

Original Research Article

A PROSPECTIVE STUDY OF THE FUNCTIONAL OUTCOME IN SURGICAL MANAGEMENT OF MALUNITED DISTAL RADIUS FRACTURES

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ABSTRACT

Background: To evaluate radiological and functional outcome of malunited distal radial fractures treated with iliac crest bone graft and Volar plating with or without K- wires.

Materials and Methods: This is a prospective study conducted on twenty adult patients with distal radial fractures treated at Department of Orthopaedics, Rangaraya Medical College, Kakinada between September 2021 to August 2023.

Results: The study included twenty cases of malunited distal radius fractures in adults treated with osteotomy, ipsilateral tri cortical iliac crest bone grafting, and volar Ellis plating over a 12- to 18-month period. Right side (dominant wrist) was involved in 12 (60%) patients and the left side involved in 8(40%) patients. In the present study 13 (65%) patients had union within 2-3 months and 7(35%) patients had union in 3-4months There were no cases of delayed union or non –union. Mean preop DASH score – Mean postop DASH score >25 Excellent Mean preop DASH score–Mean postop DASH score 16-25 good Mean preop DASH score–Mean postop DASH score 6-15 fair Mean preop DASH score–Mean postop DASH score ≤5 poor.

Osteotomy, ipsilateral iliac crest bone grafting and volar Ellis plating demonstrates good reproducible outcomes with minimal risk in appropriately selected cases of Malunion. This technique can provide adequate restoration of normal anatomy and soft tissue and vascular preservation, in addition to minimal patient morbidity, which may facilitate a more rapid return to function.

Conclusion: We can conclude that osteotomy, tricortical iliac crest bone grafting, and volar Ellis plating are a simple, reliable, and effective method for restoring normal distal radius radiological parameters, particularly in young adults. Functional end results have a direct relationship with anatomical end results, especially in young adults, though good functional results can be obtained even when anatomical results are poor in elderly people due to innate mobility of the wrist joint.

Keywords: Osteotomy, Distal radial fractures, DASH score, volar Ellis plating.

INTRODUCTION

A distal radius fracture continues to spark a lot of discussion and curiosity. One sixth of all fractures seen in emergency rooms are caused by this injury, which is frequently seen. There is a bimodal distribution of distal radius fractures where high-energy fractures occur in younger persons (predominately male) and high and low-energy

fractures occur in older persons (predominately female).^[2,3]

The traditional conservative treatment of distal radial fractures is being increasingly replaced by various forms of surgical stabilization.⁴ Despite improvements in treatment since the early 1980s, malunion remains a common cause of residual disability after distal radial fractures.

Fracture characteristics and initial treatment contribute to the development of a malunion.

Malunion can be caused by failure to achieve or maintain an accurate reduction or by inadequate duration or type of immobilization. Malunions of the distal radius may be associated with extra articular deformities, intra articular malalignment, distal radioulnar joint incongruity or instability, or a combination of these features. Extra articular deformities include shortening and excessive dorsal or volar tilt of the distal radial articular surface. Significant articular incongruity and radial shortening are more consistently correlated with the development of symptoms.

Upon clinical assessment, Patients with distal radial malunions commonly complain of pain, stiffness, weakness, and cosmetic deformity. The distal radioulnar joint, the radio carpal joint, or both may be the site of pain.

Various methods of management of distal radius Malunions include simultaneous radial closing wedge and ulnar shortening osteotomies, fixed angle volar plating and Low-profile dorsal plating for dorsally angulated distal radius fractures. Open wedge osteotomy with plate fixation is regarded as standard procedure for the commonly dorsally displaced colles fracture.

In our institute we managed selective distal radius malunions by osteotomy, Iliac crest bone grafting and volar plating.

I have selected this topic a sitisa less explored subject. In this study the surgical details and the results were discussed.

Aims and Objectives

In a selected number of 20 patients

1. To evaluate radiological and functional outcome of malunited distal radial fractures treated with iliac crest bone graft and Volar plating with or without K- wires.
2. To monitor the progress of patient and recovery during a 6-month post-surgical period.

MATERIAL AND METHODS

This is a prospective study conducted on twenty adult patients with distal radial fractures treated at Department of Orthopaedics, Rangaraya Medical College, Kakinada between September 2021 to August 2023.

