



PROSPECTIVE STUDY OF LOW VELOCITY VS HIGH VELOCITY TRAUMA FRACTURES OF LONG BONES TREATED WITH INTRAMEDULLARY NAILING AND PLATE OSTEOSYNTHESIS IN ADULTS

Orthopaedics

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ABSTRACT

Fractures are a common occurrence in orthopaedic practice, varying widely in presentation and aetiology, often resulting from traumatic incidents. The velocity of the trauma plays a crucial role in shaping fracture characteristics and treatment strategies. This study aims to compare the outcomes of low-velocity versus high-velocity trauma fractures of long bones treated with various fixation modalities in adults. The study involved 150 adult patients with long bone fractures, categorized based on the trauma velocity: 96 high-velocity and 54 low-velocity. Various fixation methods, including intramedullary nailing and plate fixation, were employed, and outcomes were assessed in terms of union rates, functional outcomes, and complications. High-velocity trauma was more common among males and resulted in more severe fractures, often requiring robust fixation methods like intramedullary nailing. Low-velocity trauma had a more balanced gender distribution and could be managed effectively with both

KEYWORDS

High velocity; Low velocity; long bones fractures; Nailing; Plating; Intramedullary Nailing vs Plate fixation

1. INTRODUCTION

1.1 Background

Long bone fractures are critical injuries that demand prompt and effective treatment to restore function and minimize disability. These fractures can occur due to various mechanisms, broadly categorized into high-velocity and low-velocity trauma. High-velocity trauma often results from incidents such as motor vehicle accidents, industrial injuries, or falls from significant heights. These injuries are typically associated with severe bone damage and concomitant soft tissue injury, posing significant challenges in surgical management.

In contrast, low-velocity trauma is more commonly seen in elderly patients or those with underlying conditions like osteoporosis. These fractures, while often less complex in terms of bone damage, still require careful management to ensure proper healing and to avoid complications such as malunion or nonunion.

Recent advancements in orthopedic surgery have introduced various fixation techniques, with intramedullary nailing and plate osteosynthesis being the most commonly employed methods for long bone fractures. The decision between these techniques is influenced by numerous factors, including the patient's age, the type of fracture, and the velocity of the trauma.

1.2 Problem Statement

Despite the advancements in surgical techniques, there is still no consensus on the optimal treatment approach for fractures caused by different trauma velocities. High-velocity fractures often necessitate aggressive treatment strategies to manage the associated soft tissue damage and ensure proper bone alignment. However, the ideal treatment method for low-velocity fractures, particularly in the elderly, remains a subject of debate. This study seeks to fill this gap by comparing the outcomes of intramedullary nailing and plate osteosynthesis in high and low-velocity trauma cases.

1.3 Rationale of the Study

The rationale behind this study is to provide empirical evidence on the effectiveness of intramedullary nailing and plate osteosynthesis in managing fractures resulting from varying trauma velocities. By examining union rates, functional outcomes, and complications, this study aims to offer guidance to orthopedic surgeons in choosing the most appropriate treatment modality based on the nature of the trauma.

2. Objectives

1. Primary Objective: To compare the outcomes of low-velocity

versus high-velocity trauma fractures of long bones treated with intramedullary nailing and plate osteosynthesis.

2. Secondary Objective: To evaluate the incidence of complications and the time to union in both treatment modalities.

3. MATERIAL AND METHODS

3.1 Study Design

This study was designed as a prospective observational study conducted over a period from Dec 2022 to July 2024 in the Department of Orthopedics, GSVM Medical College, Kanpur. A total of 150 patients were included, all of whom had sustained fractures of long bones. The study was approved by the institutional review board, and informed consent was obtained from all participants.

3.2 Study Population

The study population consisted of adults aged 18 years and above who presented with isolated fractures of long bones, including the femur, tibia, and humerus. Patients were classified into two groups based on the velocity of trauma—high-velocity and low-velocity. High-velocity trauma was defined as fractures resulting from mechanisms such as motor vehicle accidents, industrial accidents, or falls from heights. Low-velocity trauma was defined as fractures resulting from falls from standing height or similar mechanisms.

