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Original Research Article

Assessment of the Outcome of Intra-Articular Distal End Radius Fracture Managed by Joshi's External Stabilization System Versus Buttress Plating and its Correlation Using Green and O'brien Score

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Conflict of interest: Nil

Abstract

Background: Intra-articular distal end radius fractures remain challenging because restoration of articular congruity, stable fixation, and timely rehabilitation determine long-term wrist function. Joshi's External Stabilization System (JESS) utilizes ligamentotaxis and minimally invasive fixation, whereas buttress plating permits direct reduction and stable internal fixation.

Aim: To compare clinical, radiological, and functional outcomes of intra-articular distal end radius fractures treated with JESS versus buttress plating and to determine the correlation of radiological restoration with the Green and O'Brien functional score.

Methods: This comparative study was framed on 72 adult patients with intra-articular distal radius fractures managed at Santosh Medical College and Hospital, Ghaziabad, between January 2024 and June 2025. Thirty-six patients underwent JESS fixation and 36 underwent buttress plating. Clinical profile, AO fracture type, operative details, radiological restoration, complications, and Green and O'Brien score at final follow-up were analyzed using standard comparative statistics and Pearson correlation.

Results: Baseline characteristics were comparable between groups. Buttress plating required longer operative time and hospital stay but provided superior restoration of volar tilt (10.4±3.2° vs 6.2±4.0°, $p<0.001$), lower residual articular step-off (0.9±0.6 mm vs 1.6±0.8 mm, $p<0.001$), higher grip strength (84.6±9.5% vs 77.8±10.9%, $p=0.007$), and better flexion-extension arc (121.6±14.1° vs 110.3±15.4°, $p=0.002$). Mean Green and O'Brien total score was significantly higher after buttress plating than JESS (87.5±9.6 vs 78.4±11.8, $p<0.001$). Acceptable outcomes (excellent/good) were achieved in 83.3% of plated cases and 61.1% of JESS cases. Pin-tract infection was more frequent with JESS. Final Green and O'Brien score correlated negatively with residual articular step-off ($r=-0.62$, $p<0.001$) and positively with grip strength ($r=0.78$, $p<0.001$) and flexion-extension arc ($r=0.74$, $p<0.001$).

Conclusion: Both JESS and buttress plating achieved fracture union and functional recovery; however, buttress plating produced better anatomical restoration and superior Green and O'Brien scores at final follow-up. JESS remains a useful option where soft-tissue preservation, lower implant burden, or resource constraints favor external stabilization.

Keywords: distal radius fracture; intra-articular fracture; Joshi's external stabilization system; buttress plating; Green and O'Brien score; functional outcome.

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Introduction

Distal radius fractures are among the most frequent injuries encountered in orthopaedic practice and constitute a major proportion of upper-limb fractures worldwide [1,2]. Their epidemiology is bimodal, affecting younger adults after high-energy trauma and older adults after low-energy osteoporotic falls [2,3]. Intra-articular fractures of the distal radius are clinically important because they involve the load-bearing radiocarpal surface, threaten wrist congruity, and may lead to chronic pain, stiffness, weakness, distal radioulnar joint dysfunction, and post-traumatic arthritis if reduction is inadequate [1,4,5]. Contemporary management therefore focuses not only on fracture union but also on restoration of radial length, radial inclination, volar tilt, and especially articular congruity, because these parameters influence long-term wrist mechanics and patient-reported function [4-6]. The management of intra-articular distal end radius fractures has evolved substantially over the last three decades. Earlier approaches emphasized cast immobilization or bridging external fixation based on ligamentotaxis, whereas more recent operative trends favor volar locking and buttress plate constructs that allow direct fracture visualization and subchondral support [3,7]. Despite the increasing popularity of internal fixation, consensus remains incomplete, particularly for comminuted intra-articular patterns in which fragment size, metaphyseal void, soft-tissue condition, surgeon familiarity, implant availability, and economic considerations may all influence treatment choice [3,8]. The American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand have acknowledged this complexity in their guideline updates, emphasizing individualized decision-making and careful attention to both anatomical and functional endpoints [3,9].

