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Comparison of Functional Outcomes after Volar Plating versus Conventional Percutaneous Kirschner Wire Fixation in Distal Radius Fractures

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ABSTRACT

Objective: To compare the functional outcomes after volar plating versus conventional percutaneous K wire fixation in treatment of distal radius fractures.

Study Design: Quasi-experimental study

Place and Duration of Study: Orthopedic Department, Combined Military Hospital, Rawalpindi Pakistan, from Aug 2023 to Jan 2024.

Methodology: Using consecutive non probability sampling technique, patients with displaced distal radius fractures who met the inclusion criteria were randomized in 2 groups (65 patients in each group) and received either volar plating or percutaneous Kirschner wire fixation. Functional outcome was recorded at 06 weeks, 03 months and then 06 months, using quick DASH score.

Results: we included 130 patients meeting inclusion criteria and equally divided them. Group-1 received open reduction and internal fixation using volar plate as definitive treatment and Group-2 received closed reduction and percutaneous Kirschner wire fixation. we found statistically significant functional outcome difference at 6 weeks (p=0.01), but at 03 months and 06 months difference in functional outcomes in 2 groups was not found to be statistically significant (p-value 0.18 and 0.27 respectively)

Conclusion: The differences in functional outcomes between two modalities decrease with time and both interventions have equivalent outcomes in long run.

Keywords: Distal Radius Fractures, Percutaneous K Wiring, Volar Plate.

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INTRODUCTION

Distal radius fractures are one of the commonest fractures that orthopedic surgeons encounter in their routine clinical practice. Purpose of treatment in such fractures is to attain and maintain anatomical parameters so as to allow patients to have quick functional recovery without any significant deformity that hinders functional capacity.

Over last many years open reduction and internal fixation with different types of plates has come in to practice and percutaneous K wire fixation has been relegated to specific indications, especially in young patients. It has certainly increased the financial bearing and in hospital stay of treatment for such fractures. On the other hand, ORIF with plates allows early joint movements, lessens the chances of stiffness and disuse atrophy of muscles. Patients do not have to carry a slab along and return to work earlier.

Several studies have been done to determine the best treatment for these fractures that provides best functional outcomes and minimizes morbidity related to it. As per clinical practice guidelines by Shapiro LM[1], there are early benefits in terms of functional recovery for patients treated with volar plates. Several high quality studies failed to demonstrate long term functional benefits such as increased range of movements and clinically significant difference in quality of life scores in patients belonging to various age groups.

The rationale of this study was to determine the functional benefits of each treatment for distal radius fractures and propose a treatment plan for routine clinical practice that would be ideal in treating distal radius fractures in a range of patients belonging to various age groups.

METHODOLOGY

This study was conducted at Orthopedic department Combined Military Hospital, Rawalpindi from Aug 2023 to Jan 2024, after approval from ethical committee of the hospital (Certificate number 541). Sample size was calculated using WHO sample size

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calculator (n=130). Anticipating mean quick DASH in volar LCP group of 41±21 and of percutaneous K wire group 52±20, (Confidence level 90%, Absolute precision 0.05),[2] minimum 60 patients in each group (n=120) were required to be included in the study. The protocol of study is as depicted in Figure i.e. consort diagram.

Inclusion Criteria: Patients with displaced distal radius fractures belonging to age ranging from of 35 - 65 years with no history of diabetes, steroid or immunosuppressant intake were included in the study.

Exclusion Criteria: Patients with history of organ dysfunction, smoking, open fractures, multiple fractures and BMI of more than 30 were excluded from the study.