Inclusion Criteria

1. Bothmalesand females
2. Patients with closed fractures treated conservatively
3. Simpleextra-articular malunions
4. Stable DRUJ
5. Un resolving wrist pain

Exclusion Criteria

1. Intra-articular malunions
2. Post traumatic arthritis of Radiocarpal and Radioulnar joints.
3. Compound fractures previously
4. Unstable DRUJ
5. Distal radial fractures treated surgically.

6. Pathological fractures.

Between the ages of 22 and 70, there were 14 (70%) males and 6 (30%) females. 12 (60%) patients were involved on the right side (dominant wrist), while 8 (40%) were involved on the left side. All patients chosen for the study were admitted and examined in accordance with the protocol.

Injury occurred in 14 (70%) of the 20 cases due to a fall on the outstretched hand and in 6 (30%) patients due to a road traffic accident. Patients had a tibia shaft fracture, a femur shaft clavicle fracture, and trochanteric fractures. There was no involvement of the median nerve or tendon injuries in any of the patients.

RESULTS

The present study consists of 20 cases of Malunited distal radius treated at Rangaraya medical college, Kakinada between September 2021 to August 2023. All cases were Extra articular distal radial fractures with dorsal displacement. All cases were followed up periodically during the Period 2021 to 2023. The following are the observations made and the available data are analyzed as follows.

AGE INCIDENCE

In this series,3(15%) between 31-40 Years,7(45%) between 41-50 Years, 5 (30%) between 51-60 yrs, and 2(10%) patients were between 61-70 years. The mean age of the females treated was 51years. [Table 1]

SEX INCIDENCE

Out of 20 patients,14(70%) were male and 6(30%) were females, showing a male preponderance. [Table 2]

SIDE OF INVOLVEMENT

Right side (dominant wrist) was involved in 12 (60%) patients and the left side involved in 8(40%) patients. [Table 3]

MODE OF INJURY

Most common mode of injury is fall on out stretched and in 14(70%) and Road traffic accident in 6 (30%) patients. [Table 4]

OCCUPATION

In present study the most commonly injured are manual labourers (55%). [Table 5]

DURATION OF OPERATION FROM DATE OF INJURY

Surgery was done between2-6 months from the day of injury in 20(100%) patients as an elective procedure. [Table 6]

DURATION OF FRACTURE UNION

In the present study 13 (65%) patients had union within 2-3 months and 7(35%) patients had union in 3-4monthsThere were no cases of delayed union or non -union. [Table 7]

1(60%) patients had persistent postoperative pain. 2(20%) had stiffness of radiocarpal joint. 1 patient (10%) had a superficial wound infection and1 (10%) screw loosening. None of the patients had median nerve injury. [Table 8]

EVALUATION OF RESULTS

The assessment of results were made using the DASH score system.

Mean preop DASH score – Mean postop DASH score >25 Excellent Mean preop DASH score–Mean

postop DASH score 16-25 good Mean preop DASH score–Mean postop DASH score 6-15 fair Mean preop DASH score–Mean postop DASH score ≤5 poor in present series had 30% excellent, 60% good, 10% fair and 0% poor result. [Table 9]

Table 1: Age Incidence

Age in years	No. of cases	Percentage
31–40	3	15
41–50	9	45
51–60	6	30
61-70	2	10

Table 2: Sex Incidence

Sex	No. of Cases	Percentage
Male	14	70
Female	6	30

Table 3: Side of Involvement

Side	No. of Cases	Percentage
Right	12	60
Left	8	40

Table 4: Mode of Injury

Table 5: Occupation

OCCUPATION	NUMBER	PERCENTAGE
Manual labourer	14	70%
House wife	6	30%

Table 6: Duration of Operation from Date of Injury

Duration	No. of Cases	Percentage
2-6 MONTHS	20	100

Table 7: Duration of Fracture Union

Time of Union	No. of Cases	Percentage
2-3 Months	13	65
3-4 Months	7	35

Table 8: Complications

Complications	No. of Cases	Percentage
Persistent pain	6	60
Stiffness of radio carpal joint	2	20
Superficial infection	1	10
Screw loosening	1	10

Table 9: Average Gain in Dash Score

Results	No. of Cases	Percentage
Excellent	6	30
Good	12	60
Fair	2	10
Poor	0	0

DISCUSSION

Pain, mid carpal instability, post-traumatic arthritis, and decreased range of motion are all symptoms of malunited distal radial fractures.

