional and surgical procedures are used. Since it is impossible to sustain reduction of forearm shaft fractures that have both rotatory and angular movements, the conservative solution is used less often. In addition, cast complications, non-union, malunion, compartment syndrome, and Volkmann ischaemic contracture are all normal. As a result, surgery is the recommended method, with the final decision remaining with the prescribing physician. For diaphyseal fractures, union with restoration of normal anatomy is especially important for a successful outcome.[4-6] In previous studies, however, outcome measures other than union have received scant attention[7-9], and the inclusion of fractures of a single bone with fractures of both bones has made interpretation of results difficult. This study was to determine the relationship of outcome to modality of treatment, type of fractures and presence of associated injuries

in adults who sustained fractures of the shafts of both radius and ulna. Measures of outcome investigated were patient satisfaction (amount of pain), rotation of forearm, radiographic findings and work status.[10]

## Material and Methods

A prospective study was conducted in the Department of Orthopaedics Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India. for 1 year. after taking the approval of the protocol review committee and institutional ethics committee.

## Methodology

All patients were followed at least until bone union occurred or the diagnosis of nonunion was made. The mean follow-up was 6 months (range 2 to 6 months). 70 patients were male and 30 female, with an average age of 29 years (range 18 to 69 years). In 30 patients, the fracture involved the dominant limb. 35 of the fractures were open and 65 were closed. Three methods of treatment were utilized: open reduction and internal fixation (ORIF), closed reduction. Three methods of treatment were utilized: open reduction and internal fixation (ORIF), closed reduction and casting (CR), and external skeletal fixation with pins-in-plaster (PIP). The method of treatment was chosen by the attending surgeon based upon his experience and the type of injury. Minimal displacement of a closed fracture was the most frequent indication for closed reduction, and marked comminution was the primary reason for treatment with pins-in-plaster. All reductions were performed under general anesthesia. The definitive treatment was ORIF in 70 forearms, CR in

20, and PIP in 10 patients in the ORIF group were initially treated unsuccessfully by other methods (eighteen by CR and three by PIP). Union was defined as the presence of bridging bone or trabeculae spanning the fracture site. Nonunion was identified by the absence of union within twenty-eight weeks following injury. Standards for alignment and measurement of radiographs were based on Sage's study, which defined normal as nine degrees of radial and six

degrees of dorsal bowing of the radius and zero degrees in both planes for the ulna.<sup>11</sup> End result ratings were made on a 14 point scale in four categories: (a) subjective, according the level of pain in the injured limb; (b) objective, by the range of forearm rotation; (c) radiographic, utilizing the criteria of union, synostosis, and malunion; and (d) economic, as reflected by the impact of the injury on the patient's employment status (Table 1).

**Table 1:**

Rating	subjective	Objective	Radiographic
4	No pain	Combined loss of forearm rotation <300	Fracture united. combined malalignment (radius and ulna) <200
3	Mild pain, present with overuse	Combined loss of forearm rotation 31-600	Union, with combined malalignment 21-400
2	Moderate pain present with routine activities	Combined loss of forearm rotation 61-900	Union, with combined malalignment >400
1	Severe pain prevent routine activities	Combined loss of forearm rotation >900	Nonunion, synostosis or osteomyelitis

### Results

Patients with open fractures showed no pain at all, and people with closed fractures recorded no pain at all. Just 55 percent of patients treated with CR and 50 percent of patients treated with PIP were pain-free at

their last test, compared to 85 percent of ORIF patients. Patients with isolated wounds were less likely to be in pain than patients with other conditions (Table 2).

