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FRACTURES OF THE RADIUS AND ULNA IN ADULTS: AN ANALYSIS OF FACTORS AFFECTING OUTCOME

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Abstract:

Concurrent data were collected by the authors for fractures of the shafts of the radius and ulna in 90 adult patients to determine the relationship of subjective, objective, radiographic and economic outcome parameters to the method of treatment, type of fracture (open or closed), degree of commination and the presence of other injuries .Patients treated by open reduction and internal fixation (ORIF) with plate fixation had less pain, lost less forearm rotation and returned to the same work following injury more frequently than those treated by closed reduction and casting (CR) or pins-in-plaster (PIP). The greatest advantages of ORIF over other treatment methods were improved skeletal alignment and forearm rotation, the factors most often associated with return to the same work following injury.

Except for a longer time to union and a higher rate of infection, the outcomes of open and closed fractures were very similar. The presence of other injuries was a strong predictor of a compromised end result, primarily because of more pain, greater loss of forearm rotation, and less frequent return to the same work.

The inclusion of patient satisfaction and work status in the assessment of outcomes and the concept of "functional malunion", an outcome-based interpretation of a radiographic finding, should help in counselling patients as to the likely economic and functional impacts of these injuries.

Keywords: Fracture radius, ulna, factors affecting, outcome

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Introduction

Union with restoration of normal anatomy is particularly critical to achieve an optimal outcome for diaphyseal fractures of the shafts of the radius and ulna in adults. These goals have most often been met by open reduction and plate fixation.[1,2,3] In previous studies, however, outcome measures other than union have received scant attention[4-6], and the inclusion of fractures of a single bone with fractures of both bones has made interpretation of results difficult. The purpose of this study was to determine the relationship of outcome to the method of treatment, type of fracture (open or closed), and presence of associated injuries in adults who sustained fractures of the shafts of both bones of the forearm. The outcome measures investigated were patient satisfaction (amount of pain), forearm rotation, radiographic findings, and work status[7-10]

Rating	subjective	Objective	Radiographic
4	No pain	Combined loss of forearm rotation <300	Fracture united. combined malalignment (radius and ulna) <20o
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

Materials and Methods

Criteria for inclusion in this study were skeletally mature patients with fractures of the shafts of both the radius and ulna treated at the A.C.P.M medical College Hospital. All patients were evaluated by one of the authors (n=90). Complete data were available for 76 patients who had sustained (n=90) diaphyseal fractures of both the radius and ulna. Data collection and radiographic measurements were standardized for all patients.

All patients were followed at least until bone union occurred or the diagnosis of nonunion was made. The mean follow-up was thirty months (range three to 60 months). (n=55) patients were male and (n=35) female, with an average age of twenty-seventy years average (45 years)Inforty eight(n=48) patients, the fracture involved the dominant limb. Forty two (n=42) of the fractures were (n=26) open and sixty-four(64) were closed.

Mode of trauma in maximum cases (34) was due to road accidents, fall from height in 19 patients, Industrial accidents in 16 cases, Domestic Accident in 16 cases, direct blow in 3 cases and trivial trauma in 2 cases.

The grade of soft tissue injury associated with open fractures was not recorded since many of these injuries preceded the advent of the rating system of Gustillo and Anderson[11]. Three methods of treatment were utilized: open reduction and internal fixation (ORIF), closed reduction with square nailing. 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 I.V.R.A. The definitive treatment was ORIF in 45 forearms, CRIF (closed reduction) in 45 patients

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[12]. End result ratings were made on a 14 point scale in four categories:

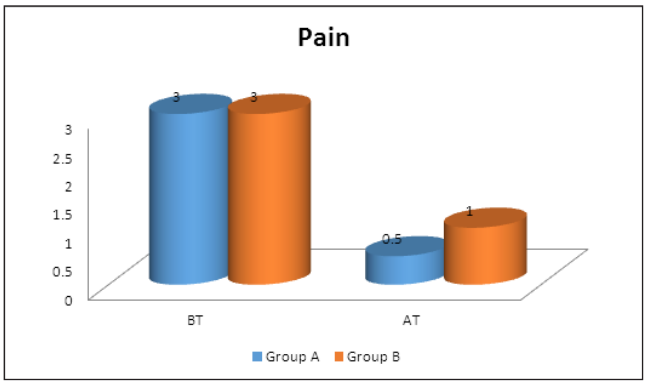
(a) subjective, according the level of pain in the injured limb;
(b) objective, by the range of forearm rotation;
(c) radiographic, utilizing the criteria of union, synostosis, and malunion;