After explaining the procedure to the patients, Informed consent was taken. Demographic characteristics including age, gender, occupation and address were noted on comprehensive proformas. Patients were randomized in 2 groups using consecutive non probability sampling technique, as depicted:

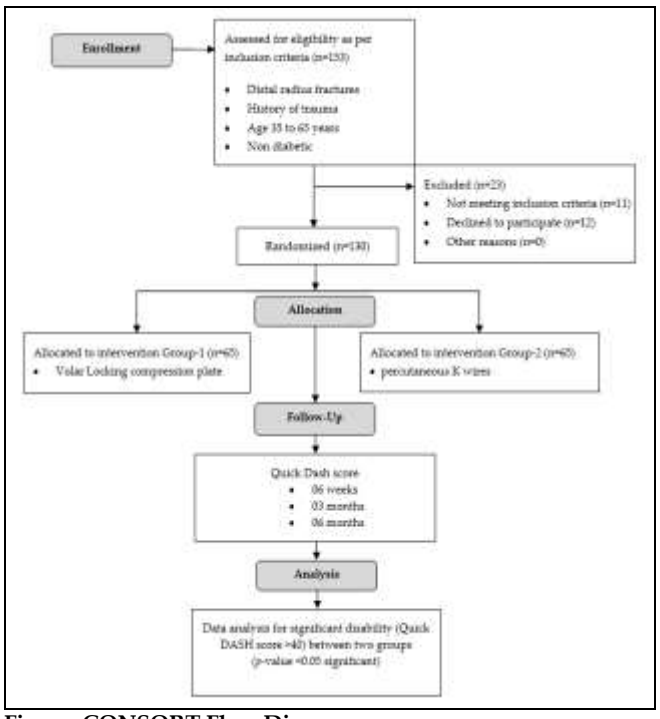

Figure: CONSORT Flow Diagram

Group-1 received open reduction and internal fixation with volar locking compression plate. Group-2 received closed reduction and fixation with Kirschner wires. Both groups were managed with standard post operative protocol and followed up at 06 weeks, 03 months and 06 months post operatively. The functional status and disability was assessed with quick DASH questionnaire score at each follow up. Quick dash score value of 40 or more was considered as a cut off value for significant disability.

Data was collected on separate score sheets. Statistical package for social sciences (SPSS) version 21.0 was used for data analysis. Descriptive statistics were used to calculate quantitative and qualitative variables. Quantitative variables were expressed in mean+SD. Qualitative variables like gender were expressed as frequency and percentages. Chi square test was applied to explore the inferential statistics. *p*-value of <0.05 was considered as cut off value for significance. Effect modifiers like age and gender were controlled by stratification.

RESULTS

Our study included 130 participants divided in two groups, with age ranging from 35 - 65 years (mean age 49.83+8.83 years). Age distribution was done showing that 30(23.07%) were between 35 - 40 years of age, 15(11.53%) between 41 - 45 years of age, 10(7.69%) between 46 - 50 years of age, 12(9.23%) between 51 - 55 years of age, 28(21.54%) between 56 – 60 years of age and 35(26.92%) between 61 - 65 years of age. Mean age in Group-1 was 49+5.07 years and mean age was 50+5.87 years in Group-2.

Gender distribution showed that total of 72(55.38%) were females, whereas 58(44.61%) were males. In Group-1 females were 39(30%) and males were 26(20%). In Group-2 females were 33(25.38%) and males were 32(24.61%).

At 06 weeks frequency of significant functional disability with quick dash score testing in Group-1 was 24(36.92%), whereas frequency of significant functional disability in Group-2 was 38(58.46%). Combined frequency of significant functional disability was 47.69% (p=0.01).

At 03 months frequency of significant disability in Group-1 was (17)26.15%, whereas it was 25(38.46%) in Group-2. Combined frequency was 32.30% (p=0.18).

At 06 months frequency of significant disability in Group-1 on quick DASH score was (10)15.38%, whereas in Group-2 it was (16)26.61%. Combined frequency was 20% (p =0.27), as depicted in Table.

