e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13(6); 317-321

Original Research Article

Determine the Relationship of the Subjective, Objective and Radiographic Method of Treatment: A Retrospective Study

Mukesh Kumar

Assistant Professor, Department of Orthopaedics, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India

Received: 04-04-2023 / Revised 27-05-2023 / Accepted 24-06-2023
Corresponding author: Dr. Mukesh Kumar
Conflict of interest: Nil

Abstract:

Aim and Objective: The aim of the study was to determine relationship of the subjective, objective and radiographic method of treatment.

Material and Methods: A prospective study was conducted in the Department of orthopaedics for the period of 12 Months. 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.

Results: Union occurred in 92 percent of radius fractures and 95 percent of ulna fractures, with an average time to union of 15.4 weeks for the radius and 16.8 weeks for the ulna. Union was more frequent after closed than after open fractures. This difference was most apparent in radius fractures where 13 percent of open fractures developed nonunions, compared to only 3 percent of closed injuries ($p = 0.140$). Also, the average time to union was 16 percent longer for open than for closed fractures of the radius ($p = 0.022$), and 35 percent longer for open fractures of the ulna ($p = 0.010$). 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 39 degrees when the combined malalignment of the radius and ulna exceeded thirty degrees ($p = 0.07$).

Conclusion: For this series of 120 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.

Keywords: Fracture Radius, Ulna, Factors Affecting, Outcome.

Introduction

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. Open wounds along with neurovascular deficit is not uncommon. Both conservative and surgical approaches are being used depending upon the level and displacement of fractures. Although the incidence of the fractures of the forearm is generally low in adults, these fractures could result in considerable disability if the native forearm geometry is not restored [1-3]. Conservative approach is less frequently used as it is difficult to maintain reduction with forearm shaft fractures having rotatory as well as angular motions. Also, it is most commonly associated with cast complications, non-union, malunion, compartment syndrome and Volksmann ischaemic contracture. Hence, surgical approach is the preferred option with final decision resting upon the treating doctor. 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 [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.

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 [10-13].

Material and Methods

A prospective study was conducted in the Department of orthopaedics Lord Buddha Koshi Medical College and Hospital, Saharsa,Bihar, India for the period of 12 Months. After taking informed consent detailed history was taken from the patient or the relatives if the patient was not in good condition. The technique, risks, benefits, results and associated complications of the procedure were discussed with all patients. All patients were followed at least until bone union occurred or the diagnosis of non union was made. The mean follow-up was 6 months (range 2 to 6 months). 80 patients were male and 40 female, with an average age of 30 years (range 18 to 64 years). In 40 patients, the fracture involved the dominant limb. 40 of the fractures were open and 80 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 80 forearms, CR in 24, and PIP in 16 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. Non union 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[14]. 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).

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 malalign-ment 21-400
2	Moderate pain present with routine activities	Combined loss of forearm rotation 61-900	Union, with combined malalign-ment >400
1	Severe pain pre-vent routine activities	Combined loss of forearm rotation>900	Nonunion, synostosis or osteo-myelitis

Statistical analysis of the data was performed using the two-sided Fishers' exact test to analyze the association of two non-ordinal categorical variables. To analyze the association of a continuous ordinal variable and a categorical variable, the Kruskal-Wallis Test was used. Statistical significance was defined as $p < 0.05$. Values for p were calculated for each association tested; numerical values of p for associations that did not reach statistical significance were reported only for selected associations.

Results

Subjective Outcomes Overall, 80 percent of patients reported no pain, with no difference between patients with open and those with closed fractures. While 84 percent of patients treated with ORIF were pain free at their last examination, only 59 percent treated with CR and 52 percent treated with PIP were painless. Patients with isolated fractures were more often pain free than were those with associated injuries (Table 2).

