Treatment of Distal Radial Fracture Fixation Using Volar Rim Distal Radius Plate:A Prospective Study

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Research article

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Abstract

Background: Unstable distal radial fractures are difficult to manage and so various treatment and management modalities have been introduced and described. The use of Volar Rim Distal Radius Plate is promoted for the management of such fractures.

Objective: This study aimed to investigate the clinical effect and functional output of Volar Rim Distal Radius Plate in the treatment of distal radius fractures. The purpose of this study is to evaluate the functional and radiological results of treating distal radial fractures with Volar Rim Distal Radius Plate

Methods: In our study from March 2017 to May 2019, the clinical efficacy of Volar Rim Distal Radius Plate in the treatment of distal radius fractures was retrospectively analyzed.

Case Description: During the study period, 23 patients met the inclusion criteria. According to the AO classification of distal radius, there were 9 patients with Ao-23b3 and 14 patients with Ao-23c3. The follow-up time was 13-17 months (average 14.6 months). All patients achieved bony union without internal fixation failure or fracture displacement. The Gartland and Werley functional system score was used to evaluate the limb function. Among them, 9 cases were evaluated as excellent, 13 cases as good, and 1 case as fair. Radiological parameters such as radial inclination, length, tilt, and ulnar variance were measured at six weeks and at the final follow-up. The functional evaluation was conducted by measuring the range of motion at the wrist joint as well as the grip strength. Gartland and Werley's demerit scoring system was used to assess the final outcome.

Literature Review: Results without nonoperative treatment of these fractures are not satisfactory and may often require a subsequent corrective osteotomy. Good and Satisfactory results can be achieved with operative treatment of the fracture when the fragments are well reduced by using the Volar Rim Distal Radius Plate.

Results: There was a significant improvement in the functional indices from six weeks to the final follow-up, while the radiological parameters were maintained. According to Gartland and Werley, excellent results were reported in 65% cases, while good results were present in 35% cases.

Clinical Relevance: Volar Rim Distal Radius Plate can give an adequate buttress to volar projection of the lunate facet and it does not interfere with wrist mobility. Moreover, the dorsal fragments can be fixed through the volar approach which may eliminate our need for a secondary posterior incision. Furthermore, patients would be informed for the potential problems and let them know about the need for the removal of the plate if unfortunately symptoms develop.

Conclusions: The use of Volar Rim Distal Radius Plate is an effective fixation method to treat distal radius fractures which can provide more firm stability, meet the needs of early functional exercise and improve the prognosis with excellent to good functional outcomes with minimal complications.

Introduction

Distal radius fracture refers to the fracture within 3 cm of the articular surface of the distal radius. Distal end radius fractures constitutes 10% of all human skeletal fractures [1]. Distal radius fracture is one of the commonest adult fractures and the incidence varies from 5.7 to 124.6 per 10,000 persons.[2] The incidence of distal radius fracture is about 26 / 10000 every year, accounting for 17% of all emergency fracture patients. The incidence of distal radius fracture is increasing year by year. These fractures usually affect the elderly population more than 50 years old and they involve low energy trauma [3]. However, in young adults, high energy trauma which results from traffic accidents accounts the substantial number of cases, the majority of which are unstable. High energy injuries often accumulate in the articular surface of the distal radius, accompanied by dorsal or volar displacement of free fracture fragments. Restoration of volar angulation, radial length, and the radial inclination are essential for good functional outcomes of the wrist joint. Stable fixation of articular congruity may reduce the incidence of osteoarthritis and will also help for early rehabilitation [4]. Open reduction and internal fixation using an interlocking plate system is a valid treatment of displaced extra-articular and intra-articular distal radius fractures in adults. [48,50-52]. When a dorsal approach is used, extensor tendon rupture and irritation caused by implants or surgical intervention are serious complications.[5,50,53]. A volar approach has been developed to fix a dorsally angulated fracture of the distal radius. It has several advantages, including the broader volar aspect of the distal radius, the avoidance of both dorsal dissection and attendant complications of the extensor tendons, and the possible deprivation of blood supply to the dorsal metaphyseal fragments[54-56]

Various treatment modalities, including plaster cast application, Kirschner wire fixation, dorsal and volar plates, and external fixation, have been described for the management of these fractures [5,6]. Osteoporosis is one of the major factors in deciding on the treatment modality [7], and locking plates are favored in the treatment of these complex fractures.