Table: Percentage of Significant Disability at 06 Weeks, 03 Months and 06 Months (n=130)

Significant disability at 06 weeks	Volar LCP group (n=65)	K wire group (n=65)	Total	*p*-value
Yes	24(36.92%)	38(58.46%)	62(47.69%)	0.01
No	41(63.08%)	27(41.54%)	68(52.31%)	
Total	65	65	130(100%)	
Significant disability at 03 months				0.18
Yes	17(26.15%)	25(38.46%)	42(32.30%)	
No	48(73.85%)	40(61.40%)	88(67.70%)	
Total	65	65	130(100%)	
Significant disability at 06 months				0.27
Yes	10(15.38%)	16(26.61%)	26(20%)	
No	55(84.62%)	49(73.39%)	104(80%)	
Total	65	65	130(100%)	

DISCUSSION

Distal radius fractures are one of the commonest fractures that an orthopedic surgeon deals with in routine clinical practice.[3] Orthopedic surgeon starts facing a variety of distal fractures from the very beginning of their career. They are typically common in old age group as a result of fall on outstretched hand. Frequency in old osteoporotic women is higher than other population groups.[4] These fragility fractures are commonly seen on orthopedic floors. These fractures are fairly common in younger age group as well, typically due to indirect high energy mechanisms.[5]

We take into consideration volar tilt, intra articular displacement, radial height and radial inclination while deciding the adequacy of reduction per operatively on C arm. Volar tilt in normal individuals is 10 - 11 degrees. If after manipulation either by closed or open means, the tilt is either neutral or anatomical, we accept it. Similarly, loss of radial height should not exceed 5mm otherwise it would lead to compromised function later on. Radial inclination in normal human beings is 23 degrees. A loss of more than 10 degrees is considered significant and should not be accepted, intra articular displacement or step is again not acceptable if it is more than 2 millimeters.

These fractures can be minimally displaced or non displaced and suitable for management in pop cast after reduction. Many a times these fractures are displaced, with intrarticular extension and cannot be reasonably reduced by closed means.[6] Combined mechanism of injury like axial loading with bending lead to complex fractures, die punch patterns and comminution at the distal end of radius.[7] Typically radial styloid, volar and dorsal fragments are there in axial loading type of mechanisms, with fracture extending into sigmoid notch and can present as further comminution of these major fragments.[8] These fractures present significant challenges in management. There is a lot of discussion and research going on to determine best approach to address these complex fractures. Some surgeons prefer to use both volar and dorsal plate if they feel the need, in face of significant chances of loss of reduction. Dorsal fragments, especially when they are comminuted are better dealt with buttressing. The chances of injury to extensor pollicis longus and long term disability are there. Some surgeons deal it with long screws via a plate placed over volar aspect. K wire fixation of small comminuted fractures is still an option in special circumstances. Volar fragments are also dealt with care. They are engaged adequately with screws through volar plate or multiple K wires in good orientation are another option. Volar ulnar corner is of critical importance as it confers stability to distal radioulnar joint. It has to be fixed meticulously and should be stable so as to allow early safe range of movements at the distal radioulnar joint. On occasions there is a very small piece of bone at volar ulnar corner and it is not possible to hold it in a stable manner with either plate or K wire, we have to use additional protection in the form of POP slab temporarily in those cases. This POP slab can be removed safely at 03 weeks and ranges of movement exercises are commenced. Short radiolunate ligament confers a very important stabilizing support. It is a small ligament at the junction of volar lip of distal radius and the lunate bone. Failure to recognize its injury can lead to loss of reduction and poor outcomes. A thought must be borne in mind if the volar distal radius segment at ulnar aspect is very small, that injury to short radiolunate ligament might be there. It has to be treated well if present. The depressed articular fragment of these die punch injuries needs support in the form of small locking screws of these low profile plates. The stability after open reduction and internal fixation must be assessed on table and any doubt regarding the stability must be addressed there and then.

These complex fractures require good reduction and stable fixation; otherwise it would certainly lead to loss of reduction and malunion.[9] Various internal devices are in use for their fixation like two column fixed angle volar locking compression plates, T type plates, column specific plates and dorsal low profile