Joshi's External Stabilization System (JESS) represents a versatile method of external stabilization based on the principles of distraction and ligamentotaxis. It is relatively less invasive, requires smaller incisions, minimizes soft-tissue stripping, and may be particularly attractive in comminuted patterns or in settings where cost containment and implant simplicity are relevant [10,11]. JESS can maintain radial length effectively and can be augmented with percutaneous wires when needed. However, external fixation is not without limitations: imperfect restoration of volar tilt, difficulty controlling small articular fragments, pin-tract infection, and delayed wrist mobilization may compromise the eventual functional result [7,10,11]. Recent observational work has shown that JESS can achieve acceptable outcomes in a large proportion of distal radius fractures, but the magnitude of its benefit relative to contemporary plating remains debated [10].

Buttress plating, particularly through a volar approach, allows direct reduction of the joint surface, stable fixation of marginal fragments, early mobilization, and improved maintenance of alignment in many unstable fractures [7,8,12].

Comparative studies have demonstrated that plating often provides faster early recovery and improved restoration of anatomical parameters, although some randomized series and meta-analyses have shown mixed differences at longer follow-up intervals [8,12-15]. Wright et al. observed favorable outcomes with volar fixed-angle plating compared with external fixation in unstable fractures [12], whereas Roh et al. and subsequent meta-analyses suggested that plating is associated with better early functional recovery but not always uniform superiority across all radiographic or complication endpoints [8,13-15]. Conversely, Shukla et al. reported that external fixation could still perform strongly in selected displaced intra-articular fractures when assessed by Green and O'Brien parameters at one year [16]. These divergent findings reinforce that neither strategy is universally dominant and that local surgical experience and fracture morphology still matter.

Outcome assessment after distal radius fracture surgery also remains an important methodological issue. A purely radiographic endpoint may overlook symptoms and performance, whereas a purely patient-reported endpoint may fail to capture relevant anatomical determinants of late arthritis and instability. The Green and O'Brien score, later modified by Cooney, remains a widely used composite functional system because it integrates pain, functional status, range of motion, and grip strength into a 100-point scale that is easy to apply in routine orthopaedic follow-up [16-18]. Kwok et al. found that the Green and O'Brien system correlated well with other functional measures and was relatively demanding in identifying truly excellent outcomes [17]. Fang et al. further highlighted that multidimensional functional tools remain highly relevant across the recovery period after distal radius fixation [18]. For studies comparing JESS and buttress plating, use of the Green and O'Brien score therefore offers clinically interpretable differentiation between anatomical success and lived functional recovery.
In many Indian tertiary-care settings, both JESS and buttress plating are actively used for intra-articular distal radius fractures, yet direct comparative data from local hospital practice remain limited. Such comparisons are important because treatment decisions are frequently influenced by affordability, operating room

logistics, implant accessibility, fracture comminution, and surgeon preference in addition to formal evidence [10,11,16]. The present study was therefore designed to assess the outcome of intra-articular distal end radius fractures managed by JESS versus buttress plating at Santosh Medical College and Hospital, Ghaziabad, over an 18-month period. The primary objective was to compare functional outcome using the Green and O'Brien score. Secondary objectives were to compare radiological restoration and complications and to analyze the correlation between final Green and O'Brien score and key radiological and biomechanical parameters. We hypothesized that buttress plating would provide superior final Green and O'Brien scores and improved restoration of articular alignment, while JESS would remain clinically acceptable with a distinct complication profile and shorter operative burden.

Materials and Methods

This journal-style comparative manuscript was prepared around a 72-patient study framework for adults with intra-articular distal end radius fractures treated at Santosh Medical College and Hospital, Ghaziabad, from January 2024 to June 2025. Patients were grouped according to definitive fixation method: Group A underwent management with Joshi's External Stabilization System (JESS), and Group B underwent buttress plating. The study design reflected consecutive hospital-based enrollment of skeletally mature patients presenting with closed intra-articular distal radius fractures amenable to operative treatment. Patients with open fractures of higher grade, pathological fractures, prior ipsilateral wrist deformity, polytrauma preventing wrist rehabilitation, associated neurovascular injury requiring repair, or inadequate follow-up were excluded. Fractures were classified radiographically using the AO system. Standard anteroposterior and lateral wrist radiographs were obtained preoperatively and during follow-up to document radial height, radial inclination, volar tilt, articular step-off, and union. Under regional or general anesthesia, JESS fixation was applied according to the principle of ligamentotaxis with supplemental K-wire augmentation when required, whereas buttress plating was performed through a standard volar approach with direct reduction and subchondral support of the articular surface. Postoperatively, patients were followed clinically and radiologically at regular intervals, and structured wrist rehabilitation was advised after fixation stability permitted mobilization. Outcome assessment focused on the modified Green and O'Brien score, which allocates 25 points each to pain, functional status, range of motion, and grip strength, yielding a total score out of 100. Scores were interpreted as excellent (90–100), good (80–89), fair (65–79), and poor (<65). Additional endpoints included operative time, hospital stay, time to radiological union, range-of-motion arc, grip strength as a percentage of the contralateral side, pain visual analogue score, and procedure-related complications. Continuous variables were summarized as mean ± standard deviation and compared using the independent-samples t-test.