Variable functional outcome has been reported when these fractures are treated non operatively.[8] In younger adults displaced fractures usually require operative intervention[9]. Some conservatively treated fractures have been found displaced in plaster later on and ultimately requiring surgery.[10,11] Anatomical and stable fracture reduction is achieved through internal fixation which allows early wrist and hand mobility and prevents stiffness[12-14]. Locking volar plates mechanically bridge the bone and bear the load through the locking construct, resulting in a lower incidence of failure. The subchondral placement of distal screws is essential to prevent a loss of correction and to achieve good functional results [15-17]. Comminuted distal end radius fractures may require the use of additional fixation methods such as Kirschner wire and dorsal plate in addition to volar fixed-angle plates. This is because the volar locking plates allow the screws to be inserted in a predefined direction, and they do not take into account the personality of the fracture and any variability in the positioning of the plate. This type of fracture can be better managed with the use of a variable-angle plate as it allows greater flexibility in terms of screw angle insertion and the engagement of periarticular fragments[18]. There have been a number of studies on the operative management of distal radial fractures treated with Volar Rim Distal Radius Plate. Most

distal radius fractures are dorsally displaced [41] and surgeons have long been familiar with the concept of buttress plating.

We retrospectively analyzed the results in a selected cohort of patients with unstable distal radial fractures in order to determine the functional and radiological outcomes of treatment with VRP. The purpose of this study is to evaluate the functional and radiological results of treating distal radial fractures with Volar Rim Distal Radius Plate

Material And Methods

1.1 General information

From March 2017 to may 2019, a prospective study to evaluate the effectiveness of distal radial fractures using Volar Rim Distal Radius Plate confined to the volar rim of the distal radius. This study was approved by institutional review boards and informed consent was obtained from all patients.

Every patient underwent an operation with Variable Angle LCP Volar Rim Distal Radius Plate 2.4mm. The patients included 16 women and 7 men of (range, 19–71y) who were followed up for an average of 13-17 months (average 14.6 months). All fractures were assessed using a computed tomography (CT) scan in addition to plain radiographs.

From March 2017 to may 2019, and from March 2018 to may 2019, the clinical efficacy of Volar Rim Distal Radius Plate for the treatment of distal radial fractures in the Department of orthopedics of Beijing Chaoyang Hospital was retrospectively analyzed. Inclusive criteria:

1. Patients aged between 19 to 71 years with closed distal end radial fractures are displaced more than 2 mm from the anatomic position, a dorsal inclination of the distal fragment of more than 20mm, a radial shortening of 10 mm or more,

1 Patient's age(16-18).

closed fracture

distal radius fracture

surgical treatment within 7 days after injury.

Exclusion criteria:

old fracture

pathological fracture

previous history of wrist surgery

previous limitation of wrist movement.

According to the inclusion and exclusion criteria, this study included 23 patients with proximal humeral fractures, aged 19-71 years, with an average of range years. According to AO classification of distal radius, there were 9 patients who are ao-23b3 type and 14 which are ao-23c3 type. All of the preoperative and postoperative data were obtained by reviewing the charts from the medical records section of the hospital. The patients were contacted by telephone of request to arrange an additional visit. All of the patients gave informed consent to participate in the study.

The study was approved by the institutional review board.

Research methods

After admitting in the hospital, the patients were evaluated and treated according to the diagnosis and treatment path. Observation indexes of this study: gender, age, fracture classification, fracture healing, internal fixation failure and fracture displacement, application of Garland and Werley functional system score was used to evaluate the limb function. functional score, wound healing, etc. In this study, the categorical data was expressed by the number of patients in each category, and the measurement data was expressed by the average.

A total of 23 patients participated in this study. The mean age of the patients was 32.82 ± 11.81 years (range 19-71). There were 7 males and 16 females. There were 17 dominant and six non-dominant hands. The mode of injury was motor vehicle accident in 18 patients, fall while walking in four patients, and assault in one patient. The fractures were classified on the basis of the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification. there were 9 patients who are ao-23b3 type and 14 which are ao-23c3 type.