Subjective Outcomes

Overall, 80 percent of patients reported no pain, with no difference between patients with open and those with closed fractures. While 82 percent of patients treated with ORIF were pain free at their last examination, only62 percent treated with CR and 54 percent treated with PIP were painless. Patients with isolated fractures were more often pain free than were those with associated injuries (Table 2).

	BT	AT				
Plating	3	0.5	-4.028a	0.000	82.8	Significant
Nailing	3	1	-3.992a	0.000	66.7	Significant

Since the observations are on ordinal scale, we have used Wilcoxon Signed Rank test to test the effect in Group A and Group B. From above table we can observe that P-Values for both the groups are less than 0.05 hence we conclude that the effect observed in both groups are significant. Further we can observe that, effect observed in Group A was 82.8% while effect observed in Group B was 66.7%.



Objective Outcomes

No patient had significant loss of wrist or elbow motion compared to the uninjured side. The average total decrease in forearm rotation, however, was twenty nine degrees, with loss of slightly more supination than pronation. There was no significant difference in the loss of forearm rotation between closed and open fractures: 63 percent of each group lost less than thirty degrees of forearm rotation .The method of treatment had a significant effect-on the loss of forearm rotation. Seventy-three percent of patients treated with ORIF lost less than thirty degrees of forearm rotation, while only 50 percent treated by CR and 23 percent by PIP lost less than thirty degrees.

Patients with multiple injuries lost more forearm rotationthan did those with isolated fractures (Table 3).

Objective Outcomes

Rating	Overall	Open Fractures	Close Fractures	Orif	Crif	Multiple Injuries	Isolated Fractures
4	62	10	63	64	46	34	70
3	12	6	14	16	24	29	9
2	10	2	7	5	10	14	9
1	6	-	6	5	10	13	2

Radiographic Outcomes

Union occurred in 93 percent of radius fractures and 97 percent of ulna fractures, with an average time tounion of 17.7 weeks for the radius and 18.3 weeks for the ulna. Union was more frequent after closed than after open fractures. This difference was most apparent in radiusfractures where 11 percent of open fractures developed nonunions, compared to only 4 percent of closed injuries ($p = 0.171$). Also, the average time to union was 18percent longer for open than for closed fractures of the radius ($p = 0.027$), and 32 percent longer for open fractures of the ulna ($p = 0.012$). 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 forty-three degrees when the combined malalignment of the radius and ulna exceeded thirty degrees ($p = 0.06$) (Table 4).

Rating	overall	Open fracture	Closed fracture	orif	CR	PIP	Multiple injuries
4	62	64	66	80	52	8	46
3	12	12	10	8	16	30	24
2	12	8	12	6	52	16	10
1	4	11	6	4	6	12	10

Table 4 Effect of Malalignment on Loss of Forearm Rotation

n	Combined Malalignment (radius and ulna)	Mean Loss of Forearm Rotation
54	0-15	26
26	16-30	24
20	>30	40

Complications

Restoration of the radial bow is important to the functional outcome.[4] Failure to restore the radial bow to within 5% of the contralateral side results in a 20% 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[5]

The incidence of refracture of the forearm after plate removal is unknown but is reportedly 4-25%. Factors contributing to refracture include premature plate removal at less than 1 year, delayed union, nonunion, the use of 4.5-mm dynamic compression plates, and poor surgical technique. Plate removal can be considered when cortical remodeling under the plate is radiographically present, typically after 18 months. Forearm protection after plate removal is recommended for 6 weeks, and a return to sports or other activities is delayed for 3-4 months.

Forearm plate removal is not without risk, including infection and nerve injury.[6]The incidence of these complications is 10-20%, and plate removal is not routinely recommended.

