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Original Research Article

FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURES MANAGED BY MULTILOCK HUMERAL NAIL SYSTEM - A PROSPECTIVE STUDY

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ABSTRACT

Background: The proximal humerus plays a key role in shoulder mobility and is prone to fractures, especially in older adults with osteoporosis. Despite the common use of the Neer and AO/OTA classifications, treatment remains challenging because of fracture complexity, variable outcomes, and complications such as avascular necrosis (AVN). This study aimed to analyse the functional outcomes of the surgical management of proximal humeral fractures using the humeral nail system. **Materials and Methods:** This prospective observational study included 20 patients diagnosed with proximal humerus fractures at the Government Rajaji Hospital in Madurai. All patients underwent clinical and laboratory evaluations, including Hb, blood sugar, ECG, RFT, and chest X-ray, to assess surgical fitness. They were followed up until satisfactory clinical and radiological outcomes were obtained. **Result:** Most patients were aged > 60 years (35%), followed by those aged 40–60 years (30%). The most common mode of injury was road traffic accidents (65%), followed by accidental falls (35%). Right-sided proximal humerus fractures were more frequent (65%) than left-sided fractures (35%). All patients were managed with closed reduction and internal fixation using an IMIL humeral nail. Based on the Constant-Murley scoring system, three patients had excellent outcomes (scores: 87, 88, and 93), whereas two had moderate outcomes (scores: 60 and 66), indicating favourable functional recovery in the majority. **Conclusion:** The Multilock Humeral Nail system provides stable fixation with minimal soft tissue damage, enabling early mobilisation and good functional outcomes. It is a safe, effective, and minimally invasive option for managing proximal humeral fractures, particularly in osteoporotic and complex cases.

INTRODUCTION

The proximal humerus forms the upper portion of the humeral bone, located just below the shoulder joint, and is vital for upper-limb mobility and function. It comprises key anatomical components, including the humeral head, which articulates with the glenoid fossa of the scapula to form the glenohumeral joint, one of the most mobile joints in the body. Additional structures such as the anatomical and surgical necks, greater and lesser tubercles, and the intertubercular groove provide essential landmarks for surgical orientation.[1,2]

These regions also serve as critical sites for the attachment of muscles, particularly the rotator cuff group, which plays a central role in shoulder stability and movement. Furthermore, the proximity of important neurovascular structures around the proximal humerus highlights its clinical significance, particularly in trauma, where injury can compromise both mechanical function and neurovascular integrity of the upper limb.[3]

Clinically, the proximal humerus is a frequent site of fracture, representing approximately 5-6% of all adult fractures and ranking as the third most common fracture in adults, with an increasing incidence due to aging populations and increased prevalence.[4] Such fractures predominantly occur in elderly patients, where osteoporotic bone quality contributes to fracture complexity and healing challenges. The injury patterns range from minimally displaced to complex comminuted fractures involving multiple fragments, posing difficulties in classification and management.[5]

The Neer and AO/OTA classification systems are commonly used for categorising proximal humerus

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fractures; however, both are associated with considerable inter- and intra-observer variability, which poses challenges for consistent diagnosis and the development of standardised treatment protocols. Despite ongoing improvements in surgical fixation techniques, the optimal management approach remains debated due to inconsistent clinical outcomes and a lack of robust evidence from high-quality randomised controlled trials.[6,7]

The primary goal of surgical fixation is to restore anatomical alignment and shoulder biomechanics, thereby promoting optimal functional recovery after injury. However, several complications can arise postoperatively, particularly in patients with osteoporotic bones. These include avascular necrosis, non-union, malunion, and hardware-related failures, all of which can compromise clinical results and patient satisfaction.[8,9]

This study aimed to analyse the functional outcomes of the surgical management of proximal humeral fractures using the humeral nail system.

MATERIALS AND METHODS

This prospective observational study included 20 patients diagnosed with proximal humerus fractures at the Department of Orthopaedics and Traumatology, Government Rajaji Hospital in Madurai. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from the patients before enrolment.

