



Original Article

Comparative Evaluation of Functional Outcomes of Joshi's External Stabilization System Versus Conservative Management in Proximal Humerus Fractures: A Prospective Comparative Observational Study

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ABSTRACT

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Background: Proximal humerus fractures are common upper-extremity injuries that may result in considerable pain, shoulder stiffness, malunion, and functional disability, particularly when displaced or unstable. Although conservative treatment remains widely used, minimally invasive fixation with Joshi's External Stabilization System (JESS) may provide stable fixation while allowing earlier mobilization and preserving the surrounding soft tissues. The present study compared the functional and clinical outcomes of JESS fixation with conservative management in patients with proximal humerus fractures.

Methods: This prospective comparative observational study was conducted in the Department of Orthopaedics, Era's Lucknow Medical College and Hospital, Lucknow, over a period of two years. A total of 42 patients with proximal humerus fractures were enrolled and divided equally into two groups: JESS fixation (n=21) and conservative treatment (n=21). Functional outcome was assessed using Neer's scoring system at 2 weeks, 6 weeks, 12 weeks, and 6 months. Fracture union and treatment-related complications were also evaluated. Continuous and categorical variables were compared using appropriate statistical tests, with $p < 0.05$ considered statistically significant.

Results: Functional recovery was significantly better in the JESS group throughout follow-up. At 2 weeks, the mean Neer score was significantly higher with JESS than with conservative treatment (75.81 ± 15.88 vs. 63.72 ± 14.65 ; $p = 0.022$). Similar differences were observed at 6 weeks (81.92 ± 15.10 vs. 68.11 ± 18.02 ; $p = 0.018$), 12 weeks (85.19 ± 11.43 vs. 74.57 ± 16.66 ; $p = 0.021$), and 6 months (91.71 ± 7.64 vs. 81.62 ± 12.12 ; $p = 0.003$). At final follow-up, excellent functional outcomes were achieved in 81.0% of JESS-treated patients compared with 47.6% of conservatively treated patients ($p = 0.004$). Fracture union occurred in 90.5% of patients in the JESS group compared with 71.0% in the conservative group. Pin-tract infection occurred in 33.3% of JESS-treated patients ($p = 0.009$), whereas malunion was observed in 33.3% of conservatively managed patients and in none of the JESS-treated patients ($p = 0.0086$). Overall complications were observed in 33.3% and 57.2% of patients in the JESS and conservative groups, respectively.

Conclusion: JESS fixation was associated with significantly better and earlier functional recovery than conservative management in patients with proximal humerus fractures. It provided higher Neer functional scores, better maintenance of fracture alignment, a lower incidence of malunion, and favourable fracture union. Although pin-tract infection was more frequent with JESS, these complications were manageable. JESS may therefore represent an effective and minimally invasive treatment option for appropriately selected proximal humerus fractures.

INTRODUCTION

Proximal humerus fractures are among the most common injuries involving the upper extremity and constitute a significant cause of pain, disability, and impaired shoulder function, especially in the elderly population. These fractures account for nearly 6% of all fractures and are considered the third most common osteoporotic fracture after distal radius and vertebral fractures [1–3]. Owing to increased life expectancy and the growing prevalence of osteoporosis, the incidence of proximal humerus fractures has risen steadily over the past few decades, creating a substantial clinical and socioeconomic burden on healthcare systems worldwide.

Proximal humerus fractures demonstrate a characteristic bimodal age distribution. In younger individuals, these fractures are usually associated with high-energy trauma such as road traffic accidents, sports injuries, and falls from height, whereas in elderly patients they commonly result from low-energy falls due to poor bone quality and osteoporosis [3,4]. Females are affected more frequently than males, with studies reporting a female predominance attributed to postmenopausal osteoporosis and increased susceptibility to falls [3,4]. Epidemiological evidence has shown a progressive increase in the incidence of these fractures, highlighting the need for effective and safe treatment strategies [1–3].

The majority of proximal humerus fractures are minimally displaced and can be treated successfully with conservative management involving immobilization followed by physiotherapy [3,4]. However, displaced and unstable fractures are associated with poor functional outcomes, prolonged stiffness, malunion, and chronic pain if not managed appropriately. Such fractures often require surgical intervention to restore anatomy and facilitate early mobilization of the shoulder joint [4].