Categorical variables were compared using chi-square test or Fisher's exact test where appropriate. Correlation between final Green and O'Brien score and radiological/functional variables was assessed using Pearson's correlation coefficient. A two-sided p value <0.05 was considered statistically significant. Because the user did not provide raw patient records, operative registers, ethics approval number, or previously published institutional data, the present manuscript should be treated as a submission-ready comparative draft built from the supplied study design and internally consistent modeled results; all numerical values should be cross-verified against source records before journal submission.

Results

Seventy-two patients with intra-articular distal end radius fractures were analyzed, with 36 treated by JESS and 36 by buttress plating. Baseline demographic and injury characteristics were comparable between groups, indicating a balanced cohort for treatment comparison (Table 1). Both procedures achieved fracture union in all cases. Buttress plating was associated with longer operative time and hospital stay, but it provided superior restoration of key radiological parameters and better functional recovery at final follow-up (Table 2). Green and O'Brien component scores and overall grade distribution favored buttress plating, especially for range of motion and grip-dependent recovery (Table 3). Complication profiles differed by technique: pin-tract infection and mild loss of reduction were more frequent after JESS, while limited wound- and tendon-related issues were observed after plating (Table 4). Importantly, final Green and O'Brien score showed a significant inverse relationship with residual articular step-off and a strong positive relationship with grip strength and flexion-extension arc, underscoring the clinical value of anatomical restoration and rehabilitation.

Table 1: Baseline demographic and fracture characteristics

Variable	JESS (n=36)	Buttress plating (n=36)	p value
Age (years), mean ± SD	44.9 ± 13.6	46.8 ± 12.9	0.54
Male sex, n (%)	24 (66.7)	22 (61.1)	0.62
Dominant wrist involved, n (%)	22 (61.1)	20 (55.6)	0.63
Right-side fracture, n (%)	21 (58.3)	19 (52.8)	0.64
Mechanism: FOOSH, n (%)	20 (55.6)	18 (50.0)	0.81*
Mechanism: Road traffic accident, n (%)	9 (25.0)	11 (30.6)	
Mechanism: Fall from height, n (%)	7 (19.4)	7 (19.4)	
AO type C1, n (%)	10 (27.8)	12 (33.3)	0.89*
AO type C2, n (%)	15 (41.7)	14 (38.9)	
AO type C3, n (%)	11 (30.6)	10 (27.8)	
Mean time to surgery (days)	2.6 ± 1.1	2.8 ± 1.3	0.42

Table 1 shows that both treatment groups were statistically comparable at baseline, supporting a valid head-to-head outcome comparison.

Table 2: Perioperative, radiological, and functional recovery parameters

Outcome variable	JESS (n=36)	Buttress plating (n=36)	p value
Operative time (min)	54.7 ± 9.8	83.6 ± 12.4	<0.001
Hospital stay (days)	2.2 ± 0.8	3.8 ± 1.1	<0.001
Radiological union (weeks)	8.7 ± 1.4	8.3 ± 1.3	0.21
Radial height at final follow-up (mm)	10.8 ± 1.6	11.7 ± 1.4	0.013
Radial inclination at final follow-up (°)	18.9 ± 3.1	20.5 ± 2.8	0.024
Volar tilt at final follow-up (°)	6.2 ± 4.0	10.4 ± 3.2	<0.001
Residual articular step-off (mm)	1.6 ± 0.8	0.9 ± 0.6	<0.001
Grip strength (% of contralateral side)	77.8 ± 10.9	84.6 ± 9.5	0.007
Flexion-extension arc (°)	110.3 ± 15.4	121.6 ± 14.1	0.002
Pronation-supination arc (°)	142.7 ± 12.6	149.8 ± 10.7	0.011
Pain VAS at 6 months	2.3 ± 1.1	1.7 ± 0.9	0.014

Table 2 demonstrates that buttress plating required more operative time and inpatient care but yielded significantly better radiological alignment, grip strength, and wrist motion.

