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Original Article

Orthopaedics Section

Assessment of Radiological Outcomes of Extra-articular Distal End Radius Fractures Treated by Volar Locking Plating versus Percutaneous K-wire and Cast Application: A Retrospective Observational Study

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ABSTRACT

Introduction: Extra-articular distal end radius fractures are among the most commonly encountered orthopedic injuries. Closed reduction with percutaneous K-wiring and cast application is a widely used method of treatment due to its minimally invasive nature and cost-effectiveness, although it requires prolonged immobilisation and carries a risk of malunion. Open Reduction and Internal Fixation (ORIF) using volar locking plates has emerged as an alternative by offering rigid fixation and enabling early mobilisation.

Aim: To compare the radiological outcomes- specifically radial height, radial inclination, and volar tilt between percutaneous Kirschner (K) wire fixation and volar plate fixation methods in extra-articular distal end radius fractures treatment.

Materials and Methods: This is a retrospective observational study conducted at Symbiosis Medical College for Women (SMCW), Pune, Maharashtra, India, involving 81 patients aged above 18 years from January 2024 to March 2024. These patients were treated between January 2021 and December 2023 for extra-articular distal radius fractures (AO Type-2R3A2 and AO Type-2R3A3). Patients were divided into two groups: 37 were treated with closed reduction, K-wiring, and casting, while 44 underwent volar plating via the Henry approach. Postoperative radiographs at three months were assessed for radial height, radial inclination, and volar tilt using the Picture Archiving and Communication System (PACS). Data analysis was performed using Statistical Package for the Social Sciences (SPSS) Statistics software, version 20, with statistical significance set at $p<0.01$.

Results: The mean age of patients in the K-wire group was 54.72 years (range: 18-87), while the mean age for the volar plating group was 42.59 years (range: 20-73). There were 11 males (29.73%) and 26 females (70.27%) in the K-wire group, whereas the volar plating group included 29 males (65.91%) and 15 females (34.09%). The results indicated that volar plating achieved significantly better restoration of radial height, radial inclination, and volar tilt ($p<0.001$**), suggesting a lower risk of malunion compared to K-wiring.

Conclusion: It is concluded that ORIF with volar plating yields superior radiological outcomes compared to closed reduction with percutaneous K-wiring and cast application in the management of extra-articular distal end radius fractures.

Keywords: Bone plates, Fracture fixation, Internal, Orthopaedic procedures, Radiographic image interpretation

INTRODUCTION

Closed reduction, percutaneous K-wiring, and cast application techniques have always been very popular treatments for extra-articular distal end radius fractures [1]. This technique has several advantages, such as providing satisfactory outcomes despite being minimally invasive and cost-effective. However, some of the disadvantages associated with this technique include the requirement for prolonged immobilisation, which may increase the risk of malunion. Nowadays, ORIF using a volar locking plate is increasingly preferred to treat distal end radius fractures, as it provides comparatively rigid fixation and facilitates early mobilisation of the wrist joint [2-4]. However, there remains a lack of consensus in the literature on the modality of fixation for distal end radius fractures [5]. While some studies advocate volar plating for its superior biomechanical stability and facilitation of early mobilisation [6,7], others favour K-wire fixation in select cases due to its minimal invasiveness, reduced surgical time, and lower cost [8,9]. Radiographs aid in the diagnosis and treatment of fractures, and postoperative radiographs are essential tools for evaluating the restoration of anatomy, which is also vital for optimum functional outcomes [10,11].

The present study aims to compare the radiological outcomes of volar plating and K-wire fixation to help determine the more effective technique for managing extra-articular distal end radius fractures.

MATERIALS AND METHODS

This retrospective observational study was conducted at Symbiosis Medical College for Women (SMCW), Pune, Maharashtra, India, from January 2024 to March 2024 after approval from the Institutional Ethical Committee (IEC No. SIU/IEC/620). Given the retrospective nature of the study, data were extracted from existing medical records, operative notes, and radiological archives available through the hospital's electronic system.