Inclusion criteria

This study included patients with Neer 2-part and 3-part proximal humerus fractures, segmental fractures involving both the proximal humerus and humeral shaft were included. Patients with fracture-dislocations, compound Grade I and II fractures based on the Gustilo-Anderson classification, polytrauma with proximal humerus fractures, and pathological fractures were included.

Exclusion criteria

Skeletally immature patients, those with Neer's 4-part fractures, compound Grade IIIA, IIIB, and IIIC fractures, refractures, comminuted fractures, old neglected fractures, and those unfit for surgery due to medical conditions were excluded.

Methods

All selected patients were examined according to the protocol, and their associated injuries were noted. Clinical and laboratory investigations were performed to determine fitness for surgery. Patients were followed up until good functional outcomes were achieved both clinically and radiologically. Patients underwent a preoperative evaluation, including the following parameters: Hb level, blood sugar level, and ECG. RFT and chest radiography were performed to assess fitness for surgery.

Surgical technique and rehabilitation: Intramedullary Multilock humerus nailing

The procedure involves the use of an intramedullary Multilock nail to fix proximal humeral fractures. Preoperative radiographic evaluation with anteroposterior and axillary views, along with CT scans, helps assess fracture alignment. Patients were administered either general anaesthesia or regional blocks. They were positioned in a beach chair or modified supine position on a radiolucent table to allow full visualisation of the humerus using a C-arm. The anterolateral approach starts from the acromion tip and proceeds distally over the deltoid, which is split and retracted. In complex cases, partial detachment of the deltoid from the acromion may be required for better exposure of the fracture site.

Fractures are reduced using indirect techniques, traction sutures, Schanz screws or K-wires. The entry point was identified at the apex of the humeral head, posterolateral to the biceps tendon. A guide rod was inserted, and a longitudinal incision was made through the supraspinatus tendon. Fracture reduction is confirmed using a reaming rod, and the canal is reamed in 0.5 mm increments to a diameter at least 1 mm larger than the nail. The nail is then inserted with twisting motions, avoiding the use of a hammer to prevent iatrogenic fractures. The nail is advanced carefully, ensuring that it lies 2–3 mm below the cartilage surface to minimise impingement and maximise stability.

Proximal locking is achieved by drilling until the subchondral bone is reached, determining the screw length with a calibrated drill bit or depth probe, and inserting 3.5 mm locking screws. Distal locking involves careful dissection and drilling through the aiming arm to insert 4.0 mm locking screws. After fixation, the wound was closed in layers, and a sterile dressing was applied.

Postoperative rehabilitation was performed according to a structured protocol. Phase I (0–5 weeks) focuses on early passive motion, grip strengthening, and gradual progression to active-assisted range of motion (ROM) and isometric exercises. Phase II (4–12 weeks) emphasised active ROM, patient self-stretching, and early resisted ROM using Therabands and light weights. Phase III (from week 12 onwards) includes isotonic strengthening, aggressive stretching, and return to functional or sports-specific activities.

Functional outcomes were assessed using the Constant-Murley Score (CMS), which includes pain (15 points), activities of daily living (20 points), ROM (40 points), and strength (25 points), for a total of 100 points. Pain and daily activities are subjective, whereas strength and ROM are objective. The score categorises the results as poor (0–55), moderate (56–70), good (71–85), or excellent (86–100) for the evaluation of shoulder function during follow-up. All data are presented as frequencies and percentages using MS Excel.

RESULTS

Most patients were over the age of 60 years (35%), followed by those aged 40–60 years (30%), 25–40

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years (20%), and under 25 years (15%). There was a male predominance, with 70% of the patients being male and 30% female. Road traffic accidents (RTA) were the most common mechanism of injury, accounting for 65% of cases, and 35% of injuries were due to accidental falls. The right side was more frequently affected, with right-sided injuries reported in 65% of patients and left-sided injuries in 35% of cases [Table 1].

Table 1: Demographic and injury profile

		Frequency (%)
Age (years)	< 25	3 (15%)
	25-40	4 (20%)
	40-60	6 (30%)
	> 60	7 (35%)
Sex	Male	14 (70%)
	Female	6 (30%)
Mechanism of injury	RTA	13 (65%)
	Accidental fall	7 (35%)
Side of injury	Right	13 (65%)
	Left	7 (35%)

Five patients with closed proximal humerus fractures underwent closed reduction and internal fixation (CRIF) using intramedullary interlocking (IMIL) humerus nailing. The mean age was 39.6 years (range: 20–60 years), with three males and two females. RTAs were the predominant mode of injury (n=3), followed by accidental fall injuries (n=2). The right side was involved in four patients and the left side in one.