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

Rating	Overall	Open Frac-tures	Close Frac-tures	OR-IF	CR	PPI	Multiple Injuries	Isolated Fractures
4	80	79	79	84	59	52	74	84
3	15	17	15	12	36	**44**	24	15
2	5	4	6	4	5	4	4	1
1	0	-	0	0	0	0	0	0

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 less than 30 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: 65 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. 76 percent of patients treated with ORIF lost less than thirty degrees of forearm rotation, while only 49 percent treated by CR and 25 percent by PIP lost less than thirty degrees. Patients with multiple 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	65	65	64	76	49	25	54	74
3	15	10	12	9	14	**34**	15	8
2	11	11	10	9	20	0	11	9
1	9	14	14	6	17	41	20	9

Radiographic Outcomes Union occurred in 92 percent of radius fractures and 95 percent of ulna fractures, with an average time to union of 15.4 weeks for the radius and 16.8 weeks for the ulna. Union was more frequent after closed than after open fractures. This difference was most apparent in radius fractures where 13 percent of open fractures developed nonunions, compared to only 3 percent of closed injuries ($p = 0.140$). Also, the average time to union was 16 percent longer for open than for closed fractures of the radius ($p = 0.022$), and 35 percent longer for open fractures of the ulna ($p = 0.010$). 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 39 degrees when the combined malalignment of the radius and ulna exceeded thirty degrees ($p = 0.07$) (Table 4).

Table 4 Effect of Malalignment on Loss of Forearm Rotation

N=120	Combined Malalignment (radius and ulna)	Mean Loss of Forearm Rotation
58	0-15	24
34	16-30	22
28	>30	39

Overall, 64 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: 81 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 54 percent and 10 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	64	65	67	82	54	10	49
3	13	14	12	7	5	54	30
2	13	10	13	6	39	34	12
1	10	11	8	5	2	2	9

Discussion

Full rotation of the forearm following fractures of the diaphyses of the adult radius and ulna is infrequent because of the difficulty in obtaining and maintaining anatomical reduction. Although numerous methods of treatment have been described for these injuries [4-6,9,14-21] 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 [4-5,7,10-11,13,21-23].

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, 80 percent of patients in this study (84 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 95 percent of all patients (97 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 [4,6,10]. Sarmiento et al. [18] 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 81 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 54 percent and 10 percent of patients treated with CR and PIP respectively. Although alignment of the radius and ulna has been measured by various methods [4,14,17,23-25], 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 [4,17,23-25]. 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 [6,10-12,19,22]. 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 44 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-(11.3 percent) compared to those patients with isolated fractures (3.5 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 [4,13,26-27].

Conclusion:

The treatment of fractures of the shafts of the radius and ulna resulted in satisfactory to outstanding outcomes in this study of 120 adult patients. The results of open and closed fractures were almost identical, other from a longer time to union and a greater prevalence of infection. As a consequence, the occurrence of other injuries was an important factor in the outcome.

Reference

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37 (8): 691-697.
2. Kasten P, Krefft M, Hesselbach J, Weinberg AM. How does torsional deformity of the radial shaft influence the rotation of the forearm? A biomechanical study. J Orthop Trauma. 20 03;17(1):57-60.
3. Tynan MC, Fornalski S, McMahon PJ, Utkan A, Green SA, Lee TQ. The effects of ulnar axial malalignment on supination and pronation. J Bone Joint Surg Am. 2000;82-A(12):1726-1731.
4. Anderson, L. D.; Sisk, T. D.; Tooms, R. E.; and Park III, W. I.: Compression plate fixation in acute diaphyseal fractures of the radius and ulna. J. Bone and Joint Surg., 1975. 57-A:287-297.
5. Burweli, H. N., and Charnley, A. D.: Treatment of forearm fractures in adults with particular reference to plate fixation. J. Bone and

