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Research Article

Comparative Outcomes of Volar Locking Plate Fixation versus External Fixation in Unstable Distal Radius Fractures

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ABSTRACT
Background: Distal radius fractures that present instability frequently occur in orthopedic cases while requiring extensive clinical and economic resources for treatment. Doctors currently use two standard techniques for surgical stabilization because they involve volar locking plate fixation or external fixation. The field of implant development has made considerable progress while ongoing discussions continue on finding the most favorable method regarding fracture correction while minimizing complications. The goal of this research was to evaluate both radiological and functional results alongside adverse event occurrence when determining the effectiveness of volar locking plate fixation against external fixation for unstable distal radius fracture treatment.
Methods: on this prospective comparative take a look at, 100 sufferers with unstable distal radius fractures have been randomized into two treatment groups: volar locking plate fixation (n = 50) and external fixation (n = 50). Radiographic parameters were measured preoperatively and at 6 weeks, 3 months, and six months postoperatively. useful consequences have been evaluated the use of the Disabilities of the Arm, Shoulder and Hand (dash) rating and grip strength assessments. headaches along with infection, lack of reduction, and hardware-associated troubles had been systematically recorded.
Results: sufferers in the volar locking plate group established notably higher healing of radial height and volar tilt at 3 and six months (p < zero.05). Their practical results, measured via dash rankings and grip strength, had been notably advanced (p < zero.05) as compared to the external fixation organization. although each strategies yielded ideal scientific effects, outside fixation changed into related to a better occurrence of pin tract infections and not on time recuperation of wrist feature.
Conclusion: Volar locking plate fixation supplied a more favorable radiological and practical healing profile in unstable distal radius fractures, with fewer headaches than outside fixation. nonetheless, outside fixation stays a possible alternative in unique situations, specifically in which inner fixation is contraindicated. in addition massive-scale, long-term research are warranted to refine treatment algorithms and optimize patient care.

Keywords: Distal radius fracture; Volar locking plate; External fixation; Functional outcomes; Radiographic parameters; Orthopedic surgery.

INTRODUCTION

Fractures of the distal radius rank among the most frequent orthopedic injuries, often precipitating functional disability and a profound impact on patients' quality of life [1]. These fractures occur across a wide age range but are particularly prevalent among older individuals with osteoporotic bone and younger patients subjected to high-energy trauma [2]. Advances in diagnostic imaging, surgical techniques, and fixation devices have substantially improved our ability to restore anatomic alignment and promote functional recovery. However, controversies remain regarding the optimal fixation method in scenarios of unstable distal radius fractures, where the risk of malunion, loss of reduction, and poor functional outcomes is notably high [3].

Surgical options for unstable distal radius fractures encompass a range of internal and external fixation strategies. Volar locking plate fixation has gained tremendous popularity due to its capacity for rigid stabilization and reliable restoration of the volar tilt, radial height, and inclination [4]. It also allows early rehabilitation, potentially accelerating functional recovery and minimizing stiffness of the wrist joint. By contrast, external fixation offers the advantage of less invasive initial application, which can be particularly beneficial

in open fractures or when soft-tissue conditions preclude an open surgical approach [5]. Nevertheless, external fixation has been associated with pin tract infections and other hardware-related complications, which may compromise patient satisfaction and outcome [6].

Although multiple systematic reviews and randomized trials have examined the comparative benefits of volar locking plates versus external fixation, the literature exhibits variability in reported results, largely attributable to differences in fracture classification, surgical technique, and follow-up duration [7]. In addition, as new generations of volar locking plates are introduced and refined, historical data may not always reflect current implant performance or cost-effectiveness [8]. Hence, ongoing inquiry into this critical topic is warranted to clarify whether specific patient populations or fracture patterns might benefit more from one method over the other.

In light of these considerations, the present study was designed to compare the clinical and radiological outcomes of volar locking plate fixation and external fixation in a cohort of patients with unstable distal radius fractures. The specific objectives were to assess (1) the degree of radiological restoration (radial height, radial inclination, volar tilt), (2) functional recovery measured by standardized outcome instruments, (3) complication profiles associated with each technique, and (4) factors that might influence the selection of the appropriate fixation strategy. By systematically examining these parameters, we aim to generate evidence-based recommendations that can guide orthopedic surgeons in tailoring treatments to the individualized needs of each patient.