Three patients achieved excellent outcomes, with CMS scores ranging from 87 to 93. Two patients demonstrated moderate outcomes with scores of 66 and 60. Overall, the procedure yielded satisfactory functional recovery in the majority of the cases [Table 2].

Table 2: Outcomes based on CMS of five patients

S. No	Age/ sex	Mode of injury	Diagnosis	Procedure done	Constant Murley score	Functional outcome
1	57 years/female	Accidental fall	Closed fracture proximal humerus right	CRIF with IMIL humerus nailing	87	Excellent
2	21 years/male	RTA	Closed fracture proximal humerus right	CRIF with IMIL humerus nailing	93	Excellent
3	40 years/male	RTA	Closed fracture proximal humerus right	CRIF with IMIL humerus nailing	88	Excellent
4	60 years/female	Accidental	Closed fracture proximal humerus right	CRIF with IMIL humerus nailing	66	Moderate
5	20 years/male	RTA	Closed fracture proximal humerus left	CRIF with IMIL humerus nailing	60	Moderate

DISCUSSION

In our study, most patients were over 60 years old, with a clear male predominance. RTA was the leading cause of injury, and the right side of the body was more frequently affected. Similarly, Giannoudis et al. studied 25 patients with a mean age of 61 years (range, 18–92 years), showing a female predominance (18 females, 7 males). Simple falls were the most common cause of injury (18 cases), followed by pedestrian-vehicle impacts. The study highlighted a typical pattern of osteoporotic fractures in elderly females.10 Wong et al. reported a frequency-weighted mean age of 64.3 years across 14 studies, indicating that proximal humerus fractures predominantly occur in older adults. They also reported a female predominance (71% females vs. 29% males), contrasting with our male-dominant sample.[11]

Prasad et al. reported a contrasting demographic pattern, with a female predominance (61%), and the majority of patients aged between 50 and 60 years. Falls from a standing height were the most frequent mode of injury in elderly patients, while younger patients sustained fractures primarily from RTAs or sports-related trauma.[12] Singh et al. reported a higher proportion of female patients (53.3%), with the 41–60 age group being the most affected (46.7%). Road traffic accidents were the leading cause of trauma (60%), followed by falls (33.3%). Most cases were closed fractures (83.3%), with two-part (40%) and three-part (26.7%) fractures being the most common per Neer's classification.[13] The demographic and injury patterns in our study highlight a region-specific variance from global trends, particularly in gender distribution and mechanism of injury, indicating the need for context-aware preventive strategies.

Among the five patients who underwent CRIF with IMIL humeral nailing, the mean age was 39.6 years. Most patients were male, with RTAs as the common cause of injury and right-sided fractures being more

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frequent. Lopiz et al. reported on 52 patients treated with either Polarus or MPHN nails, predominantly for 2-part and 3-part fractures. The mean operative time was comparable between the two groups (~100 min), and no intraoperative complications were reported.[14] Adu-Kwarteng et al. analysed postoperative outcomes in both proximal humerus and humeral shaft fractures. In the proximal humerus fracture (PHF) subgroup (1835 shoulders), the mean follow-up duration was 21.2 months, with consistent use of intramedullary nails across various fracture types.[15] Guoyun Bu et al. compared IM nailing and plating in a larger cohort and reported significantly shorter surgical duration (87.31 ± 23.32 mins vs. 101.52 ± 24.62 mins, P = 0.01), less intraoperative blood loss (189.34 ± 62.03 mL vs. 222.87 ± 76.42 mL, P = 0.03), and shorter time to bone union (11.64 ± 1.81 weeks vs. 12.53 ± 1.75 weeks, P = 0.03).[16] These findings suggest that IMIL nailing can be effectively employed in younger patients with high-energy trauma, offering a versatile solution across age groups and injury mechanisms.