Plate Design Features and Surgical Technique

The 2.4-mm Variable Angle LCP Volar Rim Distal Radius Plate is designed for the fractures of the distal radius volar rim with large fracture or multiple fragments. The distal aspect of this plate sits slightly over the volar rim of the distal radius which help to fit anatomical position of the lunate and scaphoid facets. The orientation of the variable angle screw holes directs the screws in a proximal direction, while avoiding the entrance into the radio-carpal joint. This implant has a radial and the ulnar phalange which allows additional fixation of the radial styloid and the lunate facet fracture. While the proximal straight limb offers a wider hole to permit a screw to be placed to help for the provisional fixation. The distal and proximal limbs of this plate have small holes for temporary Kirschner wire fixation, while taking images we can confirm the position of the plate and adequacy of the reduction. We used the E models software of Depuy Synthes to evaluate the efficiency of Volar Rim Distal Radius Plate.

Surgical Technique

All the operations were performed by senior surgeon. The patients were given brachial plexus anesthesia or general anesthesia at the discretion of the anesthesiologist, a tourniquet was placed on the affected limb with a pressure of 250 mmHg. The patients were given general/regional anesthesia at the discretion of the anesthesiologist. A Henry incision was taken and the skin was cut on the lateral side. The fracture was approached through the base of flexor carpi radialis of the distal radius as described by Henry et al. [19]. All of the patients underwent open reduction and internal fixation with SYNTHES Variable Angle LCP Volar Rim Distal Radius Plate 2.4mm. Prior to VRF reduction, the radial column is provisionally reduced and fixed with a 2.4mm straight plate because radial column fragments are typically reduced first in the process of a fragment-specific fixation. [20] The subcutaneous length was about 8 cm. The radial nerve and radial artery were exposed, and the radial nerve and radial artery were pulled open and protected to the radial side. The space between flexor carpi radialis and brachioradialis was obturated to expose pronator. The pronator muscle was incised sharply along the lateral edge of radius, and the periosteal stripper was used to peel off the pronator muscle to expose the fracture end. The fracture was reduced by manipulation, fixed with Kirschner wire temporarily, and the reduction of C-arm was satisfactory by fluoroscopy. The volar locking plate was selected to adjust the position of the plate and fixed with locking screw in turn. After reduction, a distal radial plate or Kirschner wire was used for fixation. The C-arm fluoroscopy confirmed that the reduction of the joint was satisfactory and the position of the plate was appropriate. Sufficient irrigation, complete hemostasis, layer by layer suture wound, pressure bandage. Immediately after the operation, the affected limb took active functional exercise, and the patient changed dressing regularly. After about 2 weeks, the stitches were removed according to the wound healing. The patients were followed up regularly, every month for the first 3 months, and intermittently until the fracture healed. The quality of reduction was measured with a standard goniometer and then classified as satisfactory in cases with a dorsal tilt $< 10^\circ$, < 2 mm of radial shortening, and < 2 mm of joint surface step-off [21,22].

Outcomes And Results

Outcomes

All patients were followed up for 13-17 months (mean 14.6 months). All patients achieved bony union without internal fixation failure or fracture displacement. Among them, 9 cases were evaluated as excellent, 13 cases as good, and 1 case as fair.

For the outcomes we reviewed the medical record of the patients who underwent the surgical treatment, which includes an injury description, and recent postoperative evaluation. By using Volar Rim Distal Radius Plate for the treatment of the fracture we found this plate provide satisfactory and good outcomes after the surgical treatment because it covers the vary far end of distal radius and the volar rim. We used wartland and werley score to calculate the postoperative outcomes for this fracture It also includes a subjective assessment of pain, the radiographic examination, and the follow up of ythe clinical

exam.. No patients had signs of nerve entrapment. The Garland and Werley functional system score was used for each patient. The Garland and Werley score is a postoperative assessment tool in which high score indicates worse postoperative outcomes. This scoring system is calculated on the base of the residual deformity, subjective evaluation, objective clinical exam, and respective Complications[23]