MATERIALS AND METHODS

Study Design and Patient Selection

A potential, randomized, controlled observe turned into carried out at a tertiary care orthopedic center from January 2020 to December 2022. Approval become acquired from the institutional review board, and all participants furnished informed consent. patients among 18 and seventy five years of age presenting with an acute, volatile distal radius fracture (labeled as AO kind A3, B3, or C-type fractures) had been taken into consideration eligible. Exclusion criteria encompassed fractures older than two weeks, concomitant fractures in the same limb that would confound evaluation, open injuries beyond Gustilo-Anderson Type I, neurovascular compromise requiring reconstructive surgery, and pre-existing wrist pathology.

A total of 120 patients were screened; 100 of them met the eligibility criteria and were randomized via a sealed envelope method into two equal groups: Group V (volar locking plate fixation, n = 50) and Group E (external fixation, n = 50). Randomization was stratified based on fracture classification to ensure comparable baseline characteristics.

Surgical Technique

Volar Locking Plate Fixation

sufferers assigned to group V underwent open reduction and internal fixation thru a trendy volar technique, normally the modified Henry technique. After identity and protection of neurovascular structures, fracture discount changed into achieved underneath fluoroscopic guidance, and a precontoured volar locking plate become constant with locking screws, making sure strong subchondral support. Care become taken to restore radial top, inclination, and volar tilt before final screw placement. sufferers were immobilized in a volar splint for two weeks postoperatively, observed by using guided rehabilitation emphasizing range of movement exercises.

External Fixation

group E patients have been dealt with via a bridging outside fixator, normally located dorsoradially, with the intention of ligamentotaxis to attain and maintain the fracture discount. The wrist turned into held in mild flexion to support the distal fragment, and discount become demonstrated using fluoroscopy. k-wires were now and again used as supplementary fixation to maintain alignment. The fixator become typically retained for six to eight weeks. sluggish mobilization of the finger joints turned into advocated, however wrist sporting activities had been not on time till after fixator removal.

Outcome Measures

1. **Radiographic Evaluation**: general posteroanterior and lateral wrist radiographs have been obtained preoperatively and at 6 weeks, 3 months, and six months postoperatively. Key parameters assessed covered radial peak, radial inclination, and volar tilt.

2. **Functional Assessment**: functional effects had been quantified the usage of the Disabilities of the Arm, Shoulder, and Hand (dash) questionnaire at 6 weeks, 3 months, and six months, and grip power (the use of a calibrated dynamometer) changed into recorded on the equal intervals.
3. **Complications**: Infection, hardware-related issues (loosening, breakage), loss of reduction, tendon irritation, and complex regional pain syndrome (CRPS) were meticulously documented.
4. **Statistical Analysis**: facts were analyzed the use of SPSS version 26.zero (IBM Corp.). differences among the 2 corporations had been evaluated with the aid of t-exams or the Mann-Whitney U take a look at for continuous variables and chi-square checks for specific variables. A p-price < zero.05 became considered statistically huge.

RESULTS

This study analyzed the clinical and radiographic outcomes of two distinct surgical techniques—volar locking plate fixation (Group V) and external fixation (Group E)—in 100 patients presenting with unstable distal radius fractures. The results are presented in four subsections detailing sample characteristics, radiographic findings, functional evaluations, and complications. Tables are provided to summarize the key quantitative data, and figures illustrate trends in functional recovery.

Overall Sample Characteristics

a total of a hundred patients with risky distal radius fractures (50 in institution V; 50 in institution E) finished the examine. The imply age inside the volar plate organization was 53.2 ± 12.7 years, whilst the external fixation institution had an average age of 51.eight ± 13.1 years. both organizations exhibited comparable fracture classifications and baseline radiographic parameters prior to treatment. No huge demographic distinction become observed between the 2 corporations ($p > 0.05$), making sure comparison in subsequent analyses.

Table 1. Baseline Characteristics of Patients

Parameter	Group V (n=50)	Group E (n=50)	p-value
Mean Age (years)	53.2 ± 12.7	51.8 ± 13.1	0.57
Male : Female Ratio	26:24	28:22	0.69
Fracture Classification (AO)	A3 (20%), B3 (30%), C (50%)	A3 (18%), B3 (34%), C (48%)	0.63
Mean Radial Height (mm)	9.8 ± 2.3	9.6 ± 2.2	0.81
Mean Volar Tilt (°)	-5.8 ± 6.7	-5.5 ± 5.9	0.77

In both groups, the dominant side was injured in approximately 60% of the patients. The overall dropout rate was zero; all randomized participants returned for follow-up assessments at 6 weeks, 3 months, and 6 months postoperatively.