Joint Surg., 1964. 46- B:404-424.
6. Chapman, M. W.; Gordon, J. E.; and Zissimos, A. G.: Compression plate fixation of acute fractures of the diaphyses of the radius and ulna. J. Bone and Joint Surg., 1989. 71-A:159-169.
7. Grace, T. G., and Eversmann, W. W.: Forearm fractures: treatment by rigid fixation with early motion.J. Bone andJoint Surg., 1980. 62-A: 43 3-438.
8. Hadden, W. A.; Reschauer, R.; and Seggl, W.: Results ofAO plate fixation offorearm shaft fractures in adults. Injury, 1983. 15:44-52.
9. Lyritis, G.; loannidis, T.; and Hartofylakidis-Garofalidis, G.: The influence of timing and rigidity of internal fixation on bony union of fractures of the forearm. Injury, 1983. 15:53-56.
10. Moed, B. R.; Keliam, J. F.; Foster, R. J.; Tile, M.; and Hansen, S.: Immediate internal fixation of open fractures of the diaphysis of the forearm.J. Bone andJointSurg, 1986. 68-A:10 08-1017.
11. Rosacker, J. A., and Kopta, J. A.: Both bone fractures of the forearm: a review of surgical variables associated with union. Orthopaedics, 1981. 4:1353- 1356.
12. Stern, P. J., and Drury, W. J.: Complication of plate fixation of forearm fractures. Clin. Orthop., 1983. 175:25-29.
13. Teipner, W. A., and Mast, J. W.: Internal fixation of forearm diaphyseal fractures: double plating versus single compression plating-a comparative study. Orthop. Clin. North America, 1980.11:381-391.
14. Sage, F. P.: Medullary fixation of forearm fractures. J. Bone andJoint Surg., 1959. 41-A:148 9-1516.
15. Evans, E. M.: Fractures of the radius and ulna. J. Bone andJoint Surg., 1951. 33-B:548-561
16. Knight, R. A., and Purvis, G. D.: Fractures of both bones of the forearm in adults.J. Bone andJoint Surg., 1949. 31-A:755-764.
17. Matthews, L S.; Kaufer, H.; Garver, D. F.; and Sonstegard, D. A.: The effect of supination-pronation on angular malalignment of fractures of both bones of the forearm. J. Bone and Joint Surg., 1982. 64-A14-17.
18. Sarmiento, A.; Cooper, J. S.; and Sinclair, W. F.: Forearm fractures: early functional bracing-A preliminary report.J. Bone andJoint Surg., 1975. 57- A:297-304.
19. Shang, T.; Gu, Y.; and Dong, F.: Treatment of forearm fractures by an integrated method of traditional Chinese and Western medicine. Clin. Orthop., 1987. 215:56-64.
20. Smith, J. E.: Internal fixation in the treatment of fractures of the shafts ofthe radius and ulna in adults. J. Bone andJoint Surg., 1959. 41-B: 122-131.
21. Street, D. M.: Intramedullary forearm nailing. Clin. Orthop., 1986. 212:219-230.
22. Grace, T. G., and Eversmann, W. W.: The management of segmental bone loss associated with forearm fractures.J. Bone andJoint Surg., 1980.62-AA1150- 1155
23. Schemitsch, E. H., and Richards, R. R.: The effect of malunion on functional outcome after plate fixation of fractures of both bones of the forearm in adults.J. Bone andJoint Surg., 1992. 74-A.:1069-1078.
24. Sarmiento, A.; Ebramzadeh, E.; Brys, D.; and Tarr, R. R.: Angular deformities and forearm function. J. Orthop. Res., 1992. 10:121-133.
25. Tarr, R. R.; Garfinkel, A. I.; and Sarmiento, A.: The effects of angular and rotational deformities of both bones of the forearm. J. Bone and Joint Surg., 1984. 66-A.:65-70.
26. Gustillo, R. B., and Anderson, J. T.: Prevention of infection in the treatment of one thousand twentyfive open fractures of long bones: Retrospective and prospective analyses. J. Bone and Joint Surg., 1976. 58-A.-453-458.
27. Vince, K. G., and Milier, J. E.: Cross-union complicating fracture of the forearm. J. Bone and Joint Surg., 1987. 69-A.640-653.