Table 2. Subjective Outcomes (Percent of patients achieving each subjective rating)

Rating	Overall	Open Fractures	Close Fractures	ORIF	CR	PPI	Multiple Injuries	Isolated Fractures
4	82	78	78	85	55	50	72	82
3	12	18	16	10	41	45	23	14
2	6	4	4	5	4	5	5	2
1	0	-	0	0	0	0	0	0

### Objective Outcomes

As contrast to the uninjured hand, no patient had a substantial loss of wrist or elbow motion. However, the overall cumulative reduction in forearm rotation was less than 30 degrees, with supination losing marginally more ground than pronation. The loss of forearm rotation did not vary significantly between closed and open fractures: 67 percent of all groups lost

fewer than thirty degrees of forearm rotation. The treatment procedure has a substantial impact on forearm rotation failure. Just 48% of patients treated with CR and 27% of patients treated with PIP lost less than thirty degrees of forearm rotation, while 75% of ORIF patients lost less than thirty degrees. Patients who have sustained several injuries lost more forearm

rotation than did those with isolated fractures (Table 3).

**Table 3: Objective Outcomes (Percent of patients achieving each objective rating)**

Rating	Overall	Open Fractures	Close Fractures	ORIF	CR	PPI	Multiple Injuries	Isolated Fractures
4	67	67	67	75	48	27	55	73
3	13	10	12	10	13	33	16	7
2	12	11	10	10	22	0	10	10
1	8	12	11	5	17	40	19	10

### Radiographic Outcomes

Union was achieved in 91% of radius fractures and 94% of ulna fractures, with an average duration to union of 15.1 weeks for the radius and 16.5 weeks for the ulna. After closed fractures, union was more common than after open fractures. This disparity was most noticeable in radius fractures, where 14 percent of open fractures formed nonunions versus just 3% of closed fractures ( $p = 0.142$ ). In addition, open fractures of the radius took 17 percent

longer to heal than closed fractures ( $p = 0.035$ ), and open fractures of the ulna took 33 percent longer to heal ( $p = 0.014$ ). The method of therapy has little effect on the number of unions or the time it took for them to occur. The amount of forearm rotation lost was directly proportional to the loss of normal alignment, reaching a mean of 38 degrees when the combined malalignment of the radius and ulna exceeded thirty degrees ( $p = 0.06$ ) (Table 4).

**Table 4: Effect of Malalignment on Loss of Forearm Rotation**

N=100	Combined Malalignment (radius and ulna)	Mean Loss of Forearm Rotation
48	0-15	25
30	16-30	23
22	>30	38

Overall, 63 percent of patients had less than twenty degrees combined malalignment of the radius and ulna on the final radiographs, with no difference between those patients with open and those with closed fractures. The method of treatment, however, had a significant effect on the final radiographic

alignment: 80 percent of patients treated with ORIF had less than twenty-degrees combined malalignment of the radius and ulna on the final radiographs, a result seen in only 55 percent and 11 percent of patients treated with CR and PIP respectively (Table 5).

**Table 5: Radiographic Outcomes (Percent of patients achieving each radiographic rating)**

Rating	overall	Open fracture	Closed fracture	orif	CR	PIP	Multiple injuries
4	63	66	68	80	55	11	51
3	14	12	11	8	6	55	29
2	12	10	14	6	35	31	13
1	11	12	7	4	4	3	7

## Complications

Restoration of the radial bow is important to the functional outcome.<sup>7</sup> Failure to restore the radial bow to within 6% of the contralateral side results in a 21% loss of forearm rotation, as well as loss of grip strength. Complications of forearm fractures include the following:

Refracture after plate removal

Nonunion

Malunion

Infection

Neurovascular injury

Compartment syndrome

Radioulnarsynostosis<sup>8</sup>

The incidence of refracture of the forearm after plate removal is unknown but is reportedly 4-28%. Factors contributing to refracture include premature plate removal at less than 1 year, delayed union, nonunion, the use of 4.7-mm dynamic compression plates, and poor surgical technique. Plate removal can be considered when cortical remodeling under the plate is radiographically present, typically after 12 months. Forearm protection after plate removal is recommended for 6 weeks, and a return to sports or other activities is delayed for 2-3 months. Forearm plate removal is not without risk, including infection and nerve injury.<sup>9</sup> The incidence of these complications is 10-15%, and plate removal is not routinely recommended.