The degree of disability following a distal radius malunited fracture has been shown to correlate with the amount of residual deformity. Persistent wrist pain is associated with permanent loss of the palmar angle and radial shortening of the distal radius.

In 2007 Lubahn JD, Hood J M, Nechleba J, Williams DP, Green T,^[5] treated Dorsal Malunions of Distal Radius in 20 Patients by Distraction Osteogenesis using a Non Bridging External Fixator. They reported 2 Non unions in their study with 10 % incidence. The present study involved iliac Bone graft as the Primary mode of treatment with Osteotomy.

M. Henry,^[4] used Osteotomy, Cancellous Iliac Crest Bone Graft, and Fixed angle Volar Plates to treat Dorsal Malunions of the Distal Radius in 19 patients in 2007.

McQueen MM1, Wakefield A,^[6] used a non-bridging external fixator and bonegrafting to treat Dorsal Malunions of the Distal Radius in 23 patients in 2008. Abramo A1, Geijer M, Kopylov P, Tägil M,^[7] A treated Dorsal Malunions of the Distal Radius in 15 Patients with Osteotomy and Biphasic Bone Substitute in 2010.

The current study involved a biological iliac bone graft with osteotomy.

In 2010, John T. Capo, MD et al,^[8] treated Dorsal Malunions of the Distal Radius in 13 patients using osteotomy, bone grafting, and an intra medullary micro nail Distal Radial system with three fixed distal locking screws and two proximal nonlocking bolts.

Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoan U,^[9] treated Dorsal Malunions of the Distal Radius in 2011 using Osteotomy, Cancellous Bone Graft placement, and Fixed angle Volar plating. However, their sample size was only 17, whereas the current study has a sample size of 20.

Mean age of the present study is 44.9 years. M. Henry,^[4] reported a mean age of 50 years with a sample size of 19 patients. McQueen MM1, Wakefield A³⁹ reported a sample size of 23 patients with a mean age of 60 years. In their study of 15 patients, Abramo A1, Geijer M, Kopylov P, Tägil M¹³ reported a mean age of 52 years.

Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoan U,^[9] found that the average age of their 17 patients was 41 years. In 13 patients, John T. Capo, MD et al⁴⁰ reported a mean age of 51 years. This implies that the current study included a younger age group. This could be because the working environment has uneven surfaces, and the majority of the patients are constructive workers and day labourers.

SEX DISTRIBUTION

The current study had a male preponderance, with 60% male patients and 40% female patients, and it is comparable to the following study, which is listed in the table above.

Males outnumbered females in Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, and Ozdoan U.^[9] A. Males have a higher rate of distal radius malunion than females. This is similar to the current study, which implicates the working group, namely males, as being prone to FOOSH at their workplace.

INVOLVED SIDE

In the current study, the right side (dominant wrist) was involved in 12 (60%) of the cases. Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoan U.^[9] A reported Dominant wrist involvement in 8 (47%). This reflects the dominant and, which was preferred for projection during the mechanism of injury.

60% of the patients in this study were manual labourers. This reflects the need to correct the distal radius malunion because they work to support the family. They sought treatment because of the restricted joint movement caused by malunion. These movements are required for their day-to-day labour work

MEAN TIME FROM FRACTURE TO OSTEOTOMY

The mean time from the time of fracture to osteotomy in [Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U.](#)^[9] study was 4.4 months. The mean time from fracture to osteotomy in the present study is 4.5 months.

VARIOUS MODES OF FIXATION FOLLOWED BY DIFFERENT AUTHORS

Lubahn JD, Hood JM, Nechleba J, Williams DP, Green Tusedanon-bridging external fixator to treat dorsal malunions. ⁸ He made no use of a bone graft. M. Henry performed osteotomy with fixed angle volar plates and an Iliac crest bone graft.^[4]

Mc Queen MM 1, Wakefield used anon-bridging external fixator and bone grafting to treat malunions. Abramo A1, Geijer M, Kopylov P, Tägil M used Biphasic bone substitute containing Calcium Phosphate and Calcium Sulphate for osteotomy.

In 5 of the 13 patients, John T. Capo, MD et al⁸ performed osteotomy and used Cortico-cancellous iliac crest bone grafts. Local cancellous bone grafts were performed on six patients. Two patients were given calcium sulphate bone substitutes.

[Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U.](#)^[9] A treated Dorsal malunions with osteotomy, placement of cancellous bone grafts and fixed angle volar plating.

The present study treated dorsal malunions of distal radius through a volar approach, did osteotomy at the site of malunion. An iliac crest bone graft taken from ipsilateral side. Ellis plates and K-wires are used for positioning and holding of the bone graft.

MEAN DURATION OF HEALING

Average duration of healing is approximately 12 weeks in studies conducted by M. Henry^[38] and [Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U.](#)^[9] The present study is similar to the above studies. John T. Capo, MD et al,^[8] had a mean duration of 11 weeks for healing, as he used an intramedullary micro nail and bone grafting which was more biological. Hence they took the advantage of minimally invasive technique of osteo synthesis achieving union in less amount of time.

POST OPERATIVE RANGE OF MOVEMENTS

M. Henry,^[4] used osteotomy, an Iliac crest bone graft, and a fixed angle volar plate to treat Dorsal Malunions and achieve a wrist arc of 120 degrees. With his technique of Osteotomy, Bone Grafting, and Distal Radius Micro Nail System, John T. Capo, MD et al,^[8] achieved an Arc of Wrist Motion of 122 degrees. The Arc of wrist motion achieved in the current study with Osteotomy, iliac crest bone grafting, and Volar Ellis plating was 122.75 degrees. As a result, the current study is closely related to the previous studies in terms of achieving the Arc of wrist motion.

M. Henry,^[4] achieved 158 degree forearm rotation after treating Dorsal Malunions with Osteotomy, Iliac Crest Bone Graft, and fixed angle volar plate. John T. Capo, MD et al,^[8] achieved a forearm rotation of 169 degrees using his technique of osteotomy, bone

grafting, and distal radius micro nail system. The forearm rotation achieved in the current study with Osteotomy, iliac crest bone grafting, and Volar Ellis plating is 135.75 degrees. As a result, the current study is closely related to the previous studies in terms of achieving the Arc of wrist motion.^[9]

This could be because the iliac crest bone graft measured could not restore the DRUJ to its pre fracture level. The mean Radial deviation in the study of [Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U](#)^[9] is 27.3 degrees. The present study in which a iliac crest bone graft is used, the mean radial deviation improved to 30 degrees.

DASH SCORE

Abramo A1, Geijer M, Kopylov P, Tägil M,^[7] treated distal radius malunions with Osteotomy and used a Biphasic bone substitute. He observed a decrease in DASH score by 13. In the present study Osteotomy and an iliac crest graft is used and a decrease in DASH score of 27.85 with Standard deviation ± 7.01 is observed. (Pre op mean DASH = 39.43 with SD ± 7.18 and Post op mean DASH = 11.58 with SD ± 3.79).

Abramo A1, Geijer M, Kopylov P, Tägil M⁷ observed a mild decrease in Post op radiological parameters due to ossification of bone substitute. Hence use of a iliac crest bone graft is superior to Biphasic bone substitute.

John T. Capo, MD et al,^[8] with his technique of Osteotomy, Bone grafting and distal radius Intramedullary micro nail observed a Post-operative mean DASH of 21. Among the 13 patients of John T. Capo, MD et al,^[8] they performed osteotomy and used Cortico-cancellous iliac crest bone grafts in 5 patients, 6 patients received local cancellous bone grafts, 2 patients had calcium sulphate bone substitutes. In the present study iliac crest bone graft is used in all the 20 patients. The postoperative mean DASH score was 13.26. Hence use of iliac crest bone graft with volar Ellis plating results were superior to distal radial Intramedullary nail.

RADIOLOGICAL PARAMETERS

McQueen MM¹, Wakefield A used a non-bridging external fixator and bone grafting to correct distal radius dorsal malunions. He corrected his dorsal tilt by 25 degrees (Pre op Dorsal tilt 20 and Post op Volar tilt 5 degrees).

Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U,^[9] achieved a mean correction of 24 degrees of dorsal tilt with his Osteotomy, bone grafting, and fixed angle volar plate (Pre op Dorsal tilt 27.4 and Post op dorsal tilt 3.4 degrees).

John T. Capo, MD et al,^[8] with his Osteotomy, Bone Grafting, and Distal Radius Technique A mean post-operative volar tilt of 2.1 degrees was achieved with an intramedullary micro nail.

