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Comparative study to assess the outcome of surgical management of humerus shaft fracture: anterior bridge plating versus humerus intramedullary nailing

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ABSTRACT

Background: Aims and objectives of the study were to assess the outcomes of surgical management of humeral shaft fractures using anterior bridge plating (ABP) versus humeral intramedullary nailing (HIN) in terms of functional recovery and complication rates.
Methods: A prospective observational and interventional study was conducted from July 2022 to June 2024 at the tertiary care hospital. Sample size of 40 patients was taken.
Results: The study included 40 patients, with similar demographics between the groups. We divided the cases in two groups (HIN group A and ABP group B). Out of 40 patients, 23 were male and 17 were female. Postoperative follow-up at 24 weeks indicated improved functional outcomes assessed by UCLA score system for the ABP group B, with 65% achieving excellent, 25% good, 10% fair and 0% poor as compared to 55% good, 30% fair, and 15% poor in the HIN group A. In terms of complication, in the group A, one (5%) patient had radial nerve palsy, 3 (15%) nonunion, 1 (5%) delayed union and 1 (5%) superficial infection whereas in group B, no radial nerve palsy and nonunion, but 3 (15%) patients have delayed union and 1 (5%) superficial infection.
Conclusions: Anterior bridge plating demonstrated superior functional recovery compared to intramedullary nailing in patients with humerus shaft fractures, suggesting it may be the preferred surgical option for better patient outcomes but no significant difference in complications like delayed union and infection. Further research is warranted to validate these findings and refine treatment guidelines.

Keywords: Humerus intramedullary nailing, MIPPO, Humerus shaft fracture, Anterior bridge humerus plating

INTRODUCTION

Humerus shaft fractures are relatively common, representing approximately 1% to 5% of all fractures.[1] It is a diaphyseal humerus fracture and can be classified into transverse, oblique, comminuted, spiral, and segmental. Humerus shaft fracture have been found to be higher with age. These fractures exhibit a bimodal age distribution, with high-energy trauma predominantly causing them in young individuals and low-impact force being a common cause in older individuals.[1] These fractures can significantly impact a patient's quality of life, necessitating timely and appropriate interventions required to restore function and mitigate long-term complications. Humerus shaft fractures represent a common orthopedic challenge, requiring precise and effective management, adequate reduction and stable fixation. Management of humerus shaft fracture includes both surgical and conservative. Traditionally, non-operative treatment, especially with the advent of the functional brace by Sarmiento et al, has been the approach for most humeral shaft fractures. However, certain cases may necessitate early surgical intervention for improved outcomes.[2,3]

Conservative management includes application of cast such as U-slab, hanging cast, functional brace, but there

are higher rates of non-union and malunion and stiffness around shoulder and elbow in conservative management. Surgical management includes Intramedullary nailing: antegrade and retrograde nailing and open reduction and internal fixation (ORIF) plating with posterior approach, anterior-lateral plating or Anterior Bridge plating by minimally invasive percutaneous plate osteosynthesis (MIPPO). In posterior approach plating extensive soft tissue dissection and periosteal stripping increases rate of infection radial nerve injury. On the other hand, intramedullary nailing is minimally invasive, but in intramedullary nailing shoulder range of motion is compromised due to rotator cuff injury.[4]

This study focuses on comparing anterior bridge plating (ABP) using MIPPO and humerus intramedullary nailing (HIN) and seeks to establish evidence-based guidelines for the optimal surgical approach, assessing outcomes like fracture union, functional recovery, and complication rates. By evaluating these factors, the research will guide orthopedic surgeons in choosing the best method tailored to the fracture type and patient needs, enhancing recovery and minimizing complications.

METHODS

This research was a prospective observational and interventional study conducted from July 2022 to June 2024 at a tertiary care center. The sample size was 40 patients with humerus shaft fracture. We divided the cases in two groups (HIN group A and ABP group B).

Inclusion criteria

Patients aged 18 years or older with humerus shaft fractures were included.

Exclusion criteria

Patients with neurological deficit, open fracture, pathological fractures, fractures at the proximal and distal ends of the humerus, and fracture shaft humerus with rotator cuff injury were excluded.