Results

Based on our inclusion criteria, 23 patients were available for analysis in the present study. The average time to complete of the operative procedure was 55 min (range, 49–65 min). There were no perioperative complications such as tendon injury, neurovascular injury and wound infection. Bone unions occurred in all patients as assessed after an average followup period 13-17 months (Range 14.6 months). In this study, all distal radial fractures 9 patients and 14 patients with AO-23C3 (AO/OTA type 23B3) and (AO/OTA type 23C.x) healed. Nine patients with (type 23B3) that were fixed with Volar Rim Distal Radius Plate, fourteen patients with (type 23B3) healed. There was no non-union or wound infection in this study. No breakage of plates was observed. No patient experienced a change in daily activity or occupation. These patients had an average Gartland and Werley score of 9 and ranged between 2 and 14. Among them, 9 cases were evaluated as excellent, 13 cases as good, and 1 case as fair. No patient experienced a postoperative complication, such as volar subluxation of the carpus, loss of reduction, plate breakage, CRPS, tendon rupture, compression neuropathy, and/or wrist joint stiffness.

Dual Plating Technique

Displaced intra-articular fractures of the distal end of the radius represent complex injuries because of the small size of the fracture fragments and their interrelationship with radiocarpal and radioulnar kinematics. Typically, volar shear fractures, classified as AO-OTA 23-B3 fractures, can be successfully stabilized through open reduction and internal fixation (ORIF) using a volar plate with a sufficient buttressing surface. However, when the volar lunate fossa fragment is too small and too distal, this fragment may be easily missed and can result in recurrent carpal translation. The volar rim of the lunate fossa is the only portion of the articular surface responsible for preventing volar carpal translation.[57-59] Therefore, as Orbay et al.[48] have said, “the volar rim fragment (VRF) of the lunate fossa is the Achilles heel of distal radius fracture fixation.” This fragment is not typically supported by standard volarly placed devices, even if the volar plate is properly placed[60-61] In the present report, we describe an operation technique to secure the Volar Rim Fragment [VRF] of the distal radius using dual locking plates, the one which we used is a 2.4-mm straight plate.

Statistical analysis.

The data of this study were analyzed by SPSS 22.0, t test and chi square test which was used to compare the results between patient groups, with statistical difference defined as 5% ($P \leq 0.05$).

Discussion

The treatment of distal end radius fractures varies from closed reduction and casting in minimally displaced fractures to open reduction and internal fixation in more complex fractures. Open reduction and internal fixation restore the wrist's anatomy and help in faster rehabilitation with good clinical outcomes [24]. The distal radius plates can not provide enough support for distal fragments. For volar fractures, particular attention should be directed toward the extent of the volar surface involved. The extent of involvement becomes increasingly relevant when a marginal fracture of the volar lunate facet is present. The volar margin of the lunate facet is the anchorage point for the short radiolunate ligament which is important for carpal stability.[25-27] Volar plating is currently favored for comminuted distal end radius fracture patterns and osteoporotic bones [28]. Therefore, Depuy Synthesis developed a universal locking plate for the distal radius of the distal volar to meet the special internal fixation needs of fractures. Depuy Synthesis anatomical volar locking plate system is a new internal fixation system which combines the advantages of existing internal fixation systems. First, the design of the plate is highly consistent with the anatomical structure of the distal radius. The shape of the distal end of the plate was in good agreement with the "watershed line" and surface anatomy of the distal end of the volar radius. When the plate is placed at the distal end, it can effectively prevent tendon stimulation and reduce the interference to soft tissue. The new design of the distal radius plate uses the "watershed line" on the volar side of the radius as the natural anatomical mark. By pushing the plate to the "watershed line", the fit between the plate and the bone surface can be improved. However, there are some problems in the clinical application of 2.4mm Volar Rim Distal Radius Plate. The distal location of the watershed line on this fragment permits its safe stabilization by buttressing implants. On the other hand, the styloid process of the radius rarely needs buttressing [47], but rather is fixed by properly directed pegs. This is fortunate, because the watershed line is proximal on this fragment and the essential volar capsular ligaments, which originate from its volar surface, which should be preserved. The first choice is that the locking hole of the distal plate points to the proximal dorsal side. At this time, the dorsal approach should be added, and the small plate should be used to effectively fix the fracture block of the dorsal side. In the clinical application of 2.4mm Volar Rim Distal Radius Plate, the fracture site of the distal volar side is located at the distal end of the radial watershed, there is a wrist volar joint capsule covering, the joint capsule forms an obstacle between the fracture and the plate, which hinders the correct placement of the plate, and because the joint capsule is thick, it hinders the maintenance and recovery of palmar inclination. Therefore, after the plate is placed correctly, the thumb should be used to press the dorsal side of the distal radius to maintain the palmar inclination of the radius, and a locking screw should be inserted to maintain the negative angle of the palmar inclination of the distal radius when the distal radius fits the distal end of the plate. If the fracture block of the distal dorsal radius is small and close to the distal end, it is difficult for the locking screw to effectively fix the fracture block of the dorsal side. At this time, the dorsal approach should be added, and the small plate should be used to effectively fix the fracture block of the dorsal side. There had been a shift in focus from the use of non-locking volar plates to locking volar plates as the latter provides secure and reliable fixation of complex fractures due to angular stability [29, 30]. Kanabar et al. [29] reported that early mobilization in fractures treated with volar locking plates does not lead to a decrease in the