straight or L shaped plates. Some fractures necessitate dual plating on volar and dorsal aspects.[10] These sophisticated low profile column specific plates are available in some centers and provide great help in treating the fractures pertaining to these specific zones. Among these plates, radial columns plates are suitable for radial dorsal aspect of distal radius due to their anatomical morphology. These low profile plates render less irritation to surrounding soft tissues. Complaints of pain and discomfort might be minimized with their use and chances of tendon rupture are lower. Ulnar column specific L shaped or simple plates are used for ulnar column specific fixation. These are also low profile and do not irritate the surrounding soft tissues. The radial column is also being fixed with a lateral buttress plates in some centers and results are encouraging. Radial styloid fractures are fixed with K wires in certain situations. An orthopedic surgeon always has to choose the individualized treatment among an array of possible options. Same treatment might not be optimal in various age groups. Open reduction and internal fixations subjects an elderly patient to an invasive and potentially long surgery. Physiological reserves in this population are already compromised. The surgical treatment in elderly population has to be thought through before embarking upon it practically. On the other hand, young patients are usually high demand and active members of society. Unnecessary delay in recovery of these patients is not desirable most of the times. Open reduction and internal fixation provides early mobility and rehabilitation for these patients. These individuals can return to their jobs faster and regain their productive roles.

We commonly use volar locking compression plate for complex fractures of distal radius in our set up. It's a common practice to fix all distal intrarticular fractures with volar plate in some centers.[11] Volar plating has certainly drawn the attention due to low profile anatomical construct and allowing early post operative range of movements and rehabilitation.[12] Patients are able to return to their jobs earlier and do not have to carry along casts or slings.[13] In active, high demand people and sportsmen it's a desirable option. Rehabilitation is quick and young patients regain their range of movements quickly. Routine disability and pain assessment scores suggest improved function as there is less pain and stiffness. Young patients are encouraged to do passive and active flexion, extension, pronation and supination in early post operative period. These patients start their activities of daily living quickly such as eating, changing clothes, buttoning shirts and combing. There are no risks of disuse atrophy of muscles and plaster disease. This translates into improved quality of life and smooth recovery process after the surgery. We keep these patients on regular follow up and there functional range of movements and ability to do daily tasks is assessed. Majority of the clientele in our hospital are actively performing physical duties and operative management of these fracture helps them a lot in early return to their jobs.

Kirschner wire on the other hand, is a classical treatment for distal radius fractures. It doesn't require long incision and sometimes may be ideal in old patients who cannot tolerate prolonged anesthesia and have limited functional demands.[14] We individually assess old age patients depending upon their degree of fracture displacement and pattern. The physiological age is also taken into consideration. Elderly patients usually have existing co morbids that may or may not be well controlled. These patients usually are diabetic, hypertensive or have an underlying cardiac condition. They may already be physiologically compromised due to these ailments and not a suitable candidate for any prolonged surgical intervention. K wires a reasonable option in these situations. Anesthesia risks are mitigated with short surgery that is done under local or regional nerve blocks. Short duration of these procedures poses lesser physiological stress on already compromised cardiorespiratory system. Risks and benefits are discussed with the patients before the operation and these patients get away with shorter anesthesia and surgery. We achieve reasonable reduction and fixation with K wires and then keep these patients on close follow up. There is a risk of loss of reduction in these patients especially in complex distal radius fractures. Patients are already informed of it in the pre operative counseling sessions.

Kirschner wires are a traditional means of treating these injuries. Depending upon the complexity of fractures the ideal configuration may vary. Lateral to medial wires and posterior to anterior wires are used to hold the radial and dorsal fractured fragments respectively. K wires alongside the sub articular surface as a rafting option to prevent collapse of articular surface. Depending upon the pattern of fracture fragments, the ideal configuration may be slightly different. Extra articular fractures are easily held with two lateral to medial oblique divergent K wires. In die punch fractures reduction is achieved first with traction and manipulation of extremity. This

is confirmed under image intensification and held in place with manual force initially. Later on, K wires in appropriate configuration are passed. Fracture stability is assessed on table with range of movements. The construct is then placed in a well padded and molded cast. This is followed by weekly radiographs to assess interval displacement or loss of reduction for up to 3 weeks.