In the present study of bone grafting and volar plating the amount of correction of dorsal tilt achieved was 21 (Pre op mean dorsal tilt 22.90 and post op mean dorsal tilt is 1.9). Hence the present study correlates with above studies.

RADIAL INCLINATION

[Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U](#),^[9] achieved a mean correction of 4.1 degrees of radial inclination with his osteotomy, bone grafting, and fixed angle volar plate (Pre op radial inclination 18.4 degrees and Post op radial inclination 22.5 degrees).

John T. Capo, MD et al,^[8] achieved a post-operative radial inclination of 20.6 degrees using his technique of osteotomy, bone grafting, and distal radius intramedullary micro nail.

The amount of radial inclination correction achieved in the current study of iliac crest bone grafting and volar plating was 7.55 degrees (Pre op mean radial inclination 11.25 degrees and post op mean radial inclination 18.8 degrees).

ULNAR VARIANCE

McQueen MM¹, Wakefield A⁶ used Non bridging external fixator and bone grafting for correction of Dorsal malunions of distal radius. He achieved 1.4 mm of correction of Ulnar variance (Pre op Ulnar variance 3.9 mm and Post op Ulnar variance 2.5 mm). John T. Capo, MD et al,^[40] with his technique of Osteotomy, Bone grafting and distal radius Intramedullary micro nail attained a post-operative Ulnar variance of + 1.

[Kiliç A, Kabukçuoğlu YS, Gül M, Sökücü S, Ozdoğan U](#),^[9] with his Osteotomy, bone grafting and fixed angle volar plate achieved a mean correction of 11 mm Ulnar variance (Pre op Ulnar variance 12.1 mm and Post op Ulnar variance < 1 mm).

In the present study of iliac crest bone grafting and volar plating the amount of correction of Ulnar variance attained was 1.9 (Pre op Ulnar variance + 1.35 mm and Post op Ulnar variance -0.55 mm).

COMPLICATIONS

For his non-bridging external fixator, Lubahn JD,^[37] had 9(45%) pin track infections. He reported two nonunions that were later treated with bone grafts. He had one case of EPL rupture (5%). The current study used iliac crest bone grafts in all of the cases, so there was no nonunion. In addition, only one case (5%) of superficial infection was treated with antibiotic & local dressing in this study. Stiffness treated by Physiotherapy. The current study found no evidence of EPL rupture.

ADDITIONAL SURGERIES

Lubahn JD, et al,^[5] treated Distal radial malunions by Distraction Osteogenesis without bone grafting. Hence he had reported 2(10%) Nonunions. He managed them by doing an additional surgery using bone graft.

McQueen MM,^[1] Wakefield A,^[6] treated Malunions with Non Bridging external fixator and bone grafting. However he could not achieve full correction by doing additional procedures like ulnar shortening osteotomy and modified Bower's procedure.

RECOMMENDATIONS FOR FURTHER STUDY

In the present study the iliac crest bone graft is placed from the volar side using a distractor at the osteotomy site. A volar incision to do the osteotomy and placing bone graft and plate fixation.

We recommend further studies on the shape of the bone graft to be used in corrective osteotomy and bone grafting procedures for distal radius malunions as it may preclude different shapes of bone grafts to be incorporated in the osteotomy to restore a better DRUJ alignment. Further recommend Distal Radius malunions treated with osteotomy & plating without bone graft.

The study included twenty cases of malunited distal radius fractures in adults treated with osteotomy, ipsilateral tricortical iliac crest bone grafting, and volar Ellis plating over a 12- to 18-month period.

CONCLUSION

We can conclude that osteotomy, tricortical iliac crest bone grafting, and volar Ellis plating are a simple, reliable, and effective method for restoring normal distal radius radiological parameters, particularly in young adults. Functional end results have a direct relationship with anatomical end results, especially in young adults, though good functional results can be obtained even when anatomical results are poor in elderly people due to innate mobility of the wrist joint.

Osteotomy, ipsilateral iliac crest bone grafting and volar Ellis plating demonstrates good reproducible outcomes with minimal risk in appropriately selected cases of Malunion. This technique can provide adequate restoration of normal anatomy and soft tissue and vascular preservation, in addition to

minimal patient morbidity, which may facilitate a more rapid return to function.

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