A thorough clinical and radiological assessment is essential for proper diagnosis and treatment planning. Clinical evaluation includes assessment of the mechanism of injury, hand dominance, pre-injury functional status, associated comorbidities, and neurovascular status, particularly the axillary nerve because of its close relation to the surgical neck of the humerus [5–8]. Radiological evaluation with standard anteroposterior, scapular Y, and axillary views provides important information regarding fracture displacement and joint congruity, while computed tomography with three-dimensional reconstruction helps in understanding complex fracture patterns and planning surgical intervention [9].

The Neer classification system remains the most commonly used classification method for proximal humerus fractures. Based on displacement and angulation of fracture fragments, it categorizes fractures into two-part, three-part, and four-part patterns [10–11]. Despite certain limitations related to interobserver reliability, this classification continues to guide management decisions and prognostic evaluation [12].

Management of proximal humerus fractures remains controversial because of the diversity of fracture patterns and available treatment modalities. Conservative treatment is generally preferred for stable fractures and elderly patients with low functional demands, whereas surgical management is indicated for displaced, unstable, open, or fracture-dislocation patterns [13]. Various surgical techniques such as locking plate fixation, intramedullary nailing, percutaneous pinning, arthroplasty, and external fixation have been described, each having distinct advantages and limitations.

Among minimally invasive techniques, Joshi's External Stabilization System (JESS) has emerged as a promising modality for the treatment of displaced proximal humerus fractures. JESS works on the principle of ligamentotaxis and utilizes percutaneous K-wires connected through an external fixator assembly to achieve fracture stabilization [14]. This method minimizes soft tissue dissection, preserves periosteal blood supply, decreases operative time and blood loss, and lowers the risk of neurovascular injury. In addition, JESS allows early mobilization, shorter hospital stay, and simple implant removal, making it particularly beneficial in elderly patients and in resource-limited settings [15].

Despite increasing evidence supporting both conservative treatment and minimally invasive fixation methods such as JESS, there remains no clear consensus regarding the optimal management of proximal humerus fractures in terms of functional outcome, fracture union, and complications. Comparative studies are therefore essential to establish evidence-based treatment protocols and improve patient outcomes.

Hence, the present study was undertaken to compare the functional outcome of the shoulder joint following Joshi's External Stabilization System (JESS) versus conservative management in proximal humerus fractures using Neer's scoring system, along with assessment of fracture union time and associated complications in both treatment groups.

MATERIAL AND METHODS

Study Design

The present study was designed as a prospective comparative observational study conducted to evaluate and compare the functional outcome of the shoulder joint following Joshi's External Stabilization System (JESS) versus conservative management in patients with proximal humerus fractures.

Study Participants

This prospective comparative observational study was conducted in the Department of Orthopaedics, Era's Lucknow Medical College and Hospital, Lucknow, over a period of two years. Patients presenting to the Orthopaedics Outpatient Department or Emergency Department with proximal humerus fractures and fulfilling the inclusion criteria were enrolled using a consecutive sampling method until the required sample size was achieved. The sample size was calculated based on expected variation in postoperative and follow-up Neer's scores using standard statistical formulae, considering $s_1 = 5.3$ and $s_2 = 4.2$ as reported by Karki P et al. [16], with 95% confidence interval and 90% study power, yielding a total sample size of 42 patients (21 patients in each group). Patients aged 18 years and above, of either gender, with displaced or undisplaced proximal humerus fractures and willing to provide informed consent were included in the study. Patients with open fractures, active skin infection near the fracture site, associated neurovascular injury, polytrauma, immunocompromised status, or those unwilling or unfit for surgery or follow-up were excluded. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment.

Group Allocation and Treatment Protocol

After enrollment, patients were allocated into two groups based on the treatment modality. Group A consisted of patients managed with Joshi's External Stabilization System (JESS), whereas Group B included patients managed conservatively using an arm sling or shoulder immobilizer. Prior to treatment, all patients underwent detailed clinical and radiological evaluation, including history regarding mode of injury, duration, associated comorbidities, and pre-injury functional status. General physical and local examination of the shoulder joint were performed along with careful neurovascular assessment of the affected limb. Radiological assessment included standard anteroposterior and lateral radiographs of the shoulder joint, and baseline functional evaluation was carried out using Neer's scoring system.

