

Comparison of minimally invasive plate osteosynthesis and intramedullary nailing in the treatment of surgical neck fractures of the humerus in elderly patients

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Received 06 February 2025; Accepted 23 March 2025

Available online 01 September 2025 with doi: 10.5455/medscience.2025.02.037

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Abstract

Proximal humerus fractures are common osteoporotic fractures in the elderly population, presenting challenges in treatment due to differences between surgical options. Minimally Invasive Plate Osteosynthesis (MIPO) and Intramedullary Nailing (IMN) are the primary techniques employed for managing these fractures, each offering distinct advantages and limitations. This retrospective study evaluated 56 patients aged 50 years or older who were treated for proximal humeral surgical neck fractures between 2018 and 2022. Locked plates were applied using the minimally invasive MIPO technique, while IMN was performed to enhance biomechanical stability. Patients were assessed for functional recovery (DASH scores), pain (VAS scores), and complication rates. The IMN group demonstrated superior functional outcomes with significantly lower DASH scores. Although pain scores were lower in the MIPO group, the difference was not statistically significant. Radiographic healing times were similar between the two groups, but the complication rate was higher in the MIPO group (12.% vs. 4.3%). While IMN appears to provide better functional outcomes, MIPO offers advantages in pain management and patient comfort due to its minimally invasive nature. However, the higher complication rates observed with MIPO warrant attention. Both IMN and MIPO are effective options for treating proximal humerus fractures in elderly patients. However, IMN is found to be more advantageous in terms of functional recovery and lower complication rates, making it a valuable alternative for specific patient populations.

Keywords: Proximal humerus fractures, minimally invasive plate osteosynthesis, intramedullary nailing, osteoporotic fractures

Introduction

Proximal humerus fractures hold a significant place among osteoporotic fractures in the elderly population and often occur as a result of low-energy trauma. These fractures are the second most common type of osteoporotic fracture after femoral fractures, with a markedly increasing incidence with age [1]. Particularly prevalent in women over the age of 60, this condition is associated with decreased bone density post-menopause and an increased risk of falls [2]. It is estimated that over half of individuals aged 80 and older face at least one fall risk annually, with women being twice as likely as men to experience such incidents [3].

Managing these fractures in elderly patients is challenging due to associated comorbidities, poor bone quality, and limited physical reserve. The reduced cortical thickness and weakened subchondral bone support in osteoporotic bones limit the biomechanical stability required for surgical fixation [4]. Moreover, restricted postoperative rehabilitation capacity in this patient group is a critical factor affecting functional outcomes following surgical treatment [5].

Minimally invasive surgical techniques are preferred for elderly patients due to their less traumatic nature. Minimally Invasive Plate Osteosynthesis (MIPO) has been developed to preserve bone biology and accelerate the healing process.

CITATION

Ulusoy I, Yilmaz M, Tantekin MF, et al. Comparison of minimally invasive plate osteosynthesis and intramedullary nailing in the treatment of surgical neck fractures of the humerus in elderly patients. Med Science. 2025;14(3):906-9.



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However, the poor bone quality and complex fracture patterns in these cases pose a risk of failure with this technique [6]. Intramedullary nailing (IMN), although a more invasive approach, offers advantages in enhancing the stability of large fracture fragments. However, achieving anatomical reduction with IMN can be challenging, potentially impacting long-term outcomes [7].

This study aims to compare MIPO and IMN techniques in managing proximal humerus fractures in elderly patients, focusing on clinical outcomes, complication rates, and functional recovery. The objective is to evaluate the advantages and limitations of these surgical approaches and provide evidence-based recommendations for optimal treatment in this patient group.

Material and Methods

This study received ethical approval from Dicle University Medical Faculty Ethics Committee for Noninterventional Studies (Ethics Committee Number: 14-29, Date: 14.03.2023). The retrospective, multicenter study involved the evaluation of patients aged 50 and above who underwent surgical treatment for proximal humerus fractures between 2018 and 2022. Out of 197 patients diagnosed with surgical neck fractures of the humerus, 141 were excluded based on inclusion and exclusion criteria, leaving a total of 56 patients eligible for the study. Inclusion criteria consisted of patients aged 50 years or older with a diagnosis of surgical neck fracture of the humerus, treated surgically, and with complete medical records during the surgical process. Exclusion criteria included open fractures, fractures not classified as surgical neck fractures of the humerus, previous humeral fractures, peripheral neuropathies, patients treated with ORIF (Open Reduction and Internal Fixation), reverse or total shoulder arthroplasty, patients with insufficient follow-up data, or those who passed away during follow-up.