radiological parameters achieved at the final follow-up [30]. However, in their case series of comminuted distal end radius fractures, Gruber et al. noticed a statically significant loss in parameters like radial inclination and volar tilt with the use of volar locking plates [31]. The implant of the VRP can be used with low-lying distal radius fractures, including A/O classification types 23A, 23B, and 23C, when achieving anatomic reduction and preserving the joint surface is challenging with a more traditional plate. The 23 patients treated with VRP had Gartland and Werley categorical rating from excellent to good and good to fair with the majority in the good range and no poor outcome, which suggests that VRP can be use for a promising solution to very distal radius fractures. The volar cortex of the distal radius was very often not as severely comminuted when compared with the dorsal cortex. Anatomical reduction of the palmar cortex may avoid the shortening of the radius, which is important for its restoration. In this study, final ulnar variance was reconstructed to excellent level, and resulted in a wide range of motion. The Volar Rim Distal Radius Plate system used in our study is a locking plate system, and this is be one of the reasons which help us for retaining good anatomical reduction.

The results with surgical treatment of OTA type B3 fracture are able to compare with OTA types A and C. which suggests us satisfactory outcome can achieve when the fragments are well reduced and secured. [32]. Results after nonoperative treatment of volar rim fractures are not satisfactory and often require subsequent corrective osteotomy. [33-35]. The majority of the traditional volar plates are not designed to stabilize the VRF. A very distal plate placement of the traditional volar plates increases the risk of placing screws in the joint. An attempt to advance a traditional volar fixed angle plate more distally to engage small VRFs also can lead to complications such as additional damage or rupture of flexor tendons because of the prominence of the implant when placed distal to the watershed line. [36-37]

In addition, the 2.4mm Volar Rim Distal Radius Plate is not good for the fixation of radial styloid process fractures. The screws used to fix the radial styloid process are located in the second row of the distal end of the plate, about 0.5cm near the watershed of the distal radius, and far away from the radial styloid process. The direction of the screws is the dorsal side of the styloid process. When the adjustable angle of the screws is 15 degrees, the screws are inserted into the dorsal side of the radial styloid process It is far away from the styloid process tip, and the radial styloid process is mostly cancellous bone, so it is not conducive to fixation. In the case of distal radius fracture, the fracture block of radial styloid process is small, so the distal radial plate can be used for auxiliary fixation. Kanabar et al. noticed that parameters such as range of motion and grip strength were regained by up to 94% in the three months after volar plating [38].

All operations in this study were performed by the same chief physician. The quality of reduction and fixation was confirmed immediately after operation, and regular follow-up was conducted after operation. Reports from previous studies reveal various complications following the treatment of VRFs, such as post-traumatic osteoarthritis, [39-41] or rupture of the extensor pollicis longus. [42]. and loss of reduction [43-44]. None of these complications were encountered in our study.