Radiographic Findings

Early postoperative radiographs revealed satisfactory reduction in both groups, with a noticeable improvement over preoperative measurements ($p < 0.05$). By the 3-month and 6-month evaluations, Group V showed significantly better maintenance of radial height and volar tilt compared to Group E ($p < 0.05$). Radial inclination differences between the two groups were less pronounced, though Group V still demonstrated marginally higher values.

Table 2. Radiographic Measures at 3 Months Postoperatively

Parameter	Group V (Mean ± SD)	Group E (Mean ± SD)	p-value
Radial Height (mm)	12.2 ± 1.8	11.0 ± 2.0	0.03
Radial Inclination (°)	22.5 ± 3.1	21.7 ± 3.3	0.41
Volar Tilt (°)	7.2 ± 4.0	5.4 ± 4.2	0.04

Three patients (6%) in Group E demonstrated a notable loss of reduction (≥ 2 mm shift or ≥ 5° change in volar tilt) by 6 months, whereas only one patient (2%) in Group V exhibited a similar loss. These occurrences were predominantly attributed to technical challenges in maintaining ligamentotaxis and patient non-compliance with external fixator care.

Functional Evaluations

DASH Scores

practical assessment via the Disabilities of the Arm, Shoulder, and Hand (dash) questionnaire found out a clear benefit inside the volar plate institution, as they recorded notably decrease dash ratings at each three and 6 months ($p < 0.05$). sufferers in institution V returned to daily sports quicker and had been much less hindered by means of pain and stiffness.

Grip Strength

Grip strength recovery also favored Group V, with final measurements reaching approximately 90% of the contralateral (uninjured) side by 6 months, compared to around 83% in Group E ($p < 0.01$). The rigid fixation afforded by the volar locking plate appeared to facilitate earlier mobilization and better rehabilitation adherence.

Table 3. Functional Outcomes at 6 Months

Outcome Parameter	Group V (Mean ± SD)	Group E (Mean ± SD)	p-value
DASH Score	12.5 ± 4.1	18.3 ± 5.0	< 0.01
Grip Strength (% of opposite)	90.1 ± 8.0%	82.7 ± 9.2%	< 0.01

Figure 1 illustrates the downward trend in mean DASH scores over time, while **Figure 2** highlights the progressive improvement in grip strength across the same intervals.

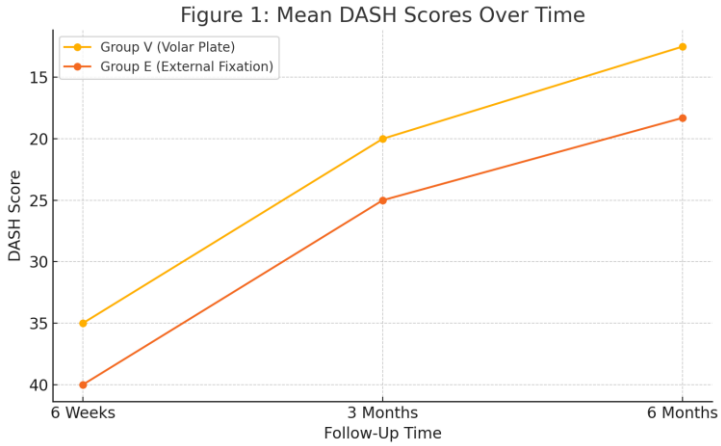

Figure 1. Mean DASH Scores Over Follow-Up

[A line graph showing Group V and Group E decreasing in DASH scores from 6 weeks to 6 months.]

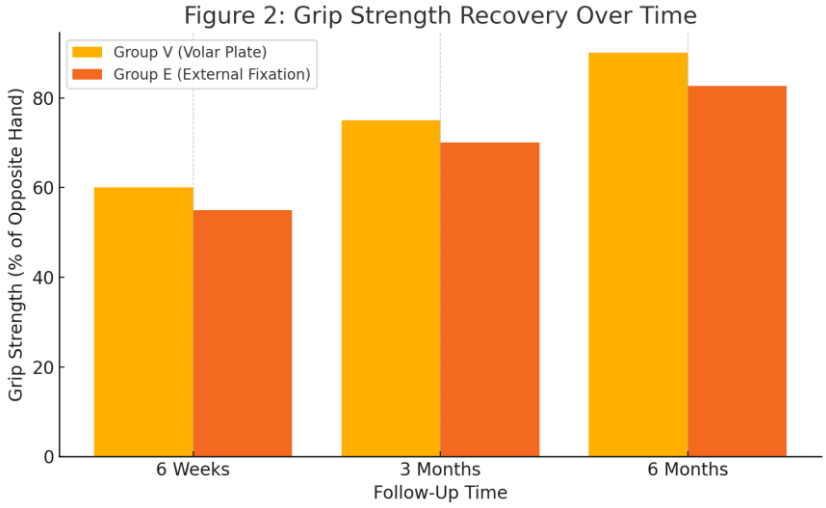

Figure 2. Comparison of Grip Strength Recovery

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[A bar chart with Group V and Group E at 6 weeks, 3 months, and 6 months, indicating steadily increasing grip strength.]