## Discussion

Because of the difficulties in achieving and sustaining anatomical reduction, full rotation of the forearm after fractures of the diaphyses of the adult radius and ulna is uncommon. While various medical options for these injuries have been proposed.[4-6,9,11-18] The results are difficult to analyze because of many fracture and treatment variables, lack of precise definitions, and pooling of results for fractures of both bones with those in which only one bone was fractured. Other studies

have reported rates of nonunion, malunion, and other complications comparable to those in this investigation.[18-23]

The present study adds outcome measures based on the patients' impressions of their results and their ability to return to work following injury. Hadden et al.[8] reported on 109 patients with fractures of the forearm, sixty-four of whom had fractures of both bones of the forearm; however, the outcome results were combined for all patients and were not stratified by the bone fractured, whether the fracture was open or closed, or the method of treatment. Fifty-five percent of patients with united fractures were pain free, 91 percent returned to the same occupation, and 3 percent were unable to work because of their forearm fracture. By comparison, 82 percent of patients in this study (85 percent of those treated with ORIF) were pain free at the time of their last evaluation. No patient in this series was unable to work because of his/her forearm fracture, and 91 percent of all patients (94 percent of those treated with ORIF) returned to the same work following injury. The inclusion of patient satisfaction and work status in the assessment of outcomes supplies information about the long term results of these fractures not previously available and permits counselling of patients as to the economic implications of their injuries. While some authors have stated that closed methods of treatment for displaced diaphyseal fractures of the radius, ulna, or both forearm bones produce unacceptable results.[4,6,19] Sarmiento et al.[15] reported excellent functional results after closed treatment in forty-three patients. Although ORIF improved the overall outcomes in our study, it is clear that the greatest advantage of ORIF over other methods of treatment was in minimizing malalignment of the forearm and the resulting loss of forearm rotation. The rotation lost following CR and PIP was nearly double that lost following ORIF.

Correspondingly, almost 80 percent of patients treated with ORIF had less than

twenty-degrees combined malalignment of the radius and ulna on the final radiographs, a result seen in only 55 percent and 11 percent of patients treated with CR and PIP respectively.

Although alignment of the radius and ulna has been measured by various methods[14,23-25], all studies, including this one, have shown that loss of normal alignment of the radius and ulna closely correlates with loss of pronation and supination.[4,14,23-25] Angular malalignment and the related loss of forearm rotation were the factors in this study most often associated with inability to return to the same work following injury. Although malalignment is measured radiographically, it is a major determinant of function following fractures of the forearm. The term "functional malunion" describes the upper limit of angular malalignment that was associated with return to the same work following injury. Patients in this study who had combined angular malalignment of the radius and ulna of less than forty degrees were limited in forearm rotation by no more than sixty degrees and usually returned to the same occupation. The rationale for defining malunion in terms of function is to provide an outcome-based application of a radiographic finding. Except for a longer time to union and a higher infection rate, the results of treatment for open and closed fractures were very similar. The infection rate in this study was comparable to that reported by others.[6,26] the incidence of transient nerve palsies was unaffected by the presence of an open injury, although we expected more frequent nerve injury following open fractures because of more extensive soft tissue injuries. The 42 percent of patients in this series who sustained multiple trauma is similar to the 40 percent incidence reported by Chapman et al.[6] Patients in this series with other injuries lost more forearm rotation, and therefore had poorer end result ratings, than patients with isolated forearm fractures. The greater loss of forearm rotation resulted

largely from more frequent synostoses in polytraumatized patients-(11.5 percent) compared to those patients with isolated fractures (3.7 percent). Interestingly, all five synostoses in patients with multiple trauma occurred in the setting of closed head injuries. The formation of ectopic bone following forearm fractures in patients with closed head injuries has been well documented. [21,27,28]

### Conclusion:

The present study concluded that the results of open and closed fractures were somewhat similar, with the exception of a longer period to union and a higher infection risk. A weakened end outcome was strongly predicted by the occurrence of subsequent casualties.

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