The study adhered to strict ethical guidelines, with approval from the institutional ethics committee and informed consent obtained from all participants in either English or Hindi, ensuring confidentiality and use of data solely for study purposes.

The study assessed treatment effectiveness clinically using the UCLA shoulder score system for pain and mobility, and radiologically through X-rays of shoulder with arm in anteroposterior and lateral views.

Preoperatively, patients underwent a detailed clinical examination and X-ray imaging. The plan of surgical treatment was assessed and decided by the surgeon who operated.

Operative techniques

ABP technique

Patient positioning

Patient was placed in supine position over OT table, abducted arm up to 60° and traction given with flexed elbow. Closed reduction of fracture under C-arm guidance.

Dissection

Procedure involved the two separate incisions. First proximal incision, approximately 3 cm long, as a part of the delto-pectoral approach, fascia was split and inter-muscular plane developed between medial bicep border and deltoid. Further dissection done by retracting biceps medially and deltoid laterally. Approx 5 cm long, along the biceps tendon lateral border, away from the fracture site. Brachialis muscle was split longitudinally, and bicep belly muscle retracted medially. Half of the brachialis belly with musculocutaneous nerve was retracted medially, the remaining half retracted laterally. With the help of plate slider and artery forceps, a plane was developed extraperosteal and submuscular between proximal to distal incisions.

Traction applied to reduce the fracture to maintain angulation and length. Pass the plate of 8-10 holes or 10-12 holes, 4.5 mm narrow DCP or LC-DCP from proximal to distal direction, hold it with K-wire temporarily. Inserted the distal screws first, but not fully tightened, then fixed the plate proximally, tightened the proximal and distal screw, check reduction under the C-arm (Figure 1).

Intramedullary nailing

Patients were placed in a supine position on the operating table, with the upper portion of the table elevated approximately 60° so that the shoulder lay over the edge of the table. A 2 cm incision was made from the outer aspect of the acromion down the lateral aspect of the arm. Using a C-arm, entry was made through the proximal humerus medial to the greater tubercle with a bone awl, a guide wire was inserted, followed by serial reaming and nail insertion, with two screws applied proximally and one screw distally.[5]

Post–op evaluation

Postoperatively the operated side immobilized in a simple sling/arm pouch, wound inspection was done after two days and sutures were removed after 14 days. Passive and active-assisted shoulder ROM exercises were started under supervision of a physiotherapist at 2 weeks after surgery and active rotation were allowed at 3-4 weeks after surgery (Figure 2). Clinical evaluation of pain, range of motion of shoulder by UCLA shoulder score system was done at 1st month, 2nd month, 4th month, and 6th months post-surgery. Radiological evaluation with X ray arm AP and lateral view to check the union of fracture.

Statistical evaluation

The comparison of categorical variables was entered into Microsoft Excel (Office 2010), and analyzed using statistical package for the social sciences (SPSS) 21.

RESULTS

Out of 40 patients, 20 were treated by humerus intramedullary nailing (group A) and 20 patients were treated by anterior bridge plating (group B) by MIPPO technique. All the patients underwent surgeries in the orthopedics department. Average operating time of 75.5 minutes for both anterior bridge plating and intramedullary nailing.

The mean age of patients was 45.3 years in HIN group A and 45.1 years in ABP group B. Out of 40 patients, 23 were male and 17 were female. The mechanism of injury includes road traffic accidents in 23 cases (57.5 %), falls while walking and from height 11 (27.5%) and assault in 6 cases (15%) (Table 1).

Post-operative AP lateral view radiograph of humerus were taken, wound inspection was done on day 2nd and suture was removed after 14 days. All the patients were followed every month for clinical and radiological evaluation till the fracture united. Fracture union was defined as formation of bridging callus on AP and lateral view of radiograph (X-ray) at the fracture site. Clinical examinations include: post op range of motion, pain, function of shoulder and strength by UCLA score system (University of California, Los Angeles shoulder rating score), and constant-Murley shoulder score for shoulder motion.