Singh et al. employed a variety of surgical methods for proximal humerus fractures, including open reduction and internal fixation (ORIF) with locking compression plates (46.7%), percutaneous pinning (20%), and intramedullary nailing in only two cases (6.7%). Radiological union was achieved within 18 weeks in the majority (73.3%), while clinical union was observed in most cases by 12–14 weeks.[13] Intramedullary nailing is a viable alternative to other fixation techniques, with comparable timelines for radiological and clinical union, particularly in select fracture types.

Functional outcomes assessed using the CMS showed satisfactory results, with most patients achieving good to excellent shoulder function. Wong et al. reported a frequency-weighted mean CMS of 72.8 across seven studies (n = 225). They found significantly better functional scores for two- and three-part fractures than four-part fractures, with higher complication and reoperation rates in the latter.[11] Giannoudis et al. evaluated 25 patients with a mean age of 61 years (range 18–92), and a female predominance (18 females, 7 males). The most common mechanism of injury was simple falls (18 out of 25 cases), followed by pedestrian-vehicle impacts and other causes. Their patient profile largely consisted of older adults and fall-related injuries, typical of osteoporotic fractures in elderly females.[10] The favourable functional scores in our study align with broader evidence supporting the use of IM nailing, particularly in cases with appropriate fracture selection and structured rehabilitation protocols.

Lopiz et al. reported mean Constant scores of 51.4 (Polarus) and 61.2 (MPHN), which improved to 72.7 and 83.3 after age- and sex-adjustment. While both showed moderate-to-good outcomes, the MPHN group had better scores, fewer complications, and a lower reoperation rate (11.5% vs. 42%).[14] Adu-Kwarteng et al. reported a mean Constant-Murley Score of 73.3 ± 12.2 in 1835 shoulders within the PHF cohort treated with IM nailing. The mean ASES and DASH scores were 80.4 ± 8.0 and 25.4 ± 16.9, respectively. The mean postoperative range of motion was 133° for forward flexion, 118° for abduction, and 41° for external rotation. Outcomes were generally favorable, particularly in cases with appropriate fracture pattern selection and timely surgical intervention.[15] This comparative evidence reinforces that implant design and surgical expertise influence postoperative outcomes and complication rates, with newer-generation nails showing potential advantages.

Prasad et al. reported a broader spectrum of outcomes based on the CMS: 13% had excellent outcomes, 34.8% good, 39.1% fair, and 13% poor. Poor outcomes were more common among elderly patients owing to poor bone quality, surgical complications, and suboptimal rehabilitation compliance.[12] Bu et al. reported no significant difference in final functional outcomes between the nail and plate groups based on VAS, ASES, and Constant scores. However, neck-shaft angle (NSA) at final follow-up was slightly better in the nailing group (137.55° ± 5.53 vs. 134.47° ± 5.92°, P = 0.02), suggesting superior anatomical alignment.[16] Singh et al. evaluated functional outcomes using Neer's scoring system. By the final follow-up, 76.7% of patients achieved excellent results (>90 score), 13.3% had satisfactory results (80–89), while only 3.3% were classified as failure. The average total score was 79.65. The consistent improvement across follow-up intervals highlights the importance of rehabilitation, irrespective of surgical method.[13]

The wide variability in reported outcomes across studies emphasizes the critical role of patient-related factors such as age, bone quality, and rehabilitation adherence in determining functional recovery. Although functional outcomes may be similar between plating and nailing, the soft tissue preservation and minimally invasive nature of intramedullary nails may provide biomechanical advantages, particularly in maintaining alignment.

Limitations

The limitations of this study include the small sample size (n=20), absence of a comparison group, and reliance solely on the CMS for functional assessment. Follow-up was limited to six months, with no stratified analysis by age, fracture type, or bone quality, and no quantitative evaluation of the radiological union.

CONCLUSION

The Multilock Humeral Nail system is a safe and effective option for proximal humerus fractures, providing stable fixation, minimal soft tissue damage, and good functional outcomes. It is particularly beneficial for osteoporotic and complex fractures, allowing early mobilisation and return to activity. This study supports the role of this technique as a reliable, minimally invasive treatment in

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appropriate cases and offers useful insights for clinical practice.

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