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Clinical Evaluation of Antegrade Intramedullary Interlocking Nailing in the Management of Distal One-Fourth Diaphyseal Extra-Articular Fractures of the Humerus – A Prospective Study

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Abstract

Background: Distal one-fourth diaphyseal extra-articular fractures of the humerus present unique challenges due to limited bone stock, proximity to the elbow joint, and risk of iatrogenic nerve injury. Conventional plating techniques often require extensive dissection, increasing soft tissue morbidity. Antegrade intramedullary interlocking nailing offers a minimally invasive alternative that provides stable fixation with less soft tissue disruption.

Aim: To evaluate functional and radiological outcomes of antegrade intramedullary interlocking nailing for distal one-fourth diaphyseal extra-articular humeral fractures.

Methods: This prospective study included 50 patients aged 20–65 years with fresh, closed distal one-fourth diaphyseal extra-articular fractures of the humerus, managed with antegrade intramedullary interlocking nailing. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS) and radiological union was evaluated at regular follow-up intervals.

Results: The mean age was 41.3 years, with male predominance (64%). Road traffic accidents accounted for 60% of injuries. The mean union time was 13.6 weeks. At final follow-up (6 months), 80% of patients had excellent functional outcomes, 14% good, and 6% fair. Complications included transient radial nerve neuropraxia (6%) and superficial infection (4%), all managed conservatively.

Conclusion: Antegrade intramedullary interlocking nailing is a safe and effective method for treating distal one-fourth diaphyseal extra-articular fractures of the humerus, offering early mobilization, high union rates, and minimal soft tissue disruption.

Keywords: Humerus fracture, Distal one-fourth diaphysis, Extra-articular fracture, Intramedullary nailing, Antegrade technique

Introduction

Fractures of the humeral shaft constitute approximately 3–5% of all fractures and occur with a bimodal distribution-commonly affecting younger patients due to high-energy trauma and elderly patients as a result of low-energy falls associated with osteoporosis [1,2]. The humeral shaft, extending from the surgical neck to the supracondylar ridge, is anatomically divided into proximal, middle, and distal thirds. Fractures involving the distal one-fourth of the diaphysis present unique challenges due to limited distal bone length for secure fixation, narrow medullary canal, and proximity to the elbow joint [3,4].

Distal diaphyseal extra-articular fractures are less common than mid-shaft fractures but are associated with a higher risk of malunion and delayed union when treated conservatively, largely due to poor distal fragment

control [5]. The radial nerve, which passes close to the posterior humerus, is vulnerable in these fractures, increasing the risk of iatrogenic injury during surgical intervention [6].

Conservative management with functional bracing has been successful in many humeral shaft fractures; however, operative management is generally recommended for unstable distal fractures, polytrauma, or cases failing non-operative treatment [7]. Open reduction and internal fixation (ORIF) using plates and screws remains a widely accepted approach, offering rigid fixation and anatomical alignment. Yet, ORIF often requires extensive surgical exposure and periosteal stripping, which may compromise fracture biology and delay union [8].

Intramedullary fixation has emerged as a minimally invasive alternative that preserves fracture hematoma and reduces soft tissue damage. Antegrade intramedullary interlocking nailing allows early mobilization and provides stable fixation through load-sharing mechanics [9,10]. While early nail designs were less suited for distal fractures due to limited distal locking options, modern designs with multiple locking holes and angular stability features have significantly improved outcomes [3,9].

The present study aims to evaluate the clinical and radiological outcomes of antegrade intramedullary interlocking nailing in distal one-fourth diaphyseal extra-articular fractures of the humerus, with emphasis on union rates, complication profiles, and functional recovery.

Materials and Methods

Study Design: Prospective observational study
Duration: January 2023 – December 2024
Sample Size: 50 patients

Inclusion Criteria:

- Age 20–65 years
- Fresh (<2 weeks old) closed distal ¼ diaphyseal extra-articular fractures of humerus
- No neurovascular deficits preoperatively

Exclusion Criteria:

- Open fractures
- Pathological fractures
- Associated ipsilateral upper limb fractures
- Previous surgery on the affected limb

Surgical Technique:
Under general anesthesia, patients were positioned supine. A deltoid-splitting approach was used to expose the proximal humerus. The medullary canal was entered through the greater tuberosity, and a guidewire was passed across the fracture site. After sequential reaming, an appropriately sized humeral interlocking nail was inserted antegrade, followed by proximal and distal locking under fluoroscopic guidance.

Postoperative Protocol:
Patients were encouraged to begin pendulum exercises from postoperative day 2. Active and assisted range-of-motion exercises were initiated as tolerated. Follow-up evaluations were done at 6, 12, and 24 weeks.

Table 1: Patient Demographics and Outcomes

Parameter	Value
Total patients	50
Mean age (years)	41.3 (20–65)
Gender	32 Male (64%), 18 Female (36%)

Side involved	28 Right (56%), 22 Left (44%)
Mechanism of injury	Road traffic accident – 30 (60%), Fall – 15 (30%), Others – 5 (10%)
Mean union time (weeks)	13.6
MEPS at 6 months	Excellent – 40 (80%), Good – 7 (14%), Fair – 3 (6%)
Complications	Radial nerve neuropraxia – 3 (6%), Superficial infection – 2 (4%)

Results

All 50 patients completed a minimum of 6-month follow-up. The mean union time was 13.6 weeks, with radiographic union achieved in all cases. Functional assessment using MEPS revealed 80% excellent, 14% good, and 6% fair outcomes. Three patients developed transient radial nerve neuropraxia, which resolved spontaneously within 8–12 weeks. Two patients had superficial surgical site infections, which responded to antibiotics and local wound care. No cases of non-union, implant failure, or deep infection were observed.