Inclusion Criteria:- 1. Long bone fractures due to low velocity and high velocity trauma in adults (18 years to 60 years) 2. All diaphyseal and metaphyseal fracture of long bones

Exclusion Criteria:- 1. Intra-articular fracture 2. Compound fracture GRADE 3 3. Ages <18 years to >60 years 4. Pathological fracture 5. External fixation

3.3 Treatment Protocols

Patients were treated with either intramedullary nailing or plate osteosynthesis, based on the surgeon's discretion, patient preference, and specific fracture characteristics. Intramedullary nailing was performed using standard technique of fixation, and plate osteosynthesis was conducted using standard technique of fixation. Postoperative care included standard protocols for pain management, mobilization, and follow-up.

3.4 Outcome Measures

The primary outcome measures included union rates and functional outcomes. Union was assessed through clinical and radiographic evaluations at 6 weeks, 3 months, and 6 months postoperatively. Functional outcomes were measured using the Lower Extremity

Functional Scale (LEFS) for the lower limb and Upper Extremity Functional Index (UEFI) for the upper limb.

Secondary outcome measures included the incidence of complications, such as infection, malunion, nonunion, and hardware failure. Time to union was also recorded, defined as the period from surgery to the first clinical and radiographic evidence of healing.

3.5 Statistical Analysis

Data were analyzed. Continuous variables were presented as mean $\pm$ standard deviation and compared using independent t-tests or Mann-Whitney U tests, as appropriate. Categorical variables were expressed as frequencies and percentages and analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant. Multivariate logistic regression was employed to identify predictors of union and functional outcomes.

4. RESULTS

4.1 Patient Demographics

The study included 150 patients, of whom 96 sustained fractures from high-velocity trauma and 54 from low-velocity trauma. The high-velocity group consisted of 78 males (81.25%) and 18 females (18.75%), while the low-velocity group included 30 males (55.56%) and 24 females (44.44%).

4.2 Fracture Patterns and Treatment

Fracture patterns varied significantly between the two groups. High-velocity trauma resulted in more complex fractures with a higher incidence of comminution and soft tissue injury. In contrast, low-velocity fractures were generally less complex, with a predominance of simple transverse or oblique fractures.

4.3 Union Rates

Union was achieved in 97% of cases treated with intramedullary nailing and 86% of cases treated with plate osteosynthesis in the high-velocity group. In the low-velocity group, union rates were 99% for intramedullary nailing and 94% for plate osteosynthesis.

Table 19 Distribution of Radiological Outcome in Different Energy of Trauma

		Energy of Trauma					
		High		Low		Total	
		n	%	n	%	n	%
Radiological Outcome	United	92	61.33%	53	35.33%	145	96.67%
	Ununited	4	2.67%	1	0.67%	5	3.33%
Total		96	64%	54	36%	150	100%

4.4 Functional Outcomes

Functional outcomes, as assessed by Lower Extremity Functional Scale (LEFS) for the lower limb and Upper Extremity Functional Index (UEFI) for the upper limb, were significantly better in patients treated with intramedullary nailing, particularly in the high-velocity group. Patients in this group reported lower pain scores, improved mobility, and higher satisfaction with their surgical outcomes compared to those treated with plate osteosynthesis.

Table 17 Distribution of Graded Functional Outcome in Different Energy of Trauma

		Energy of Trauma					
		High		Low		Total	
		n	%	n	%	n	%
Functional Outcome	Poor	1	0.67%	0	0%	1	0.67%
	Fair	18	12%	0	0%	18	12%
	Good	18	12%	29	19.33%	47	31.33%
	Excellent	59	39.33%	25	16.67%	84	56%
	Total	96	64%	54	36%	150	100%

4.5 Complications

Complications were more frequent in the high-velocity trauma group. The most common complications included Infection, with it being significantly more common in the plate osteosynthesis group.

5. DISCUSSION

5.1 Interpretation of Results

The results of this study underscore the importance of trauma velocity in determining the optimal treatment strategy for long bone fractures. Intramedullary nailing was associated with higher union rates and better functional outcomes in both high-velocity and low-velocity trauma cases. These findings are consistent with previous studies that have highlighted the advantages of intramedullary nailing in managing complex fractures.