There are many reasons that why the dorsal aspect of the radius is a poor site for the placement of internal fixation little space is available between the skin and the bone surface and it is occupied fully by extensor tendon sheath,, the dorsal surface of the radius is convex, inducing extensor tendons to rub forcefully against dorsal implants, therefore increasing their likelihood of injury; blood vessels to the distal fragments are mainly on the dorsal aspect, exposing them to harm during dissection; the dorsal cortex usually is comminuted, increasing the difficulty of the procedure; and finally, dorsal scars are less well tolerated . The volar aspect is a better choice for implant application for the following reasons: more space is available, because flexor tendons are located far from the volar radial surface and the pronator quadratus is conveniently interposed; the concave surface of the distal radius protects flexor tendons from hardware irritation and the blood supply is less likely to be disturbed by a volar approach; the volar cortex usually is less comminuted, facilitating volar osteosynthesis; and finally, volar scars are better tolerated.[45,46].Careful examination of the volar aspect of the distal radius reveals anatomic features that must be considered to optimize the technique of volar fixed angle fixation.

However, as a retrospective study, this study has limitations and needs further long-term, large sample randomized controlled study. However, we believe that the data from the present study can be used for comparison in future studies.

Conclusion

In this study, Volar fixed angle fixation of distal radius fractures was introduced as a solution for the dorsal fracture shortly after the initial disappointment with dorsal fixed angle plates. Volar fixed angle plates are designed for the management of volar fractures. A large number of distal radius fractures occur in elderly and infirm patients and these have special requirements: their limited coping abilities compel that function be restored promptly to maintain their independence, their poor bone quality requires particularly capable fixation, and the risk for anesthesia and surgical morbidity must be minimized. Volar fixed angle fixation has proven adequate treatment method for this patient population [48]. The rim plate has a low profile to allow its placement distal to the watershed line without increasing the risk of flexor tendon irritation. Despite its distal placement, in this series, there were no cases of flexor tendon rupture and only two of the four cases of implant removal were for flexor or extensor tendon irritation. This is consistent with the literature which suggests that attrition flexor tendon rupture is infrequent yet may occur with prominent higher profile plates placed at the watershed line, but is unlikely in cases where plates are designed to be placed more distal to this line, probably due to their contoured design and low profile.[49]

In conclusion, It is an effective fixation method to treat distal radius fractures with 2.4mm Volar Rim Distal Radius Plate, volar rim plates give an adequate buttress of the volar radius distal to volar projection of the lunate facet and do not interfere with wrist mobility. The use of such plates helps in early rehabilitation without the fear of a decrease in radiographic indices and hence functional results, which can provide more firm stability, meet the needs of early functional exercise and improve the prognosis. Volar Rim Distal Radius Plate is useful for achieving good anatomical reduction, but care must be taken to avoid

the complication of tendon rupture. Placing the plate proximally to the watershed line and removing the plate soon as the fracture united were necessary to avoid the complication of tendon rupture. This plate is suitable for the anatomical locking plate of distal radius fracture. It can be used for the fixation of distal radius fracture and distal watershed fracture, and does not significantly increase the carpal tunnel pressure.

By these considerations, Volar Rim Distal Radius Plate can provide excellent results in treating distal radius fractures. This surgical technique is simple and easy to employ, which give the great promise for its clinical application. Despite the small sample size, the present study should provide the basis for a future prospective study involving Volar Rim Distal Radius

Declarations

Ethical Approval and Consent to participate

This article contains the studies with human participants performed by the authors. The present study was approved by the Beijing Chaoyang Hospital Ethics Committee and informed consent was obtained from all patients.

Consent for publication

All authors agree for publication.

Availability of supporting data

The data analyzed during the current study is available from Corresponding author on reasonable request.

Competing interests

The authors have no conflict of interest or financial disclosures.

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Authors' contributions

Yang Liu, Waheed Muhammad Zeeshan and Junlin Zhou designed this study; Yang Liu did the surgical treatment of patients; Waheed Muhammad Zeeshan and Dong Wang collected and analyzed the data; Waheed Muhammad Zeeshan wrote the article and Junlin Zhou revised the article. All the authors read and approved the final manuscript.