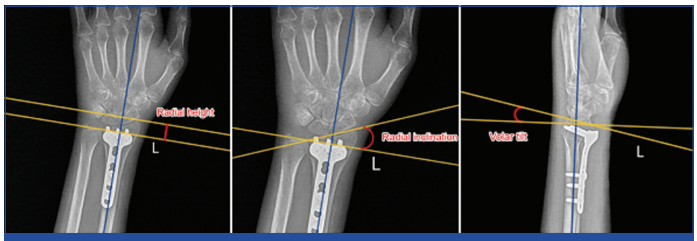
Inclusion and Exclusion criteria: All patients aged above 18 years who were treated between January 2021 and December 2023 for extra-articular distal radius fractures (AO Type-2R3A2 and AO Type-2R3A3) [12] with either ORIF volar plating or closed reduction with K-wiring and cast application were included. Patients treated with alternative modalities of fixation and those who did not have postoperative follow-up until three months were excluded from the study.

A total of 81 patients were available for analysis after exclusions. Of these, 37 patients were treated with K-wire fixation, while 44 patients were treated with volar plating. Patients in the K-wire group

were immobilised in a below elbow cast for six weeks, after which both the cast and wires were removed. In contrast, those in the volar plating group underwent ORIF via the Henry approach [13], and wrist mobilisation was initiated the day after surgery.

Postoperative radiographs taken at three months were assessed. The parameters evaluated included radial height, radial inclination {in the Posteroanterior (PA) view} and volar tilt (in the lateral view) [Table/Fig-1,2]. Picture Archiving and Communication System (PACS) was used for measurement. The ideal parameters for radial height, radial inclination, and volar tilt were considered to be 13 mm, 23 degrees, and 11 degrees, respectively. A radial height of 13 mm with shortening of less than 5 mm, a radial inclination of 23 degrees with a variation of less than 5 degrees, and a volar tilt of 11 degrees with a change of less than 5 degrees in dorsal angulation were considered acceptable standards [14].

[Table/Fig-1]: Radial height, radial inclination and volar tilt measured in a case fixed with K-wire.



[Table/Fig-2]: Radial height, radial inclination and volar tilt measured in a case fixed with volar plate.

STATISTICAL ANALYSIS

Means and standard deviations were calculated. Intergroup comparisons were conducted using independent sample t-tests. A p-value of <0.01 was considered statistically significant. Radiographic findings were analysed by calculating the means of radiological parameters in both groups and comparing them using a one-sample t-test. Data analysis was performed using SPSS version 20.0.

RESULTS

A total of 81 patients met the inclusion criteria, of which 37 patients were treated with K-wiring, while 44 were treated with volar plating. Fracture union occurred in all patients at the three month follow-up after surgery. The mean age of patients treated with K-wire was 54.72 years (range: 18-87 years), while those treated with volar plating had a mean age of 42.59 years (range: 20-73 years). In the K-wire group, there were 11 males (29.73%) and 26 females (70.27%), whereas the volar plating group comprised 29 males (65.91%) and 15 females (34.09%).

There was a statistically significant difference in the average value of radial height (p<0.001*), with the mean radial height being 11.10±1.11 mm in the volar plating group compared to 8.29±1.30 mm in the K-wire group [Table/Fig-3]. Additionally, there was a statistically significant difference in the average value of radial inclination (p<0.001*), with the mean radial inclination being 21.88±1.11° in the volar plating group versus 19.19±1.30° in the K-wire group [Table/Fig-4].

There was a statistically significant difference in the average value of volar tilt (p<0.001), with the mean volar tilt measuring 7.01±1.58° in the volar plating group compared to 1.70±2.15° in the K-wire group [Table/Fig-5]. These results suggest superior outcomes with volar plating over K-wire fixation.

Groups	N	Mean	S.D	't'-value	p-value	Level of significance
K-wire	37	8.2865	1.30366	10.483	<0.001**	P<0.01
Volar plating	44	11.0977	1.11031			

[Table/Fig-3]: Comparison of radial height between the two study groups.

Groups	N	Mean	SD	't'-value	p-value	Level of significance
K-wire	37	19.1892	1.30366	10.325	<0.001**	P<0.01
Volar plating	44	21.8818	1.11031			

[Table/Fig-4]: Comparison of radial inclination between the two study groups.