In Group A, JESS fixation was performed under regional or general anesthesia under strict aseptic precautions. Closed reduction was achieved under fluoroscopic guidance, following which percutaneous K-wires were inserted and connected externally using the JESS assembly to obtain stable fixation. Postoperatively, patients were encouraged to begin early passive shoulder mobilization as tolerated, and regular pin site care and follow-up were advised. Implant removal was performed on an outpatient basis after radiological evidence of fracture union. In Group B, patients were treated conservatively with an arm sling or shoulder immobilizer for an appropriate duration depending on fracture pattern and pain tolerance. Gradual shoulder mobilization exercises were initiated after the immobilization period, and all patients were advised physiotherapy according to standard rehabilitation protocol.

Follow-Up and Outcome Measures

Patients in both groups were followed up at 2 weeks, 6 weeks, 12 weeks, and 6 months after initiation of treatment. At each follow-up visit, detailed clinical examination and radiological assessment were performed to evaluate fracture union and detect any complications. Functional assessment of the shoulder joint was carried out using Neer's scoring system.

The primary outcome measure of the study was functional outcome of the shoulder joint assessed using Neer's scoring system, which included pain (35 points), function (30 points), range of motion (25 points), and anatomy (10 points), with a maximum score of 100. Based on the total score, results were graded as excellent (>85), good (70–84), fair (56–69), and poor (<55). Secondary outcome measures included time to radiological union and complications such as infection, stiffness, malunion, and implant-related problems.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were expressed as frequencies and percentages. Comparison between the two groups was performed using appropriate statistical tests such as Student's t-test and Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 42 patients with proximal humerus fractures were included in the present study and were equally divided into two groups: JESS group ($n = 21$) and conservative treatment group ($n = 21$). Demographic characteristics, functional outcomes according to NEER's scoring system, fracture union, and complications were assessed and compared between the two groups during the follow-up period.

Table 1. Distribution of Study Subjects According to Age Group, Gender, and Side of Injury in JESS and Conservative Treatment Groups (N = 42)

Variable	Category	JESS (n = 21), n (%)	Conservative (n = 21), n (%)	Total (n = 42), n (%)
Age Group (Years)	18–30	1 (4.8%)	2 (9.5%)	3 (7.1%)
	31–40	4 (19.0%)	5 (23.8%)	9 (21.4%)
	41–50	11 (52.4%)	7 (33.3%)	18 (42.9%)
	51–60	4 (19.0%)	5 (23.8%)	9 (21.4%)
	61–70	1 (4.8%)	2 (9.5%)	3 (7.1%)
Gender	Male	7 (33.3%)	11 (52.4%)	18 (42.9%)
	Female	14 (66.7%)	10 (47.6%)	24 (57.1%)
Side Involved	Right	11 (52.4%)	11 (52.4%)	22 (52.4%)
	Left	10 (47.6%)	10 (47.6%)	20 (47.6%)

This table shows the demographic characteristics of study subjects in both treatment groups. The majority of patients belonged to the 41–50 years age group, accounting for 42.9% of the total study population. Females constituted 57.1% of the total patients, showing an overall female predominance. Right-sided injuries were slightly more common than left-sided injuries, accounting for 52.4% of cases. Both treatment groups demonstrated comparable distribution with respect to age, gender, and side of injury.

Table 2. Distribution of Study Subjects According to NEER's Functional Outcome Score at Different Follow-Up Intervals in JESS and Conservative Treatment Groups (N = 42)

Follow-Up	Outcome (NEER Score)	JESS (n = 21), n (%)	Conservative (n = 21), n (%)	χ^2 value	p-value
2 Weeks	Excellent (>85)	6 (28.6%)	0 (0%)	34.70	<0.001
	Good (70–84)	9 (42.9%)	0 (0%)		
	Fair (55–69)	4 (19.0%)	0 (0%)		
	Poor (<55)	2 (9.5%)	21 (100%)		
6 Weeks	Excellent (>85)	10 (47.6%)	0 (0%)	28.57	<0.001
	Good (70–84)	7 (33.3%)	0 (0%)		
	Fair (55–69)	3 (14.3%)	15 (71.4%)		
	Poor (<55)	1 (4.8%)	6 (28.6%)		
12 Weeks	Excellent (>85)	14 (66.7%)	7 (33.3%)	11.840	0.003
	Good (70–84)	5 (23.8%)	7 (33.3%)		
	Fair (55–69)	2 (9.5%)	5 (23.8%)		
	Poor (<55)	0 (0%)	2 (9.5%)		
6 Months	Excellent (>85)	17 (81.0%)	10 (47.6%)	13.276	0.004
	Good (70–84)	4 (19.0%)	7 (33.3%)		
	Fair (55–69)	0 (0%)	4 (19.0%)		
	Poor (<55)	0 (0%)	0 (0%)		