Surgical Techniques

Minimally Invasive Plate Osteosynthesis (MIPO)

MIPO is a surgical technique designed to stabilize fractures while minimizing soft tissue damage. In this study, Acumed Locking Compression Plates (Acumed, Hillsboro, Oregon, USA) were used. Plates were placed through deltopectoral or deltoid split incisions, and their positions were carefully adjusted under radiological guidance to ensure biomechanical stability of fracture fragments and subchondral support. Locking screws were applied to enhance fragment stability.

Intramedullary Nailing (IMN)

The IMN method aims to enhance biomechanical stability using a minimally invasive approach. The TST Titanium Humeral Nail System (TST Tibbi Aletler Sanayi ve Ticaret A.Ş., İstanbul, Türkiye) was utilized. Following deltoid muscle dissection, the nail was inserted into the humeral head via an antegrade approach. Proximal and distal stability was achieved using locking screws, and implant positioning was confirmed intraoperatively with C-arm fluoroscopy.

Clinical and Functional Assessment

Clinical evaluations were conducted at follow-ups (15 days, 1 month, 3 months, 6 months, and 12 months post-surgery) and included pain assessment using the Visual Analog Scale (VAS) and the investigation of potential complications. Functional assessment was performed using the Disabilities of the Arm, Shoulder, and Hand (DASH) score, where a score of 0 indicates no dysfunction and 100 signifies severe limitations.

Radiological Assessment

Radiological union was assessed based on specific criteria: continuity of the cortex on both sides of the fracture, visible callus formation in at least two planes, loss of fracture line visibility on radiographs, and reduced pain alongside functional improvement consistent with radiological healing. These criteria served as the foundation for objective evaluation of the healing process.

Statistical Analysis

All collected data were analyzed using SPSS version 21 (SPSS Inc., Chicago, IL). Continuous variables were analyzed using means and standard deviations, and differences between groups were determined using the independent samples Student's t-test. Categorical data were compared using the Chi-square test. A significance threshold of P<0.05 was applied. Analyses were conducted to ensure reliable comparisons and statistical validity of the study's findings.

Results

In this retrospective study, a total of 56 patients treated for proximal humeral surgical neck fractures were evaluated. Of the patients, 64% were female (36 patients), and 36% were male (20 patients), with an age range of 51 to 82 years (mean age: 71.4). Thirty-three patients were treated with Minimally Invasive Plate Osteosynthesis (MIPO), while 23 underwent Intramedullary Nailing (IMN). The mean follow-up duration was determined to be 21 months (Table 1).

Table 1. Demographic and clinical characteristics of MIPO and IMN

Variable	MIPO	IMN	p
Gender (F/M)	24/9	12/11	0.158
Age (mean±SD)	73.17±7.85	54.38±20.79	0.365
Fracture dominant limb	34%	76%	0.068

MIPO: minimally invasive plate osteosynthesis, IMN: intramedullary nailing

Although it was observed that patients with fractures in the dominant extremity had increased fixation with IMN, it was not statistically significant. The surgical technique decision may have affected this. In addition, no statistically significant relationship was found between the fracture in the dominant extremity and VAS and DASH scores.

The DASH scores were significantly lower in the IMN group

(27.8 ± 21 in the IMN group vs. 49 ± 11 in the MIPO group; $p<0.05$), indicating that the IMN technique may provide superior functional outcomes. On the other hand, VAS pain scores were lower in the MIPO group (45 ± 25.7 compared to 58.1 ± 12.5), although this difference was not statistically significant ($p>0.05$) (Table 2). This suggests that the less invasive nature of MIPO may offer advantages in pain management.

Table 2. Functional and pain assessment results between MIPO and IMN

Variable	MIPO	IMN	p
Mean follow-up duration	20 months	23 months	-
DASH score	47.8 ± 21.0	27.0 ± 11.0	0.035
VAS score	45 ± 25.7	58.1 ± 12.5	0.079

MIPO: minimally invasive plate osteosynthesis, IMN: intramedullary nailing, DASH score: disabilities of the arm, shoulder, and hand score, VAS score: visual analogue scale score

Radiological healing times were similar in both groups, with an average completion of union by the 4th postoperative month.

However, two patients (6%) in the MIPO group and one patient (4%) in the IMN group experienced nonunion (Table 3).

Table 3. Comparison of radiological union times in MIPO and IMN

Variable	MIPO	IMN	p
Mean union time (months)	4.1 ± 0.8	4.0 ± 0.7	0.621
Nonunion rate (%)	6 (2 patients)	4 (1 patient)	0.724

MIPO: minimally invasive plate osteosynthesis, IMN: intramedullary nailing

The complication rate was calculated to be 12.1% in the MIPO group, which included two cases of superficial infection (6%), one case of humeral head avascular necrosis (3%), and one case of implant failure (3%). The infections were successfully treated with antibiotics. The patient with humeral head avascular necrosis

underwent prosthetic replacement 24 months later, while the patient with implant failure was reoperated on using the IMN method. In the IMN group, the complication rate was lower at 4.3%, with only one case of superficial infection reported, which was also successfully managed with antibiotic treatment (Table 4).