Groups	N	Mean	S.D	't'-value	p-value	Level of significance
K-wire	37	1.7027	2.15013	12.785	<0.001**	P<0.01
Volar plating	44	7.0114	1.57985			

[Table/Fig-5]: Comparison of volar tilt between two study groups.

Radial height was within acceptable standards in 44 (100%) patients treated with volar plating, compared to 32 (86.5%) patients in the K-wire group. Similarly, radial inclination was within acceptable standards in all 44 (100%) patients in the volar plating group and in 33 (89.2%) patients in the K-wire group. Volar tilt was found to be within the ideal standards in all patients treated with both fixation methods, with 44 (100%) in the volar plating group and 37 (100%) in the K-wire group.

DISCUSSION

This retrospective study analysis revealed that volar plating achieved significantly better radiological alignment than K-wire fixation. Parameters such as radial height and inclination were more frequently within acceptable ranges, indicating a reduced risk of malunion. The findings of this study align with previous research [15-18]. Chung KC et al., also observed significantly better mean radial length, inclination, and volar tilt in patients treated with plating, with malunion rates of 4% versus 13.2% for K-wiring [4].

Closed reduction, percutaneous K-wiring, and cast application have traditionally been widely used due to their minimally invasive nature, ability to achieve good reduction, and shorter operative time [1,8]. However, this approach carries inherent disadvantages, including a greater likelihood of loss of reduction and delayed mobilisation [3,8,11]. In contrast, volar plates offer rigid fixation and facilitate early wrist movement [18-23].

Numerous studies in the literature support the advantages of volar plating over K-wiring for the treatment of intra-articular distal end radius fractures. Volar plates are biomechanically superior implants [19,22,23] and have several advantages in the fixation of intra-articular fractures, such as the ability to hold multiple fragments, locking screws providing a rigid construct, and buttressing the volar fragments. Although articular congruity is maintained in extra-articular fractures, the superior biomechanical strength of the volar locking plate has been shown to prevent loss of reduction compared to K-wire, as demonstrated in this study.

Several studies have indicated that achieving radiological parameters within acceptable criteria postoperatively is essential, and the failure to achieve this can lead to suboptimal functional outcomes [10,11,24]. Zhang YX et al., (2021) reported that volar plate fixation demonstrated improved radiological parameters and grip strength compared to non operative treatment in older adults, reinforcing the significance of anatomical restoration for functional recovery [25]. The findings of the present study were similar to those of Henry MH, who found that K-wires cannot protect against radial collapse in osteoporotic patients, and to those of Shinde R

et al., who noted higher maintenance of alignment in osteoporotic cases treated with plating [15,26]. This study's results also align with findings by McFadyen I et al., who concluded that volar-locked plates achieve superior radiological and functional outcomes with minimal complications across all age groups for the treatment of dorsally displaced, unstable distal radius fractures [16]. However, it is worth noting the observation by Brennan SA et al., who found that although superior radiological outcomes were achieved with volar plate fixation over K-wire, these results could not be translated into better functional outcomes at 32 months of follow-up, concluding that the beneficial effects of plate fixation diminish with time [17].

The findings of this study support the use of volar plate fixation in achieving superior radiological alignment compared to percutaneous K-wire fixation in managing extra-articular distal end radius fractures. Volar plating consistently restored key anatomical parameters within acceptable limits, which may translate into better functional outcomes over time. These results align with previously published literature and reinforce the importance of choosing fixation methods tailored to fracture pattern, bone quality, and early mobilisation goals.

Limitation(s)

As a retrospective observational study, limitations include a lack of randomisation and potential selection bias; this analysis was also limited to information available from medical records. Functional outcomes were not assessed, and long-term comparisons are lacking. Additionally, this study had a short follow-up period of three months. Nevertheless, since all fractures have shown signs of union, the radiological parameters are unlikely to change.

CONCLUSION(S)

This study concludes that ORIF with a volar locking plate has superior radiological outcomes compared to closed reduction with percutaneous K-wire and cast application in the treatment of extra-articular distal end radius fractures. It is also associated with a lesser chance of malunion, making it a more reliable method in appropriate cases.

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