The post-operative physiotherapy and mobilization of the shoulder was given once pain was decreased. Assisted exercises were allowed after the bone union seen on x-ray and clinically no pain over fractured site. Daily activities were allowed after one-month post-operation but lifting of light weight was allowed once after radiological bone union seen at fracture site. UCLA shoulder scores after 6 months were better in ABP group B as compared to group A (Tables 2 and 3). In group A, 15 (75%) patients treated with IM nailing had decreased in postoperative shoulder motion (Abduction and external rotation) as compared in group B, no decrease in shoulder motion. P value was 0.000482 (Table 4).

Table 1: Socio-demographics details of patients.

Variables	Group A: IM nailing	Group B: anterior bridge plating
	Frequency (%)	Frequency (%)
Gender		
Male	11 (55.0)	12 (60.0)
Female	9 (45.0)	8 (40.0)
Age (years)		
≤45	13 (65.0)	14 (70.0)
>45	7 (35.0)	6 (30.0)
Mean±SD	45.3±11.6	45.1±10.3
Type of fracture		
Oblique	9 (45)	8 (40)
Transverse	7 (35)	7 (35)
Comminuted	4 (20)	5 (25)
Total	20 (100.0)	20 (100.0)
Mechanism of injury		
RTA	23 (57.5 %), 11 for group A, 12 for group B	
History of fall	11 (27.5%), 6 (group A), 5 (group B)	
Assault	6 (15%), 3 (group A), 3 (group B)	

Average operative time: 75.5 minutes (72.5 min for group A and 79.5 min for group B); time of union of fracture: 15.5 weeks for group A and 14.5 weeks for group B.

Table 2: Distribution of study patients by post-op follow-up for UCLA functional outcome for group A.

Outcome	1 month (4 weeks) (%)	2 months (8 weeks) (%)	4 months (16 weeks) (%)	6 months (24 weeks) (%)
Poor	17 (85)	9 (45)	5 (25)	3 (15)
Fair	3 (15)	9 (45)	10 (50)	6 (30)
Good	0 (0)	2 (10)	5 (25)	11 (55)
Excellent	0 (0)	0 (0)	0 (0)	0 (0)

Table 3: Distribution of study patients by post-op follow-up for UCLA functional outcome for group B (anterior bridge plating).

Outcome	1 month (4 weeks) (%)	2 months (8 weeks) (%)	4 months (16 weeks) (%)	6 months (24 weeks) (%)
Poor	16 (80)	7 (17.5)	3 (15)	0 (0)
Fair	4 (20)	7 (17.5)	4 (20)	2 (10)
Good	0 (0)	5 (12.5)	7 (35)	5 (25)
Excellent	0 (0)	1 (5)	6 (30)	13 (65)

Table 4: Distribution of study patients by post-op shoulder motion (abduction and external rotation) by constant-Murley shoulder score.

Outcome	Group A (frequency, %)	Group B: (frequency, %)	Total	Statistics
Normal	5 (25)	20 (100)	25	Chi square test
Decreased	15 (75)	0	15	P value 0.000482
Good	3 (15)			
Fair	9 (45)			
Poor	3 (15)			

Table 5: Distribution of complication between group A and group B.

Complications	Group A (frequency %)	Group B (frequency %)	Total	P value
Delayed union	1 (5.0)	3 (15.0)	4	0.604990
Non-union	3 (15.0)	0	3	0.230769
Radial nerve injury	1 (5.0)	0	1	1.00
Superficial infection	1 (5.0)	2 (10.0)	3	1.00
Deep infection	0	0	0	1.00

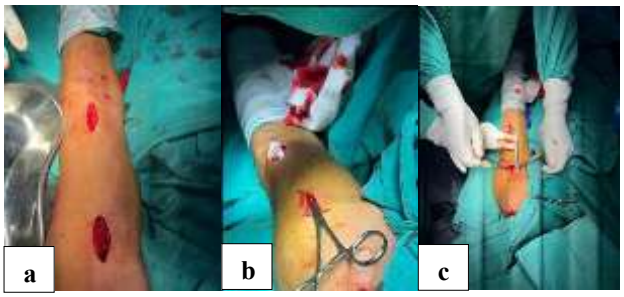

Figure 1 (a-c): Anterior bridge plating intraoperative image showing two incisions proximal and distal over arm.