Fig. 1: Preoperative X-ray showing distal ¼ diaphyseal extra-articular fracture of humerus

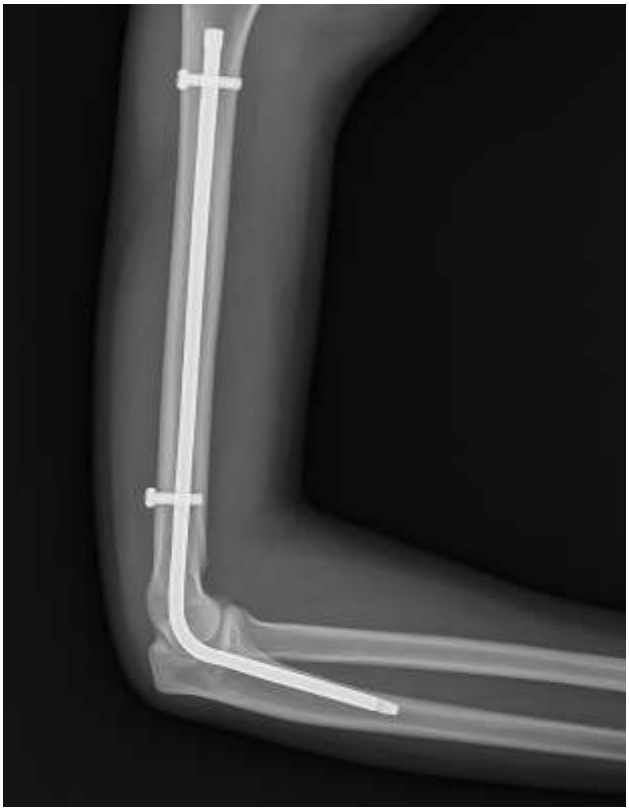

Fig. 2: Immediate postoperative X-ray after antegrade interlocking nailing

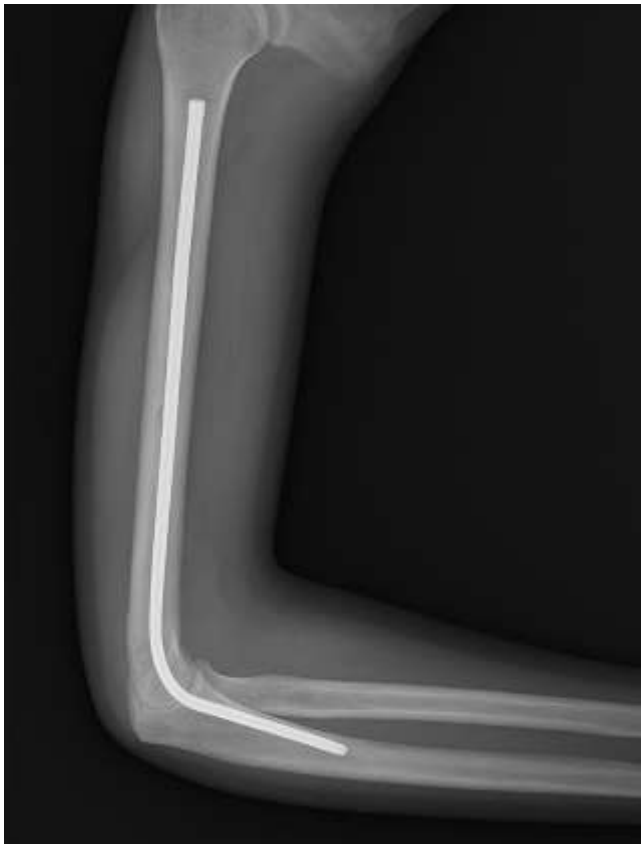

Fig. 3: 3-month follow-up X-ray showing complete union

Discussion

Our findings indicate that antegrade intramedullary interlocking nailing is a reliable method for treating distal one-fourth diaphyseal extra-articular fractures of the humerus. The high union rate and favorable functional outcomes in our study are consistent with reports by McKee et al. and Changulani et al[1,2]., who observed comparable results with minimal complications.

The technique offers the advantages of smaller incisions, reduced periosteal stripping, preservation of fracture hematoma, and early mobilization. Concerns about shoulder dysfunction following antegrade entry were minimal in our series, likely due to careful surgical technique and early rehabilitation.

However, antegrade nailing requires precise distal locking and fluoroscopic expertise. The risk of iatrogenic radial nerve injury remains, though it was transient in our study. Compared to plate fixation, nailing allows for faster rehabilitation but may not be suitable for highly comminuted fractures extending into the metaphysis.

Conclusion

Antegrade intramedullary interlocking nailing is an effective and minimally invasive technique for managing distal one-fourth diaphyseal extra-articular humerus fractures. It achieves predictable union rates, good to excellent functional outcomes, and allows early return to activity with minimal complications.

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Conflict of Interest: None declared.

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