Since the use of compression plating became a standard treatment, malunion and nonunion of forearm fractures have been occurring less commonly. With proper technique and a compliant patient, the nonunion rate is approximately 2%.

Discussion

The present study deals with 90 cases of mid shaft of radius ulna fractures. The randomization of cases done according to which unit patient gets admitted. The operative method included in this comparative study was dynamic compression plating (3.5mm DCP) and intramedullary nailing by Talwalkar radius and ulna nail. The highest age incidence was found in the age group of 21 to 40 years and more common in males as compared to females. Right side forearm is more involved than the left as right side dominance is more as compared to left. Transverse and oblique fractures were more common (total 86%) and middle third level was more common in about 56.66% of cases.

In this study vehicular accident and fall from height contribute to maximum number of cases (26). There were four compound fractures (upto Grade II compound) in this study, which were treated with debridement, antibiotics and wound was healed with primary intention. Vehicular accidents were having more associated injuries[1-3,13-15] and managed appropriately. In this comparative study of 90 cases of fractures of both radius and ulna plating versus nailing excellent results in plating were 80.6% as compared to nailing which was 73.32%. The results were evaluated on the basis of Anderson's functional scoring system. The main stress was given on the two movement pronation and supination. Unsatisfactory results were more in nailing (20%) as compared to plating (13.3%).

In complications, superficial infection rate was more in plating (3 cases) nailing. Out of 3 cases at superficial infection 2 cases were primarily compound (one Grade I and another Grade II) fracture[16-18]. Superficial infection was by debridement and appropriate antibiotics, none of the patients required implant removal. There were five cases of delayed union in which plating (2) and nailing (3). One case of plating and one case of nailing had compound fracture with comminution on admission. Delayed union cases of nailing were treated with bone grafting, immobilization in slab for few weeks and they finally unite at the end of 6 to 7 months. The delayed union cases of plating united without a bone graft. One case of nailing was declared non union which was primarily compound comminuted fracture of ulna[19-20].

Thus, the complication rate was less in plating (13.33%) as compared to nailing which was (26.66%).The average period for immobilization was less in plating (2-4 weeks) as compared to nailing (4-6weeks).In this study we have prospectively collected data on patients randomized by unit

system to treatment by plating or nailing.

As the number of cases and duration of study was small no statistical significance was found ($p>0.05$)

After a successful closed nailing, the soft tissue envelope around the fracture is well preserved, with good blood supply to the bone ends.

Biologically, due to undisturbed soft tissues and hence the periosteal blood supply, the fracture healing is rapid, in a successful closed IM nailing.[7] If an open nailing is needed, then it would be little slow and after a plate fixation, it would be still slow due to some soft tissue disturbance. However, due to absolute stability achieved after a plate fixation, it is possible to use the forearm for some light activities (Except a Monteggia or a Galeazzi injury, where external immobilization is required for the adjacent joint injury).

The nail is straight and an elastic implant, often taking the shape of the bone, in which it is inserted. In the fracture of upper/3 of radius, often the straight nail reduces the lateral radial bow.[8] However, in clinical appearance and in the final range of motion, this is not noticeable.

Conclusion:

For this series of 90 adult patients, the end results following treatment of fractures of the shafts of the radius and ulna were good to excellent regardless of the method of treatment chosen. Except for a longer time to union and a higher infection rate, the outcomes of open and closed fractures were very similar. The presence of associated injuries was a strong predictor of a compromised end result. These patients had more pain, greater loss of forearm rotation, and longer times to 18 The Iowa Orthopaedic Journal Fractures of the Radius and Ulna in Adults union. Treatment with ORIF resulted in better out comes than treatment with either CR or PIP, largely because ORIF minimized malalignment and the resulting loss of forearm rotation.[9] These two factors were closely associated with the inability to return to the same work following injury.

The addition of patient satisfaction and work status to the assessment of outcomes following fractures of the shafts of the radius and ulna in adults supplies previously unavailable information about the long term results of these injuries[10]. The concept of "functional malunion"[11] provides an outcome-based interpretation of a radiographic finding that more closely associates the radiographic alignment of the forearm with expected functional limitations.

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