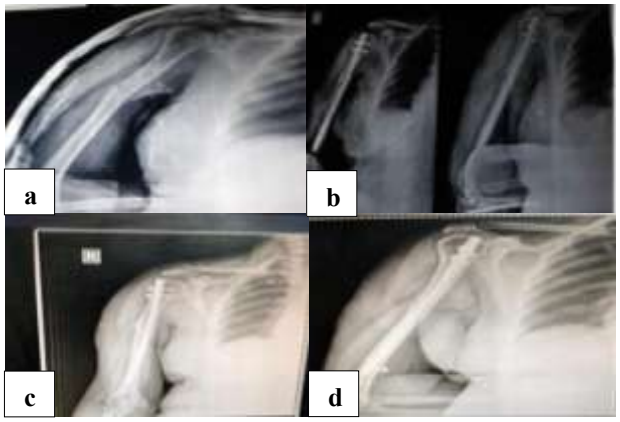

Figure 2 (a-d): Preoperative and postoperative radiographs of the right arm showing fracture shaft of humerus, intramedulary locking nail with fracture healing after 14 weeks.

In terms of complication, in the group A, one (5%) patient had radial nerve palsy which was neuropraxia in nature and recovered in 6 months with cock-splint, physiotherapy, and methylcobalamin (1500 mcg) and 3 (15%) patients had nonunion, who were re-operated with plating and autologous iliac crest bone grafts. 1 (5%) Patients in group A and 2 (10%) in group B had superficial infection which were treated with debridement and antibiotics. In group A, one (5%) patient and 3 (15%) patients in group B had developed delayed union which was managed with ultrasonic therapy, segmental brace application and bone grafting. As per the complication in both groups p value was not statistically significant (Table 5 and Figure 3-5).

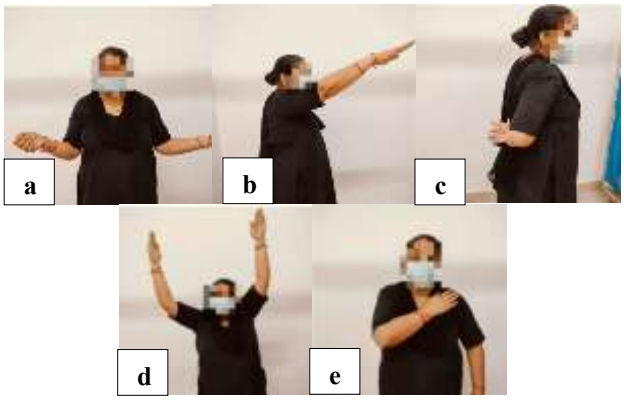

Figure 3 (a-e): Clinical outcomes and range of motion of right shoulder 6 months after intramedullary nailing surgery showing external rotation, forward flexion, internal rotation, abduction and adduction.

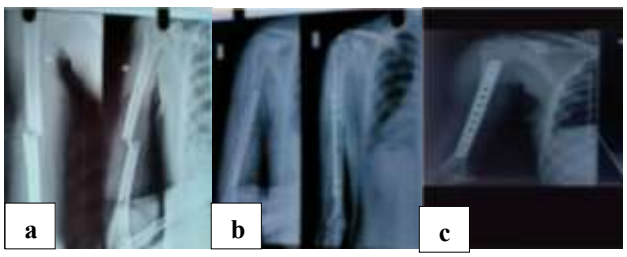

Figure 4 (a-c): Preoperative and postoperative radiographs of the right arm showing fracture shaft of humerus, anterior bridge plating with fracture healing after 14 weeks.