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Tables

Table1: Patient Demographics

No.of Patients	Age	Gender	Injured side	Injury mechanism	DRUJ INSTABILITY	ULNARSTYLOID FRACTURE
1	51	M	R	Road Traffic Incident	NO	YES
2	37	F	L	Road Traffic Incident	NO	YES
3	83	F	L	FALL	NO	NO
4	68	F	L	FALL	NO	NO
5	58	M	R	FALL	NO	YES
6	64	F	R	FALL	NO	NO
7	77	M	L	FALL	NO	NO
8	59	F	R	FALL	NO	YES
9	55	F	L	Road Traffic Incident	NO	NO
10	55	M	L	FALL	NO	NO
11	33	F	L	Road Traffic Incident	NO	NO
12	45	F	L	Road Traffic Incident	NO	YES
13	53	M	R	FALL	NO	YES
14	78	F	L	FALL	NO	NO
15	50	F	L	Road Traffic Incident	NO	YES
16	65	F	L	FALL	NO	YES
17	82	F	L	FALL	NO	YES
18	71	M	L	FALL	NO	YES
19	32	F	L	Road Traffic Incident	NO	NO
20	60	F	L	FALL	NO	NO
21	61	F	L	FALL	NO	YES
22	50	F	L	Road Traffic Incident	NO	YES

No.of Patients	Age	Gender	Injured side	Injury mechanism	DRUJ INSTABILITY	ULNARSTYLOID FRACTURE
23	72	M	R	FALL	NO	NO

F: female, L: left, M: male, mo: month, R: right, yr: year.

Table 2: Surgical Time and the plate type

No.of Patients	SURGICAL TIME(MIN)	SECONDARY SURGERY	BONE GRAFT	PLATE	AO/OTA classification	Follow-up (mo)
1	53	NO	NO	VA-LCP	23C3	17
2	51	NO	NO	VA-LCP	23B3	15
3	54	NO	NO	VA-LCP	23C3	14
4	58	NO	NO	VA-LCP	23C3	12
5	49	NO	NO	VA-LCP	23B3	17
6	55	NO	NO	VA-LCP	23C3	14
7	52	NO	NO	VA-LCP	23C3	12
8	57	NO	NO	VA-LCP	23B3	10
9	54	NO	NO	VA-LCP	23B3	13
10	59	NO	NO	VA-LCP	23C3	11
11	51	NO	NO	VA-LCP	23B3	16
12	53	NO	NO	VA-LCP	23C3	14
13	54	NO	NO	VA-LCP	23C3	17
14	57	NO	NO	VA-LCP	23C3	13
15	55	NO	NO	VA-LCP	23B3	11
16	58	NO	NO	VA-LCP	23B3	16
17	56	NO	NO	VA-LCP	23C3	13

No.of Patients	SURGICAL TIME(MIN)	SECONDARY SURGERY	BONE GRAFT	PLATE	AO/OTA classification	Follow-up (mo)
18	52	NO	NO	VA-LCP	23C3	14
19	55	NO	NO	VA-LCP	23B3	16
20	59	NO	NO	VA-LCP	23C3	13
21	55	NO	NO	VA-LCP	23C3	11
22	53	NO	NO	VA-LCP	23B3	17
23	55	NO	NO	VA-LCP	23C3	15

Table 3: Operative Complications–Nerve Injury–and the Daily Activity

Operative Complications	Nerve Injury	Tendon Irritation	Wound Infection	Healing Time	Plate Breakage	Daily Activity
No	No	No	No	10 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	13 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	13 weeks	No	Normal
No	No	No	No	9 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	13weeks	No	Normal
No	No	No	No	11 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	11 weeks	No	Normal
No	No	No	No	10weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	14 weeks	No	Normal
No	No	No	No	10 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	11weeks	No	Normal
No	No	No	No	13 weeks	No	Normal
No	No	No	No	12 weeks	No	Normal
No	No	No	No	10 weeks	No	Normal
No	No	No	No	10weeks	No	Normal
No	No	No	No	12 weeks	No	Normal

Table 4: **Clinical Profile of Patients**

Clinical Profile	Data
Age, y	32.82 ± 11.81
Gender	
Male	7
Female	16
Mode of injury	
RTI	8
Fall	14
Assault	1
Type of fracture (AO classification)	
B3	9
C3	14

Abbreviation: RTI, road traffic incident.

aValues are expressed as mean ± standard deviation or No.

The radiological parameters during the immediate post-operative period were compared with those at the time of final follow-up, as outlined in [Table 5] The average radial inclination loss was 0.68 mm, radial length was 0.1 mm, volar angle was 0.26°, and ulnar variance was 0.16 mm, although the change in indices was not statistically significant.