This table demonstrates the comparison of NEER's functional outcome scores between the JESS and conservative treatment groups at different follow-up intervals. At 2 weeks and 6 weeks, the JESS group showed significantly superior functional outcomes compared to the conservative group, with a higher proportion of patients achieving excellent and good scores. At 12 weeks and 6 months, the JESS group continued to demonstrate better outcomes, with 81.0% of patients achieving excellent results at final follow-up compared to 47.6% in the conservative group. The differences between the groups were statistically significant at all follow-up intervals, indicating superior functional recovery with JESS fixation.

Table 3. Comparison of Mean NEER Functional Scores Between JESS and Conservative Treatment Groups at Different Follow-Up Intervals (N = 42)

Follow-Up	Group	Mean $\pm$ SD	t-value	p-value
2 Weeks	Conservative	63.72 $\pm$ 14.65	-2.38	0.022
	JESS	75.81 $\pm$ 15.88		
6 Weeks	Conservative	68.11 $\pm$ 18.02	-2.48	0.018
	JESS	81.92 $\pm$ 15.10		
12 Weeks	Conservative	74.57 $\pm$ 16.66	-2.41	0.021
	JESS	85.19 $\pm$ 11.43		
6 Months	Conservative	81.62 $\pm$ 12.12	-3.23	0.003
	JESS	91.71 $\pm$ 7.64		

This table compares the mean NEER functional scores between the two groups at various follow-up intervals. The JESS group demonstrated significantly higher mean NEER scores at all follow-up visits compared to the conservative treatment group. The differences were statistically significant throughout the study period, indicating consistently superior functional outcomes in patients managed with JESS fixation.

Table 4. Distribution of Study Subjects According to Complications and Union Status in JESS and Conservative Treatment Groups (N = 42)

Variable	Category	JESS (n = 21), n (%)	Conservative (n = 21), n (%)	p-value
Pin-Tract Infection	Present	7 (33.3%)	0 (0%)	0.009
	Absent	14 (66.7%)	21 (100%)	
Malunion	Present	0 (0%)	7 (33.3%)	0.0086
	Absent	21 (100%)	14 (66.7%)	
Union Status	Non-union	2 (9.5%)	4 (19%)	0.66
	United	19 (90.5%)	17 (71%)	
Overall Complications	Present	7 (33.3%)	12 (57.2%)	0.12
	Absent	14 (66.7%)	9 (42.8%)	

This table shows the comparison of complications and fracture union status between the two treatment groups. Pin-tract infection was observed only in the JESS group and the difference was statistically significant ($p = 0.009$). Conversely, malunion occurred exclusively in the conservative treatment group, with a statistically significant difference ($p = 0.0086$), suggesting better maintenance of fracture alignment with JESS fixation. Fracture union was achieved in 90.5% of patients in the JESS group and 71% in the conservative group, although the difference was not statistically significant ($p = 0.66$). Overall complications were more frequent in the conservative group compared to the JESS group; however, the difference did not reach statistical significance ($p = 0.12$).

DISCUSSION

Proximal humerus fractures constitute approximately 5–6% of all fractures and are recognized as the third most common osteoporotic fracture after hip and distal radius fractures [1,2]. Management of these fractures remains controversial, especially in displaced fractures where both conservative and operative modalities continue to be widely practiced. The present prospective comparative observational study was undertaken to evaluate and compare the functional and radiological outcomes of proximal humerus fractures managed with Joshi's External Stabilization System (JESS) and conservative treatment in 42 patients.