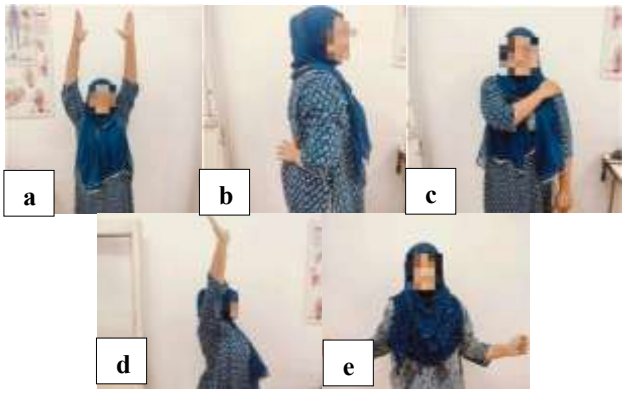

Figure 5: Clinical outcomes and range of motion of right shoulder 6 months after anterior bridge plating surgery showing range of motion of right shoulder (a) abdomen, (b) internal rotation, (c) adduction, (d) forward flextion, and (e) external rotation.

DISCUSSION

The concept for treatment of humeral shaft fracture still follows the interfragmentary strain theory.[6-9] This study aimed to evaluate the surgical outcomes of humerus shaft fractures managed using anterior bridge plating and humerus intramedullary nailing.

Regarding the distribution of fracture types, both nailing and plating methods were employed across different types of humerus fractures. HIN was used in 45% of oblique fractures in group A, slightly less than the 40% treated with ABP in group B. Similarly, both methods treated transverse fractures equally at 35% each. In cases of comminuted fractures, HIN accounted for 20% while ABP treated 25% of cases. Overall, an equal number of fractures (20 each) were treated with nailing and plating methods, indicating a balanced distribution of treatment modalities across the various fracture types studied. Davies et al in 2016 conducted a study on 30 patients who concluded all types of fracture shaft humerus, and 15 each patient operated with IM nailing and MIPO.[10]

In our study, we were comparing the time taken for union of fracture between group A and B. The results indicated that in group A, 16 (80%) participants achieved bone union within 16 weeks, whereas 20% required more than 16 weeks. Conversely, in group B, 17 (85%) participants attained union within 16 weeks, while only 15% needed more than 16 weeks. These findings suggest that ABP group B may slightly outperform HIN group A in terms of achieving faster union in humerus shaft fractures. These findings contribute valuable insights into surgical management decisions for humeral shaft fractures, emphasizing the need for further research to validate these results across broader patient populations. Patel et al observed varying durations for union among 20 patients undergoing anterior bridge plating treatment for humeral shaft fractures.[11] Average time of union of fractures was 13.5 weeks in the study.

The data highlights the effectiveness of both techniques, with a marginally higher success rate in the ABP group B for faster union.

Our study compared postoperative complications in patients treated for humerus shaft fractures using either HIN group A or ABP group B. In group A, 5% of participants experienced delayed union, 15% faced non-union, 5% had radial nerve injury, and 5% suffered from superficial infection. In group B, 15% of participants had delayed union and 10% had superficial infection, with no cases of non-union or nerve injury. The majority, 75%, had no complications. In terms of complications, p value was not statistically significant in both groups. This data indicates that both groups have no major complication outcomes. As per the study done by Davies et al, in 30 patients, they found significant differences in complications among the two groups.[10] In IM nailing, 20% had radial nerve injury, 27% had non-union, 7% had infection, revision surgery was done in 27% while in MIPO, one patient (7%) had non-union fracture as a complication.

The results of our study indicate the effectiveness of both surgical techniques while suggesting a marginal advantage for ABP group B in reducing specific complications such as non-union and nerve injury.

The study compared the functional outcomes by UCLA score system between two groups of patients undergoing different treatments for humeral fractures, focusing on their recovery over a span of six months. In group A, 15% had poor outcomes, 50% had fair outcomes and 55% had good outcomes after 6 months while in group B, 10% had fair outcomes, 25% had good outcomes and 65% had excellent functional outcomes. As per the study done by Kulkarni et al, on 112 patients shows that post op range of movement of shoulder with the UCLA score was significantly better (score of 32.26 in MIPO) as compared to 27.54 in IMN.[12]

Limitations

The limitations of our study include the small sample size and short duration of follow up, and single-centric tertiary care center.

CONCLUSION

Overall, the results affirm the effectiveness of both IM nailing and anterior bridge plating in managing humerus shaft fractures, but anterior bridge plating had better functional outcomes, but no significant difference in complications like delayed union and infection.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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