Table 5: **Radiological Parameters a,b**

Parameter	Immediate Postoperative Period	At Final Follow-Up	P Value
Radial length, mm	12.04 ± 1.91	11.84 ± 2.04	0.1309
Radial inclination,°	23.08 ± 2.46	22.89 ± 2.64	0.0951
Volar angulation, °	5.56 ± 5.54	5.21 ± 5.72	0.1334
Ulnar variance, mm	-0.33 ± 0.68	-0.29 ± 0.58	0.1337

aValues are expressed as mean ± standard deviation.

There was no significant difference in the radiological parameters between different follow-ups.

The clinical parameters (flexion, extension, supination, and pronation) as measured at eight weeks and at final follow-up revealed significant improvement [Table 6]. According to Gartland and Werley's scoring

system, 9 patients had excellent results and 13 patients had good results and 1 fair result.

Table 6: **Clinical Outcome Measures**

Parameter	At Six Weeks	Final Follow-Up
Flexion,°	46.73 ± 7.24	71.91 ± 8.08
Extension, °	49.08 ± 6.28	76.95 ± 5.70
Pronation, °	72.04 ± 5.09	77.65 ± 6.01
Supination, °	75.47 ± 6.02	81.86 ± 6.28
Percentage grip power, %	41 ± 6.23	94.52 ± 5.02

Table 7: Gartland and Werley Score of Patients

No.of Patients	FLEXION	EXTENSION	SUPINATION	PRONATION	GARTLAND AND WERLEY SCORE
1	90	85	85	90	3
2	90	90	85	90	2
3	50	90	40	85	8
4	60	90	90	90	4
5	85	40	85	50	10
6	90	90	90	85	2
7	35	30	85	90	6
8	90	35	40	40	13
9	40	60	85	85	6
10	30	80	35	75	8
11	85	85	85	90	2
12	90	85	90	90	0
13	30	35	70	85	8
14	40	35	75	70	7
15	90	90	85	85	2
16	30	80	35	70	9
17	40	30	60	70	11
18	80	35	80	70	5
19	90	85	90	85	1
20	40	30	70	80	8
21	85	90	80	90	2
22	85	85	90	90	1
23	35	30	30	80	13

Figures

Figure 1

Three dimensional view of distal radius showing the Volar Rim, Scaphoid, Ulna and the lunate facets

Figure 2

PA and Lateral view of radiographs of Patient No.8 showing distal radial fracture

Figure 3

Axial and Saggital CT scan of Distal Radius of Patient No.8 showing degrees of involment of radioulnar joint.

Figure 4

Evaluate the efficiency of volar rim distal radius plate by using Depuy synthes E-models software.Volar rim plate give an adequate buttress to volar projection of the lunate facet of the Distal radius.

Figure 5

Figure shows the Henry incision was taken and the skin was cut on the lateral side, Stable Fixation of distal radial fracture in Patient No.12 was achieved by using distal radial volar Rim locking plate

Figure 6

PA and Lateral radiographs of distal radius fracture of Patient No.12 showing the distal position of the distal radius volar plate after surgery.

Figure 7

Saggital CT scan of Patient No.12 showing the distal position of the distal radius volar rim plate.

Figure 8

PA and Lateral radiographs of distal radius fracture of Patient No.12 at 1st month follow up

Figure 9

PA and Lateral radiographs of distal radius fracture of Patient No.12 at 3rd month follow up

Figure 10

Figure shows that volar lunate fossa fragment is too small and too distal during the surgical technique of Patient No.8 we use dual locking plates to secure the Volar Rim Fragment (VRF) Using 2.4 mm straight plate

Figure 11

PA and Lateral view of distal radius fracture of Patient No.8 showing the buttressing of lunate facet using dual locking plate technique after surgery.

Figure 12

Axial and Saggital CT scan of Patient No.8 showing the butterness of lunate facet using dual locking plate

Figure 13

Radiographic view of distal radius fracture of Patient No.8 using dual locking plate at 1st month follow up.

Figure 14

PA and Lateral radiographs of distal radius fracture of Patient No.12 showing the distal position of the distal radius volar rim plate at final follow up.

Figure 15

Figure shows the Flexion[90],Extension[85].Supination[90]and Pronation[90] of Patient No.12 after the final follow up