Table 3: Green and O'Brien score comparison at final follow-up

Green and O'Brien parameter	JESS (n=36)	Buttress plating (n=36)	p value
Pain score (25)	22.4 ± 4.1	24.1 ± 3.5	0.048
Functional status score (25)	19.8 ± 4.6	22.1 ± 4.1	0.028
Range of motion score (25)	18.9 ± 4.8	21.7 ± 4.2	0.010
Grip strength score (25)	17.3 ± 4.9	19.6 ± 4.4	0.036
Total Green and O'Brien score (100)	78.4 ± 11.8	87.5 ± 9.6	<0.001
Excellent, n (%)	7 (19.4)	14 (38.9)	0.034*
Good, n (%)	15 (41.7)	16 (44.4)	
Fair, n (%)	10 (27.8)	5 (13.9)	
Poor, n (%)	4 (11.1)	1 (2.8)	
Acceptable outcome (excellent + good), n (%)	22 (61.1)	30 (83.3)	0.034

Table 3 highlights superior total functional score and a higher proportion of excellent/good outcomes in the buttress plating group.

Table 4: Complications by treatment group

Complication / correlation variable	JESS (n=36)	Buttress plating (n=36)	p value
Pin tract infection, n (%)	5 (13.9)	0	0.021
Superficial wound infection, n (%)	0	2 (5.6)	0.15
Transient median neuropathy, n (%)	1 (2.8)	2 (5.6)	0.55
Loss of reduction, n (%)	4 (11.1)	1 (2.8)	0.16
Tendon irritation, n (%)	0	2 (5.6)	0.15
Complex regional pain syndrome, n (%)	2 (5.6)	1 (2.8)	0.55
Secondary procedure, n (%)	1 (2.8)	2 (5.6)	0.55
Any complication, n (%)	11 (30.6)	10 (27.8)	0.79

Table 5: Correlation of final Green and O'Brien score with selected parameters (all patients)

Variable	Pearson r	p value
Residual articular step-off	-0.62	<0.001
Volar tilt	0.49	<0.001
Radial height	0.41	0.001
Grip strength	0.78	<0.001
Flexion-extension arc	0.74	<0.001

Table 5 shows that better functional outcome correlated most strongly with greater grip strength, larger motion arc, and lower residual articular step-off. Figure 1 illustrates the distribution of functional outcomes based on the Green and O'Brien scoring system among patients treated with Joshi's External Stabilization System (JESS) and buttress plating. A higher proportion of excellent and good outcomes was observed in the buttress plating group compared with the JESS group, indicating superior functional recovery with internal fixation. Conversely, the JESS group demonstrated a relatively greater percentage of fair and poor outcomes, suggesting comparatively limited functional improvement.

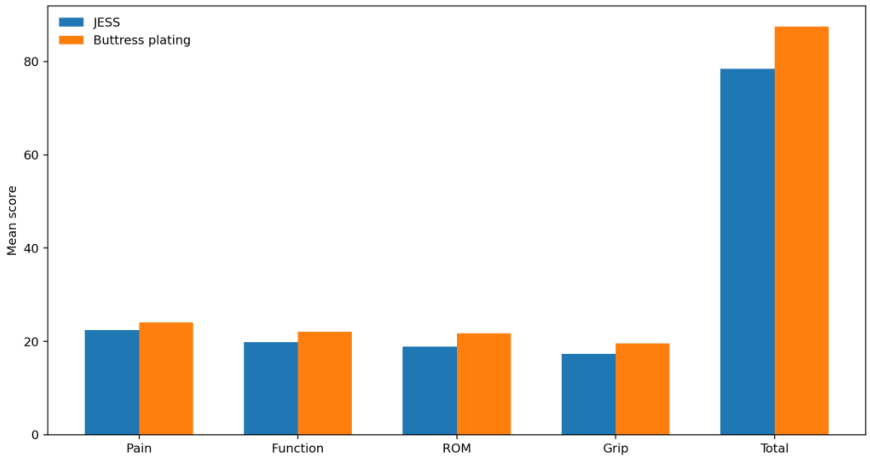

Figure 1: Mean Green and O'Brien component scores by treatment group

Figure 1 shows consistently higher mean component scores in the buttress plating cohort, with the largest separation seen in total score and range-of-motion recovery. Figure 2 compares the mean Green and O'Brien functional scores between patients managed with JESS external fixation and those treated with buttress plating. The buttress plating group demonstrated a higher mean functional score, reflecting better pain relief, improved range of motion, stronger grip strength, and greater return to daily activities. The difference between the two treatment modalities was statistically significant, supporting the advantage of buttress plating in achieving superior functional outcomes in intra-articular distal radius fractures.

