Long-Term Outcomes Following Intramedullary Nailing for Proximal Humeral Shaft Fractures

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INTRODUCTION: Proximal humeral fractures (PHFs) are the third most common adult fracture after hip and distal radius injuries, accounting for ~5% of all fractures and occurring predominantly in older adults after low-energy falls, with a smaller high-energy peak in younger patients. Within this spectrum, proximal humeral shaft fractures (PHSFs)—proximal-third diaphyseal fractures contiguous with the surgical neck—pose similar indications for surgery when displaced or unstable. Nonoperative care is appropriate for minimally displaced patterns; operative fixation is favored for displaced two-/three-part PHFs and selected four-part injuries, as well as unstable PHSFs. Locking plates have been widely used but carry risks (intra-articular screw penetration, subacromial impingement, avascular necrosis). Intramedullary nailing (IMN) offers a less invasive, load-sharing alternative. Third-generation straight, locking nails, placed through a medialized transmuscular entry with options for calcar support, aim to reduce rotator-cuff morbidity and enhance construct stability versus earlier designs. Early studies are encouraging, yet most evidence is small, mixed-implant, and short to mid-term. We evaluated consecutive patients with displaced PHFs/PHSFs treated with straight IMNs, focusing on long-term patient-reported outcomes (PROMs), complications, and satisfaction at up to 8 years of follow-up to inform real-world durability and clinical decision-making.

METHODS: We conducted a retrospective cohort study after institutional review board approval (IRB #2022-1255). Using institutional billing data, we identified proximal humeral fracture (PHF) cases with CPT codes 24515 and 24516 from 2016–2024 performed by a single fellowship-trained orthopedic surgeon. Of 34 PHF cases, 10 consecutive patients underwent intramedullary nailing; 3 were excluded due to loss to follow-up, yielding 7 patients for final analysis. 5 female and 2 male patients were reported in the study. Demographic and clinical variables, including mechanism of injury, time to surgery, preoperative QuickDASH, nail manufacturer, and implant size, were abstracted from medical records. An anchor-based question was used to evaluate current shoulder pain, asking patients to rate their pain as none, mild, moderate, or severe relative to their preoperative state. Patients were also asked about overall satisfaction with shoulder function. Due to loss of telephone follow-up, 3 patients were excluded from the final analysis. Postoperative complications and reoperations were recorded across the clinical course. Continuous variables were summarized with means and standard deviations, and categorical variables with counts and percentages. Analyses were performed in IBM SPSS Statistics v30 (IBM Corp., Armonk, NY).

RESULTS SECTION: Seven patients (mean age 66.1 years [43–75], 71.4% female) sustained low-energy ground-level falls, and all were treated with Tornier straight intramedullary nails. Mean BMI was 26.5 kg/m² (3/7 overweight/obese). The mean telephone follow-up interval was 4 years. QuickDASH improved from 67.1 (SD 34.0) preoperatively to 9.2 (SD 18.0) at final follow-up (mean ≈4 years). Final SANE averaged 87.3 (SD 14.6). Shoulder pain at follow-up (n=7): 5 none, 2 mild. No revision surgeries occurred (**Table 1)**. Subgroup analyses were not performed due to the small sample size (n=7).

DISCUSSION: Our study sought to evaluate the long-term clinical outcomes of third-generation straight antegrade intramedullary nailing for proximal humeral shaft fractures.QuickDASH decreased from 67.1 (SD 34.0) preoperatively to 9.2 (SD 18.0) at final follow-up, a mean improvement of 57.9 points—approximately fourfold greater than the established MCID. Final SANE averaged 87.3 (SD 14.6), indicating high function with low pain. Previous studies report high revision rates with intramedullary nailing: in our cohort, no revisions occurred (0/7; 95% CI 0–43%). Overall, intramedullary nailing for proximal humeral shaft fractures may result in pain-free shoulder mobility up to 8 years postoperatively. Future studies with larger sample sizes and matched treatment controls are necessary to uphold the validity of these findings.

SIGNIFICANCE/CLINICAL RELEVANCE: This study aims to bolster the literature regarding third-generation, antegrade intramedullary nailing for humeral shaft fractures by providing long-term PROMs and complication rates.

Table 1: Summary of Long-Term Patient PROMs and Outcomes

Patient	Mechanism of Injury	Nail Used	Pre-Operative QuickDASH	Post-Operative QuickDASH	SANE Score	Current Shoulder Pain	Revision
1	Trip and Fall	Tornier IM Nail	32.5	2.5	60	No	No
2	Trip and Fall	Tornier IM Nail	100	0	96	No	No
3	Trip and Fall	Tornier IM Nail	100	4.55	70	Yes	No
4	Trip and Fall	Tornier IM Nail	60	2.5	100	No	No
5	Trip and Fall	Tornier IM Nail	86.36	54.54	85	Yes	No
6	Trip and Fall	Tornier IM Nail	91.66	2.27	100	No	No
7	Trip and Fall	Tornier IM Nail	6.81	2.27	100	No	No