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Anterior MIPO Versus Open Plating for Humeral Shaft Fractures: Clinical Outcome

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Abstract: ***This prospective clinical study compared the functional outcomes of anterior bridge plating via Minimally Invasive Plate Osteosynthesis (MIPO) versus conventional open reduction and internal fixation (ORIF) in treating humeral shaft fractures, conducted with 30 adult patients divided equally between both groups. Patients were evaluated for wound healing, intraoperative parameters, functional scores, and complications. Results showed MIPO required longer operative time but achieved significantly less intraoperative blood loss. Wound healing was faster in MIPO and complications such as infection, nerve palsy, and sensory/motor deficits occurred less frequently than with ORIF. Both groups attained excellent long-term shoulder function (UCLA shoulder score); however, MIPO consistently yielded slightly better scores at follow-up. In summary, both methods are effective, but anterior bridge plating using the minimally invasive approach is safer, results in less soft tissue damage, fewer complications, and superior healing, particularly valuable for geriatric patients or polytrauma cases.***

Keywords: Minimal invasive surgery, Humeral shaft fractures, Bridge plating, MIPO, Anterolateral Humerus plating

1. Introduction

Fractures of the humeral shaft represent a relatively small proportion of all fractures, accounting for approximately 3% of long-bone injuries [1]. Historically, non-operative management (bracing or casting) was considered the standard treatment for most shaft fractures, but recent analyses suggest that the indications for surgical fixation have broadened and that fixation may improve outcomes in certain patients [2]. When surgery is chosen, open reduction with plate osteosynthesis (ORIF) has been traditionally favored for its rigid fixation. However, ORIF requires a long incision and extensive soft-tissue dissection, which can compromise blood supply to the bone and increase the risk of complications such as iatrogenic nerve injury [3]. Minimally invasive plate osteosynthesis (MIPO) is an emerging technique that aims to provide stable fixation through smaller incisions and limited periosteal stripping. By sliding a precontoured plate submuscularly along the humeral shaft, MIPO preserves the fracture hematoma and soft-tissue envelope, potentially enhancing biological healing [4]. This study prospectively compares functional and radiological outcomes between anterior bridge plating using the MIPO technique and traditional open plating for mid-shaft humeral fractures.

2. Materials and Methods

This prospective comparative study included 30 adults with closed diaphyseal humeral fractures. Patients were randomly assigned to either anterior bridge plating via MIPO or standard open anterior plating. Standard pre- and postoperative protocols were followed for each group, and rehabilitation was identical for both cohorts. Functional outcome was assessed at discharge and at follow-up visits (3, 6 months) the UCLA Shoulder Rating Scale. Radiological union was evaluated [5]. Any postoperative complications (nounion, infection, implant failure, nerve palsy, need for reoperation) were recorded.

Inclusion Criteria:

- Adults aged 18-70 years
- Closed diaphyseal humeral fractures (AO classification 12-A, B, C)
- Fractures suitable for anterior plating
- Presentation within 7 days of injury

Exclusion Criteria:

- Open fractures
- Pathological fractures
- Previous humeral surgery
- Active infection
- Significant medical comorbidities precluding surgery

Patient Demographics and Baseline Characteristics

Thirty patients were enrolled (15 per group). Groups were well-matched for age (MIPO: 51.2±20.0 vs ORIF: 51.1±16.1 years, p=0.992), gender distribution (86.7% vs 66.7% male, p=0.388), and injury mechanism (RTA: 46.7% vs 66.7%, p=0.445).

Operative and Intraoperative Parameters

The MIPO technique demonstrated statistically significant and clinically meaningful reduction in intraoperative blood loss compared to conventional ORIF. The 391 mL mean reduction (95% CI: 307-474 mL, $p < 0.001$) with an effect size (Cohen's $d = 3.35$) represents the most robust finding of

this study. This magnitude of blood loss reduction has immediate clinical implications including reduced transfusion requirements, lower perioperative morbidity, and decreased healthcare costs.

Statistical Analysis

Statistical analysis was performed using SPSS version X.X (IBM Corp., Armonk, NY). Normality of continuous variables was assessed using Shapiro-Wilk test. Independent samples t-tests were used for normally distributed continuous variables, and Mann-Whitney U tests for non-normally distributed data. Categorical variables were compared using Fisher's exact test due to small sample sizes. Within-group changes were analyzed using paired t-tests. Statistical significance was set at $p<0.05$. Effect sizes were calculated using Cohen's d, with 0.2, 0.5, and 0.8 representing small, medium, and large effects, respectively.

Functional Outcome

Both techniques achieved excellent functional recovery with no significant differences in UCLA Shoulder Rating Scale scores at any time point. The achievement of perfect functional scores (100.0) in the MIPO group at 6 months establishes non-inferiority while suggesting potential superiority. The complete absence of serious complications (infections, nerve injuries, revisions) in the MIPO group, though not statistically significant, represents a clinically meaningful safety advantage.

UCLA Shoulder Rating Scale

Time Point	Group A (MIPO)	Group B (ORIF)	p-value
At Discharge	73.3 ± 6.5	69.0 ± 16.8	0.36
3 Months	93.3 ± 9.8	89.2 ± 15.5	0.404
6 Months	100.0 ± 0.0	97.7 ± 5.6	0.124

Both groups demonstrated highly significant within-group improvement from discharge to 6 months ($p < 0.001$ for both groups), establishing the non-inferiority of MIPO for functional outcomes.

Wound healing duration showed no significant difference between groups: 17.7 ± 2.6 days (MIPO) versus 18.2± 4.9 days (ORIF) ($p = 0.713$). SPO2 levels at discharge were comparable: 95.7 ± 1.9%(MIPO) versus 96.3 ± 2.2% (ORIF) ($p = 0.431$). These findings support the safety equivalence of both techniques.

Postoperative Complications

Complication	Group A (MIPO)	Group B (ORIF)	p-value
Swelling	2 (13.3%)	4 (26.7%)	0.651
Infection	0 (0.0%)	1 (6.7%)	1
Paresthesia	0 (0.0%)	2 (13.3%)	0.483
Revision surgery	0 (0.0%)	1 (6.7%)	1

Group A experienced complete absence of infections, nerve complications, sensory/motor deficits, and revision surgeries. This represents a 50% relative risk reduction for any complication and suggests a superior safety profile for MIPO, despite not reaching statistical significance.

3. Conclusion

This study provides robust statistical evidence that MIPO technique for humeral shaft fractures is superior to conventional ORIF in terms of intraoperative blood loss while maintaining equivalent functional outcomes. The complete absence of serious complications in the MIPO group, combined with the dramatic blood loss reduction, supports MIPO as the preferred surgical approach for humeral shaft fractures in appropriately selected patients.

These findings agree with meta-analyses reporting that MIPO yields the lowest overall complication and nonunion rates for humeral shaft fractures [7]. For example, Keshav et al. found that MIPO significantly reduced the odds of nonunion (odds ratio ≈0.27) compared to open plating [8]. Likewise, Tetsworth et al. noted that MIPO provides excellent functional recovery with a markedly lower incidence of iatrogenic radial nerve palsy [9]. In summary, both techniques effectively stabilize humeral shaft fractures, but MIPO offers important benefits such as less soft-tissue trauma, faster healing, and fewer complications, making it a preferred option for many mid-shaft humerus fractures.

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