In the present study, the majority of patients (42.9%) belonged to the 41–50 years age group, followed by 31–40 years and 51–60 years age groups, each constituting 21.4% of the study population. These findings correlate well with Gupta OP et al. [17], who reported a mean age of 40.5 years among JESS-treated patients. Similarly, Somvanshi et al. [18] reported mean ages of 46.3 ± 6.9 years in the JESS group and 48.1 ± 7.5 years in the PHILOS group, while Arshad et al. [19] observed that 40% of patients were between 41–60 years. Kushwaha et al. [20] also demonstrated a predominance of middle-aged patients in their study cohort. In contrast, epidemiological studies by Court-Brown et al. [1] and Passaretti et al. [2] reported higher mean ages, particularly among osteoporotic elderly populations. The relatively younger age profile in the present study may be attributed to the inclusion of high-energy trauma-related fractures in addition to fragility fractures.

Females constituted 66.7% of patients in the JESS group in the present study, whereas males accounted for 52.4% in the conservative group. Court-Brown et al. [1] similarly demonstrated female predominance in proximal humerus fractures due to osteoporosis and postmenopausal bone loss. However, Gupta OP et al. [17], Somvanshi et al. [18], and Kushwaha et al. [20] reported male predominance in surgically managed patients, likely reflecting higher incidence of trauma-related injuries in males. Right-sided injuries were slightly more common in our study (52.4%), which is consistent with findings reported by Gupta OP et al. [17], Somvanshi et al. [18], and Arshad et al. [19], suggesting dominance-related biomechanical susceptibility during falls or trauma.

The most important finding of the present study was the significantly superior functional recovery observed in patients treated with JESS fixation compared to conservative management. At 2 weeks follow-up, 28.6% of JESS patients achieved excellent outcomes and 42.9% had good outcomes, whereas 100% of patients in the conservative group had poor outcomes ($\chi^2 = 34.70$, $p < 0.001$). Similarly, mean NEER scores at 2 weeks were significantly higher in the JESS group (75.81 ± 15.88) compared to the conservative group (63.72 ± 14.65 ; $p = 0.022$). These findings strongly support the role of JESS in promoting early mobilization and functional recovery. Comparable results were reported by Arshad et al. [19], who observed rapid improvement in Murley scores from 48.81 ± 8.94 immediately after fixator removal to 78.45 ± 12.11 within two months. Somvanshi et al. [18] also reported significantly superior early Constant scores in JESS patients compared to PHILOS fixation ($p = 0.002$). Gupta A et al. [21] and Akbar et al. [22] similarly emphasized the advantages of minimally invasive fixation and early rehabilitation associated with JESS.

At 6 weeks follow-up, the superiority of JESS fixation became even more evident. In the present study, 47.6% of JESS patients achieved excellent outcomes compared to none in the conservative group, while 71.4% of conservatively managed

patients continued to have only fair outcomes and 28.6% had poor outcomes ($\chi^2 = 28.57$, $p < 0.001$). Mean NEER scores at 6 weeks were significantly higher in the JESS group (81.92 ± 15.10) compared to the conservative group (68.11 ± 18.02 ; $p = 0.018$). These findings are consistent with Kushwaha et al. [20], who reported earlier mobilization in JESS-treated patients (3.14 ± 1.46 weeks) compared to conservative treatment (4.73 ± 1.84 weeks), resulting in improved early range of motion. Das and Laskar [23] also demonstrated superior early functional stability with modified JESS fixation. Somvanshi et al. [18] similarly reported significantly higher Constant scores at 8 weeks in JESS patients (75.8 vs 67.2; $p = 0.002$). These observations collectively suggest that JESS fixation allows stable fracture fixation while preserving soft tissue integrity, thereby facilitating accelerated rehabilitation.

At 12 weeks follow-up, excellent outcomes were achieved in 66.7% of JESS patients compared to 33.3% in the conservative group ($\chi^2 = 11.840$, $p = 0.003$). Mean NEER scores remained significantly higher in the JESS group (85.19 ± 11.43) compared to the conservative group (74.57 ± 16.66 ; $p = 0.021$). Similar findings were reported by Somvanshi et al. [18], who observed significantly superior Constant scores in JESS patients at 12 weeks (84.2) compared to PHILOS fixation (78.3). Arshad et al. [19] reported excellent Murley scores averaging 91.70 ± 2.83 in high-performing patients treated with JESS. Kulkarni et al. [24] and Kandel et al. [25] also demonstrated excellent mid-term functional outcomes with JESS fixation. Although studies by Jagiasi et al. [26] and Doshi et al. [27] reported satisfactory results with PHILOS plating, these techniques were associated with greater surgical exposure, soft tissue dissection, operative duration, and blood loss compared to minimally invasive external fixation.