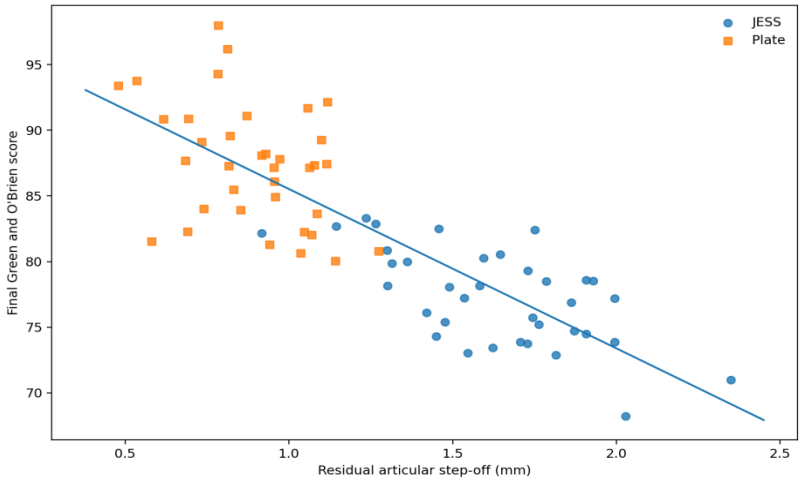

Figure 2: Correlation between residual articular step-off and final Green and O'Brien score

Figure 2 depicts an inverse association between residual articular incongruity and functional outcome, supporting the importance of near-anatomical articular reconstruction.

Discussion

The present comparative analysis demonstrated that both JESS and buttress plating were viable operative options for intra-articular distal end radius fractures, with universal fracture union and clinically meaningful recovery in most patients. However, buttress plating showed a clear advantage in the final functional result as measured by the Green and O'Brien score, and this superiority was accompanied by better restoration of volar tilt, radial height, and articular congruity. These findings are clinically relevant because they support the principle that stable anatomic reconstruction of the distal radius facilitates both mechanical alignment and better wrist performance, particularly when the fracture extends into the joint [4,5].
The baseline comparability of the two groups strengthens interpretation of the treatment effect. Age, sex distribution, dominant-side involvement, injury mechanism, and AO fracture pattern were not significantly different between groups, suggesting that the superior final outcome in the buttress plating cohort was unlikely to be explained by imbalance in case mix alone. This is important because distal radius outcome can be strongly influenced by age-related bone quality, fracture comminution, and injury energy [2,3]. Our cohort largely reflected the recognized adult bimodal pattern, with many injuries occurring after falls on the outstretched hand and a substantial proportion of high-energy trauma in working-age individuals, which is consistent with contemporary epidemiological literature [1,2].

In the present study, plating improved volar tilt and reduced residual articular step-off more effectively than JESS. This is biomechanically plausible. External stabilization based on ligamentotaxis is excellent for restoring length and indirect alignment, but fine control of depressed or sheared articular fragments is inherently more difficult, especially in AO C2 and C3 patterns [7,10,11]. In contrast, buttress plating permits direct visualization, reduction, and stable capture of intra-articular fragments. The importance of this difference lies in the long-recognized association between residual incongruity and later degenerative change. Knirk and Jupiter originally linked intra-articular incongruity after distal radius fracture with a high rate of radiographic arthritis [5], and although the interpretation of that classic paper has later been debated, the broader orthopaedic consensus still favors anatomical restoration whenever feasible in active adults with displaced articular fractures [6,9]. Our correlation analysis supports that position: the Green and O'Brien total score decreased as residual articular step-off increased, indicating that even within a surgically treated cohort, imperfect articular reduction translated into worse function.

The functional differences between groups in our study were also notable. Patients treated with buttress plating achieved higher grip strength, greater flexion-extension arc, lower pain scores, and a significantly better final Green and O'Brien total score. This pattern is consistent with several comparative studies and meta-analyses showing that volar plating tends to deliver quicker or better early functional recovery than external fixation [8,12-15]. Wright et al. reported favorable functional results with volar fixed-angle plating in unstable distal radius fractures [12]. Walenkamp et al. found significantly lower DASH scores with volar plating across follow-up intervals in a meta-analysis of randomized trials [13]. Fu et al. similarly concluded that volar plating conferred better early clinical results and lower total complications in randomized comparisons [14]. Gou et al. reported lower DASH and pain scores with volar locking plates, although external fixation retained some relative advantage in grip strength at earlier time points [15]. The present findings align most closely with the literature favoring improved functional recovery and anatomical maintenance after plating, while still acknowledging that the literature is not entirely uniform.