Table 4. Comparison of complications in MIPO and IMN

Complication type	MIPO (n=33)	IMN (n=23)	p
Superficial infection (%)	6 (2 patients)	4.3 (1 patient)	0.893
Humeral head avascular necrosis (%)	3 (1 patient)	0	0.589
Implant failure (%)	3 (1 patient)	0	0.589
Total complication rate (%)	12.1 (4 patients)	4.3 (1 patient)	0.639

MIPO: minimally invasive plate osteosynthesis, IMN: intramedullary nailing

Discussion

The surgical management of proximal humerus fractures presents significant challenges, particularly in elderly patients due to osteoporosis and associated comorbidities. In this context, studies evaluating the effectiveness of techniques such as Minimally Invasive Plate Osteosynthesis (MIPO) and Intramedullary Nailing (IMN) have highlighted the advantages and limitations of these methods. In our study, MIPO and IMN techniques were compared. The findings indicate that while both methods are effective, there are notable differences in complication rates and clinical outcomes.

MIPO, owing to its minimally invasive nature, offers advantages

such as shorter surgical duration, preservation of soft tissue integrity, and improved postoperative pain management. The literature reports that MIPO is particularly effective in providing stabilization in osteoporotic bones and achieving satisfactory DASH scores [8,9]. IMN stands out for its ability to enhance biomechanical stability and its effectiveness across a wide range of fracture patterns. Studies have reported that IMN achieves better DASH scores and facilitates early functional recovery [10]. In our study, the DASH scores in the MIPO group (49 ± 11) were statistically significantly worse than those in the IMN group (27.8 ± 21 ; $P<0.05$). This finding aligns with studies suggesting that MIPO may offer limited functional outcomes compared to methods that provide superior mechanical stability [11].

On the other hand, the soft tissue preservation capability and minimally invasive approach of MIPO provide significant advantages in terms of patient comfort and pain management. The literature indicates that MIPO is particularly effective in reducing postoperative pain, as reflected in VAS scores [12]. In our study, although the MIPO group showed better VAS pain scores compared to the IMN group, the difference was not statistically significant ($P>0.05$). This finding aligns with previous studies supporting MIPO's effectiveness in pain management.

Healing time is an essential parameter in evaluating the success of surgical techniques. Studies have reported that patients treated with IMN typically exhibit shorter healing times [9,12]. While MIPO's minimally invasive nature offers advantages in preserving soft tissue integrity, its mechanical limitations may negatively impact healing time [13]. Conversely, IMN's superior biomechanical stability may lead to more consistent healing outcomes. Especially in osteoporotic bones, MIPO may fall short in providing adequate stability, potentially resulting in longer healing times or nonunion [14]. In our study, the mean healing time was approximately four months in both groups, with no statistically significant difference observed. However, the rate of nonunion was higher in the MIPO group (6%) compared to the IMN group (4%). The observed nonunion rate in our study among MIPO-treated patients aligns with the average reported in the literature, emphasizing the importance of careful patient selection.

Complication rates are critical for evaluating the long-term efficacy and safety of surgical techniques. The literature frequently highlights higher infection rates in the MIPO group compared to the IMN group. In the literature, they attributed this to mechanical stability limitations of MIPO, which may increase the risk of infection and other complications [11,13]. Complications such as implant failure and humeral head avascular necrosis observed in the MIPO group have also been frequently reported in the literature [12]. In our study, the complication rate was 12.1% in the MIPO group and 4.3% in the IMN group. These findings are consistent with Wang et al.'s results, which link IMN with lower complication rates [9].

This study has some limitations. The retrospective design and relatively small sample size restrict the generalizability of the findings. Differences in the surgical expertise of the performing surgeons may also introduce potential bias in the results. Additionally, subjective assessment tools such as DASH and VAS scores can be influenced by variations in patient perception. Future studies with larger sample sizes and multicenter data are necessary to strengthen the evidence in this field.

Conclusion

In conclusion, Minimally Invasive Plate Osteosynthesis (MIPO) and Intramedullary Nailing (IMN) are effective options for the treatment of proximal humeral surgical neck fractures. Our study

demonstrates that IMN offers advantages over MIPO in terms of functional outcomes and lower complication rates, making it a valuable alternative for specific patient groups.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

Dicle University Medical Faculty Ethics Committee for Noninterventional Studies, Date&number: 14.03.2023/14-29.

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