There are certain fracture pattern related risk factors that might predict the probability of loss of reduction once it is achieved and held with K wires. These include dorsal comminution, loss of radial height and initial displacement after the fracture. These factors are always considered when choosing specific treatment options. Such risk factors for loss of reduction might be a straight away indication for a surgical treatment in a younger age group. In elderly population these cases pose difficulty in choosing treatment and one has to see the overall picture while treating these fractures. The decisions in these cases are individualized. If general condition of the patients allows, these fractures are better dealt with open reduction and internal fixation as this provides a more biomechanically strong construct. Fortunately even with K wire fixation of such fractures, eventual loss of reduction has not translated into long term functionally disabling situation. Most of the elderly patients treated with K wire fixation were able to attain reasonable function at 01 year even after radiographic evidence of loss of reduction in early follow ups.

Studies comparing the effectiveness, benefits and disadvantages of these two treatments have yielded varied results. Most studies agree to the proposed benefit of early functional benefits of volar plates and other internal devices.[15] Range of movements and grip strengths are found to be better in plating groups and rehabilitation is quicker.[16] Studies do agree that over time these functional benefits reduce to clinically insignificant values. Patients after a period of 6 months to 1 year post surgery do not perceive a clinically significant difference in function after either treatment.[17] Young people would like to attain their function quicker and completely. Young professional tend to return to their jobs early with operative treatment.

The Purpose of our study was to formulate a treatment plan for distal radius fractures that will guide us to use volar plates or kirschner wires so as to achieve an acceptable functional outcome in various age groups of patients. We can tailor a specific treatment plan taking into consideration the expectations and requirements and age of individual patients.[18] This will provide maximum functional benefit with satisfaction of patients as well as mitigate unnecessary financial impact.[19] Many centers use various methods of reducing and fixing distal radius fractures like plates, K wires and other external devices.[20] Distal radius fractures have been managed equally well in long term using various standard fixation techniques.

LIMITATION OF STUDY

Our study was done over a period of 6 months. Long term differences in the functional outcomes cannot be determined with such short study. Patients can be followed up for longer period of time to assess and compare the functional outcomes with specific scores.

CONCLUSION

Treatment of distal radius fractures with volar plating does provide short term benefits such as improved range of movements and better execution of activities of daily living. With time the kirschner wire treatment patients also attain significant improvement in function of wrist and hand. There is no long term statistically or functionally significant difference in both treatment groups. We conclude that volar plating may be a better choice in young patients who desire to achieve quicker recovery and earlier return to work. Kirschner wire is also a reasonable option for elderly, moderate demand patients with co morbid where anesthesia issues might preclude prolonged surgery. Specific decision should be individualized.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

FS & MNI: Data acquisition, data analysis, critical review, approval of the final version to be published.

MAR & MJ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Shapiro LM, Kamal RN; Management of Distal Radius Fractures Work Group; Nonvoting Clinical Contributor; Nonvoting Oversight Chairs; Staff of the American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand. Distal Radius Fracture Clinical Practice Guidelines-Updates and Clinical Implications. J Hand Surg Am 2021; 46(9) :807-811. https://doi.org/10.1016/j.jhsa.2021.07.014