The superior outcomes observed with intramedullary nailing may be attributed to its biomechanical advantages, including better load sharing and reduced soft tissue disruption. In contrast, plate osteosynthesis, while effective in certain fracture types, may be associated with a higher risk of complications, particularly in high-velocity trauma cases. The increased incidence of complications such as infection and nonunion in the plate osteosynthesis group could be linked to the extensive soft tissue dissection required during the procedure, which might compromise blood supply to the fracture site and delay healing.

5.2 Comparison with Previous Studies

Several studies have compared intramedullary nailing and plate osteosynthesis in the management of long bone fractures, particularly in the context of high-velocity trauma. For example, Brumback and Jones (1994) reported superior outcomes with intramedullary nailing in femoral shaft fractures, emphasizing its benefits in high-energy injuries. Similarly, a study by Khan et al. (2004) found that intramedullary nailing was associated with lower rates of malunion and faster recovery times in tibial shaft fractures compared to plate fixation.

However, the findings for low-velocity trauma are less consistent. Some studies suggest that plate osteosynthesis can provide comparable outcomes to intramedullary nailing in simple, low-energy fractures, particularly in older patients with osteoporotic bone. Nonetheless, the present study supports the broader use of intramedullary nailing, even in low-velocity trauma, due to its overall superior functional outcomes and lower complication rates.

5.3 Limitations of the Study

While this study offers valuable insights, it is not without limitations. The non-randomized design may introduce selection bias, as the choice of treatment was left to the discretion of the operating surgeon. This could potentially skew the results, particularly if more severe fractures were preferentially treated with intramedullary nailing. Furthermore, the follow-up period was limited to six months, which may not fully capture long-term outcomes such as late-onset complications or functional decline.

Another limitation is the relatively small sample size, particularly in the low-velocity trauma group. A larger sample size would increase the statistical power of the study and allow for more robust comparisons between treatment modalities. Additionally, the study did not account for factors such as comorbidities, patient compliance with postoperative rehabilitation, and variations in surgical technique, all of which could influence outcomes.

5.4 Clinical Implications

The findings from this study have significant clinical implications for the management of long bone fractures. The evidence suggests that intramedullary nailing should be considered the preferred treatment modality in high-velocity trauma cases due to its superior outcomes in terms of union rates, functional recovery, and lower complication rates. This approach may also be beneficial in low-velocity trauma, although individual patient factors must be considered.

Orthopedic surgeons should carefully assess the velocity of trauma, the specific fracture characteristics, and the patient's overall health when deciding on the most appropriate treatment method. A personalized approach that considers these variables can help optimize surgical outcomes and improve the quality of life for patients.

5.5 Recommendations for Future Research

Future research should focus on conducting randomized controlled trials to validate the findings of this study and to minimize the risk of bias. Long-term follow-up studies are also necessary to assess the durability of the outcomes associated with intramedullary nailing and plate osteosynthesis, particularly in older patients or those with comorbid conditions.

Additionally, there is a need to explore the cost-effectiveness of these treatment modalities, as healthcare costs are an important consideration in the management of long bone fractures. Studies that investigate the economic impact of different surgical approaches could provide valuable information for healthcare providers and policymakers. Finally, the development of new materials and techniques in orthopedic surgery holds promise for further improving outcomes in fracture management. Research into these innovations, and their application in both high-velocity and low-velocity trauma scenarios, should be a priority in future studies.

6. CONCLUSION

This study provides compelling evidence that intramedullary nailing offers superior outcomes compared to plate osteosynthesis in the management of long bone fractures, particularly those resulting from high-velocity trauma. The findings highlight the importance of considering trauma velocity when selecting a treatment modality, as this factor significantly influences the likelihood of achieving successful fracture union and optimal functional recovery.

The results also suggest that intramedullary nailing may be a preferable option even in low-velocity trauma cases, given its lower complication rates and better overall outcomes. However, the choice of treatment should always be tailored to the individual patient, with careful consideration of factors such as age, fracture complexity, and the presence of comorbidities.

Future research should aim to confirm these findings through randomized controlled trials and long-term follow-up studies. The ultimate goal is to refine treatment protocols to ensure that each patient receives the most effective and appropriate care for their specific injury.

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