At the final follow-up of 6 months, 81% of patients in the JESS group achieved excellent outcomes compared to 47.6% in the conservative group ($\chi^2 = 13.276$, $p = 0.004$). Mean NEER scores at 6 months were 91.71 ± 7.64 in the JESS group and 81.62 ± 12.12 in the conservative group ($p = 0.003$). These findings demonstrate excellent long-term shoulder function with JESS fixation and compare favorably with previous literature. Gupta OP et al. [17] reported a mean Constant score of 72 at 6 months, while Kushwaha et al. [20] observed Constant scores of 72.33 ± 2.51 in JESS-treated patients at 9 months follow-up. Arshad et al. [19] similarly demonstrated excellent Murley scores reaching 91.70 ± 2.83 . The high NEER scores observed in the present study indicate that JESS fixation provides durable long-term functional recovery with maintenance of joint mobility and alignment.

Complication analysis in the present study revealed pin-tract infection as the most common complication in the JESS group, occurring in 33.3% of patients, whereas no cases were observed in the conservative group ($p = 0.009$). Although the incidence was higher compared to Gupta OP et al. [17] (11.1%), Arshad et al. [19] (2%), and Somvanshi et al. [18] (3.13%), these infections were superficial and manageable with local care and antibiotics, without adversely affecting final outcomes. The higher incidence observed in the present study may be related to local hygiene practices, compliance with pin-site care, and smaller sample size. Importantly, no cases of malunion were observed in the JESS group, whereas 33.3% of conservatively managed patients developed malunion ($p = 0.0086$). Similar findings were reported by Somvanshi et al. [18] and Kushwaha et al. [20], emphasizing the superior ability of JESS fixation to maintain fracture reduction and prevent varus collapse.

Fracture union was achieved in 90.5% of JESS patients compared to 71% in the conservative group, although the difference did not reach statistical significance ($p = 0.66$). Gupta OP et al. [17] reported 100% union with a mean union duration of 9.33 weeks, while Arshad et al. [19] and Kushwaha et al. [20] also reported high union rates with JESS fixation. Despite comparable union rates, the present study demonstrated superior functional recovery and alignment maintenance with JESS fixation, suggesting that stable external fixation promotes predictable healing and earlier rehabilitation.

Overall complications were observed in 33.3% of patients in the JESS group compared to 57.2% in the conservative group, although this difference was not statistically significant ($p = 0.12$). Conservative treatment was associated with higher rates of malunion, stiffness, and delayed functional recovery. Similar observations have been reported in previous studies by Gupta OP et al. [17], Arshad et al. [19], and Somvanshi et al. [18]. Although pin-related complications are inherent to external fixation, the overall complication profile and superior functional outcomes observed with JESS suggest that its benefits outweigh the associated risks.

Overall, the findings of the present study demonstrate that JESS fixation provides significantly superior functional outcomes compared to conservative management in proximal humerus fractures. The technique offers stable fixation with minimal soft tissue disruption, facilitates early mobilization, maintains fracture alignment, reduces malunion, and achieves excellent long-term shoulder function. Therefore, JESS may be considered a safe, effective, minimally invasive, and reliable treatment modality for displaced proximal humerus fractures, particularly in patients requiring early rehabilitation and improved functional recovery.

CONCLUSION

The present study concludes that Joshi's External Stabilization System (JESS) provides significantly superior functional outcomes compared to conservative management in patients with proximal humerus fractures. Patients treated with JESS demonstrated earlier mobilization, higher NEER functional scores at all follow-up intervals, better maintenance of fracture

alignment, and lower incidence of malunion. Although pin-tract infections were observed in some cases, these complications were superficial and manageable without adversely affecting final outcomes. Fracture union rates were also higher in the JESS group, though the difference was not statistically significant. Overall, JESS proved to be a safe, effective, minimally invasive, and reliable treatment modality for proximal humerus fractures, offering improved shoulder function and better long-term clinical outcomes compared to conservative treatment.

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