2. Karantana A, Downing ND, Forward DP, Hatton M, Taylor AM, Scammell BE et al. Surgical treatment of distal radial fractures with a volar locking plate versus conventional percutaneous methods: a randomized controlled trial. J Bone Joint Surg Am 2013; 95(19): 1737-1744. https://doi.org/10.2106/JBJS.L.00232
3. Mauck BM, Swigler CW. Evidence-Based Review of Distal Radius Fractures. Orthop Clin North Am 2018; 49(2): 211-222. https://doi.org/10.1016/j.ocl.2017.12.001
4. Quadlbauer S, Pezzei C, Jurkowitsch J, Rosenauer R, Kolmayr B, Keuchel T et al. Rehabilitation after distal radius fractures: is there a need for immobilization and physiotherapy? Arch Orthop Trauma Surg 2020; 140(5): 651-663. https://doi.org/10.1007/s00402-020-03367-w
5. Bachoura A, Shin EK. Emerging Technologies in Distal Radius Fracture Fixation. Curr Rev Musculoskelet Med 2019; 12(3): 369-378. https://doi.org/10.1007/s12178-019-09568-0.
6. Hess DE, Carstensen SE, Moore S, Dacus AR. Smoking Increases Postoperative Complications After Distal Radius Fracture Fixation: A Review of 417 Patients From a Level 1 Trauma Center. Hand (N Y) 2020; 15(5): 686-691. https://doi.org/10.1177/1558944718810882
7. Greig D, Silva M. Management of Distal Radius Fractures in Adolescent Patients. J Pediatr Orthop 2021; 41(Suppl 1): S1-S5. https://doi.org/10.1097/BPO.0000000000001778
8. Cay P, Leung B, Curlewis K, Stone A, Roper T, Ricketts D. Quotation errors related to the Distal Radius Acute Fracture Fixation Trial paper. J Hand Surg Eur Vol 2021 Jul;46(6):654-658. https://doi.org/10.1177/17531934211002985
9. Vaghela KR, Velazquez-Pimentel D, Ahluwalia AK, Choraria A, Hunter A. Distal radius fractures: an evidence-based approach to assessment and management. Br J Hosp Med (Lond) 2020; 81(6): 1-8. https://doi.org/10.12968/hmed.2020.0006
10. Vakhshori V, Alluri RK, Stevanovic M, Ghiassi A. Review of Internal Radiocarpal Distraction Plating for Distal Radius Fracture Fixation. Hand (N Y). 2020; 15(1): 116-124. https://doi.org/10.1177/1558944718787877
11. Sengab A, Krijnen P, Schipper IB. Risk factors for fracture redisplacement after reduction and cast immobilization of displaced distal radius fractures in children: a meta-analysis. Eur J Trauma Emerg Surg 2020; 46(4): 789-800. https://doi.org/10.1007/s00068-019-01227-w
12. Bhan K, Hasan K, Pawar AS, Patel R. Rehabilitation Following Surgically Treated Distal Radius Fractures: Do Immobilization and Physiotherapy Affect the Outcome? Cureus 2021; 13(7): e16230. https://doi.org/10.7759/cureus.16230
13. Gottschalk MB, Wagner ER. Kirschner Wire Fixation of Distal Radius Fractures, Indication, Technique and Outcomes. Hand Clin 2021; 37(2): 247-258. https://doi.org/10.1016/j.hcl.2021.02.007
14. Cognet JM, Bauzou F, Louis P, Mares O. Using Ultrasonography During the Fixation of Distal Radius and Finger Fractures. Hand Clin 2022; 38(1): 109-118. https://doi.org/10.1016/j.hcl.2021.08.012
15. Lubbe RJ, Kokmeyer DT, Young CP. Distal Radius Fractures: Recognizing and Treating Complex Fracture Patterns. J Orthop Trauma 2021; 35(Suppl 3): s33-s36. https://doi.org/10.1097/BOT.0000000000002209
16. Gutiérrez-Espinoza H, Araya-Quintanilla F, Olguín-Huerta C, Gutiérrez-Monclus R, Valenzuela-Fuenzalida J, Román-Veas J, et al. Effectiveness of surgical versus conservative treatment of distal radius fractures in elderly patients: A systematic review and meta-analysis. Orthop Traumatol Surg Res 2022; 108(5): 103323. https://doi.org/10.1016/j.otsr.2022.103323
17. Sobel AD, Calfee RP. Distal Radius Fractures in the Athlete. Clin Sports Med 2020; 39(2): 299-311. https://doi.org/10.1016/j.csm.2019.10.005
18. He JJ, Blazar P. Management of High Energy Distal Radius Injuries. Curr Rev Musculoskelet Med 2019; 12(3): 379-385. https://doi.org/10.1007/s12178-019-09555-5
19. Alter TH, Varghese BB, DelPrete CR, Katt BM, Monica JT. Reduction Techniques in Volar Locking Plate Fixation of Distal Radius Fractures. Tech Hand Up Extrem Surg 2022; 26(3): 168-177. https://doi.org/10.1097/BTH.0000000000000380
20. Ahmad AA, Yi LM, Ahmad AR. Plating of Distal Radius Fracture Using the Wide-Awake Anesthesia Technique. J Hand Surg Am 2018; 43(11): 1045.e1-1045.e5. https://doi.org/10.1016/j.jhsa.2018.03.033