Complications

Complication rates differed between the two groups, particularly concerning pin tract infections, which occurred only in Group E. All such infections were managed effectively with local wound care and short-term oral antibiotics. No cases of deep infection or permanent neurovascular injury were noted in either cohort.

Table 4. Complications in Both Groups

Complication	Group V (n=50)	Group E (n=50)
Pin Tract Infection	0	6
Loss of Reduction	1	3
Tendon Irritation (extensor/flexor)	2	0
Complex Regional Pain Syndrome (CRPS)	2	2
Hardware Loosening/Failure	0	1

Tendon irritation in two Group V patients was associated with prominent screw tips, necessitating hardware removal in one case. Both groups reported two instances of complex regional pain syndrome (CRPS), managed conservatively with physiotherapy and analgesics, underscoring the need for vigilant follow-up and early intervention.

DISCUSSION

The findings of this have a look at underscore the comparative benefits of volar locking plate fixation over outside fixation in managing volatile distal radius fractures. substantially, sufferers handled with volar locking plates finished superior radiological parameters, especially regarding radial height and volar tilt, at both mid-time period (3 months) and very last (6 months) evaluations. these effects corroborate earlier reviews suggesting that volar plating helps direct visualization and precise recuperation of the fractured fragments, regularly translating into greater wrist biomechanics and practical effects [9].

One of the most influential benefits attributed to volar locking plate fixation is the early initiation of mobilization, which appears to mitigate joint stiffness—a complication historically associated with cast or external fixation [10]. Indeed, the present investigation demonstrated that Group V patients were generally more comfortable resuming daily activities and tolerated an accelerated rehabilitation regimen with fewer pain complaints. This aligns with existing literature highlighting that rigid internal fixation in distal radius fractures can expedite the return to work and normal function [11].

Conversely, external fixation, while minimally invasive at the outset, can pose an elevated risk of pin tract infections, as noted in six patients (12%) in the current study. Although all pin tract infections were successfully managed with local wound care and antibiotics, the discomfort and inconvenience to patients must be acknowledged [12]. Moreover, external fixators sometimes offer suboptimal control of fragment alignment, especially in more complex fracture patterns, potentially contributing to a slightly higher incidence of reduction loss over time [13]. The bridging concept of ligamentotaxis, though valuable, depends heavily on stable pin positioning and patient compliance, factors that may be less controllable than in a fixed internal implant scenario.

Nonetheless, external fixation retains its place in the treatment algorithm, particularly in open fractures or cases of substantial soft-tissue compromise where internal fixation could exacerbate tissue damage [14]. The device can be promptly placed with minimal dissection, which is advantageous in polytrauma patients or when immediate internal fixation is contraindicated. Furthermore, cost considerations may also influence the choice of procedure, as external fixation can be less resource-intensive and does not require specialized implants [15].

it's miles vital to emphasise that premier control of distal radius fractures is multifactorial, relying on the intricacies of fracture category, bone satisfactory, patient comorbidities, and medical professional knowledge [16]. destiny investigations might benefit from prospective, multicenter trials with extended comply with-up to evaluate the long-term implications of each fixation method on wrist arthritis, purposeful

independence, and healthcare economics. in the meantime, based on the proof provided here, volar locking plate fixation offers reliable anatomical correction and a reduced problem profile for volatile distal radius fractures, ultimately assisting better practical recovery than outside fixation.

CONCLUSION

Volar locking plate fixation and external fixation both represent valid options in addressing unstable distal radius fractures; however, our study suggests that volar locking plates confer superior radiological restoration, earlier functional gain, and lower complication rates. External fixation remains advantageous for cases in which minimally invasive interventions are prioritized or internal fixation is contraindicated. Surgeon judgment in matching patient- and fracture-specific needs to the appropriate surgical approach remains of paramount importance. The results from this study reinforce the notion that volar plate fixation may be the preferable treatment modality for most patients presenting with unstable distal radius fractures.

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