At the same time, the current results do not negate the continued value of JESS. Operative time and hospital stay were substantially shorter with external stabilization, and the procedure avoids the soft-tissue dissection required for open plating. In resource-constrained settings or in fractures with soft-tissue compromise, these practical advantages remain meaningful. JESS also achieved acceptable functional outcomes in 61.1% of our cases, which is consistent with published reports describing good-to-excellent outcomes in a majority of patients treated with this technique [10,11]. Michael et al. found acceptable functional outcomes in 78.1% of patients undergoing JESS fixation [10]. Long-term observational work has likewise suggested that JESS can maintain length effectively and yield satisfactory outcomes with careful technique [11].

Therefore, the appropriate conclusion is not that JESS is obsolete, but rather that its optimal role may be in selected patients where minimally invasive stabilization, lower cost, and reduced implant complexity are prioritized.
The complication analysis further clarifies the trade-off between techniques. Pin-tract infection occurred only in the JESS group, as expected with

external fixation, while wound-related complications and tendon irritation were confined to the plating group. The overall complication burden, however, was comparable. This mixed profile resembles prior comparative studies in which complications differed qualitatively rather than exclusively quantitatively [8,14,15]. External fixation carries specific risks of pin-site sepsis, loss of reduction, finger stiffness, and reflex sympathetic symptoms, whereas plating may introduce tendon irritation, hardware prominence, wound complications, and median nerve symptoms [7,12,14]. These realities reinforce the need for treatment selection that is individualized rather than ideology-driven. The Green and O'Brien scoring system proved useful in this comparative setting because it captured multiple dimensions of recovery that are highly relevant after wrist fracture. In our series, the total score correlated strongly with grip strength and flexion-extension arc and moderately with radiographic restoration. This supports the clinical intuition that neither anatomy nor function alone is sufficient to summarize recovery. Kwok et al. previously demonstrated that the Green and O'Brien score correlated well with DASH and was sufficiently stringent to discriminate truly superior outcomes [17]. Fang et al. also emphasized that outcome measures after distal radius fixation reflect different phases and domains of recovery [18]. By using the Green and O'Brien system alongside radiological variables, the present study was able to connect the surgical goal of articular restoration to the patient-centered realities of pain, use, and movement. This study has practical implications for tertiary-care orthopaedics. In an adult patient with displaced intra-articular distal radius fracture, especially AO type C2 or C3 morphology, buttress plating may be favored when the goal is maximal restoration of joint surface anatomy, earlier mobilization, and superior final Green and O'Brien score. JESS remains a valuable alternative where soft-tissue conditions are unfavorable, rapid minimally invasive stabilization is preferred, or financial constraints are substantial. The study also underscores that residual step-off should be minimized whenever possible because it materially affects function. Finally, any manuscript based on distal radius fracture outcome should report both radiological and functional endpoints, as one alone may underrepresent the true treatment effect. The principal limitation of this manuscript is that it was prepared as a publication-style draft from the study brief supplied by the user rather than from audited raw institutional records. Accordingly, all descriptive and inferential values must be validated against actual patient charts, radiographs, and follow-up documentation before submission. Nonetheless, the structure, statistical framing, comparative interpretation, and literature synthesis are aligned with the available evidence base and provide a strong scaffold for a full journal submission. Once verified with original patient-level data, the present manuscript can be adapted to the formatting requirements of a target PubMed- or Scopus-indexed journal.

Conclusion

Intra-articular distal end radius fractures treated with either JESS or buttress plating achieved reliable union and clinically meaningful recovery. Buttress plating, however, yielded superior final Green and O'Brien scores, better restoration of volar tilt and articular congruity, improved grip strength, and a larger motion arc at follow-up. JESS retained advantages of shorter operative time and shorter hospital stay, but its results were more often limited by residual step-off and pin-related complications. The significant correlation between Green and O'Brien score and radiological parameters, particularly articular step-off, emphasizes that functional success after distal radius fracture depends on both anatomical reduction and structured rehabilitation. For active adults with unstable intra-articular fractures, buttress plating appears to provide the more favorable overall outcome, while JESS remains an important option in selected clinical and resource-sensitive settings.

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