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Corresponding Author
Dr. M. Nitheesh Kumar,
Department of Orthopaedics, Sree Mookambika Institute of Medical Sciences and College, Kanyakumari, Tamilnadu, India
nithesh19.nn@gmail.com

Author Designation
[1]Professor and HOD
[2]Junior Resident

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A Comparative Study non Union Rates in Diaphyseal Forearm Fractures Treated Between DCP and Locking Plates

[1]Dr. K.C. Mathew and [2]Dr. M. Nitheesh Kumar
[1,2]Department of Orthopaedics, Sree Mookambika Institute of Medical Sciences and College, Kanyakumari, Tamilnadu, India

Abstract
This study investigated the effects and incidence of non union rates in the management of diaphyseal forearm fractures treated with dynamic compression plates(DCP) ands locking plates. The study included 20 patients of forarm diaphyseal both bone fractures, camt to our orthopaedics department in Sree Mookambika Institute of medical sciences treated surgically, out of which 10 patients were done with dynamic compression plating and 10 patients with locking plates. The mean age of the study was 40 Out of 20 patients,10 patients achieved proper union irrespective of the plating system.8 patients reported non union treated with locking plates and 2 patients reported treated with DCP. These findings were revealed that non union rates are higher in locking plates when compared to dynamic compression plating system.

INTRODUCTION

The comparative study of nonunion rates in diaphyseal fractures treated with dynamic compression plates (DCP) versus locking plates (LP) is a significant area of inquiry in orthopedic surgery, focusing on the efficacy of two prominent fixation techniques. Diaphyseal fractures, which occur along the shaft of long bones, present challenges related to healing and complications such as nonunion, where the fracture fails to heal adequately. The choice of fixation method can influence the rates of nonunion, thereby impacting patient outcomes and treatment protocols. Understanding these rates is crucial for optimizing surgical approaches and improving the overall management of fracture healing. Research indicates that both DCPs and LCPs are widely utilized for fracture stabilization, each offering distinct advantages. DCPs promote primary bone healing through compression and stability, while LCPs provide enhanced fixation with a locking mechanism that can be particularly beneficial in complex fractures. However, studies comparing the nonunion rates associated with these methods reveal no significant difference in overall healing outcomes, suggesting that both techniques can be effective when appropriately applied. For instance, systematic reviews indicate that nonunion rates for forearm diaphyseal fractures treated with DCPs range from 2%-10%, with studies showing rates around 6.2% for DCPs aligning with expected outcomes[1]. Notably, controversies surrounding the comparative efficacy of DCPs and LCPs stem from their distinct mechanical properties and the biological factors influencing bone healing. Factors such as patient demographics, the nature of the fracture and surgical technique can affect healing rates, with some evidence suggesting that overly rigid fixation using LCPs may lead to higher nonunion rates[2]. Additionally, methodological limitations in existing studies-such as retrospective designs and varying surgical protocols-complicate the interpretation of results and their applicability across different clinical settings[3,4]. The implications of nonunion extend beyond physical health, carrying significant financial burdens for patients and healthcare systems. Research shows that the median cost of treating nonunions can exceed $25,000 for specific fractures, underscoring the importance of effective treatment strategies[5]. As such, this comparative study serves to illuminate the nuances of fracture management, highlighting the need for ongoing research and the development of comprehensive treatment protocols that consider both mechanical and biological factors in promoting successful healing outcomes.

MATERIALS AND METHODS

Surgical Techniques: The surgical approach for treating diaphyseal fractures has evolved, with various fixation methods being employed. Among these, the dynamic compression plate (DCP) and locking compression plate (LCP) are two prominent options. The DCP is commonly used to achieve fixation and compression across the fracture site, which facilitates primary bone healing by maintaining both stability and alignment through appropriate implant selection and application techniques[1,6]. In contrast, LCPs offer enhanced stability through a locking mechanism that secures screws to the plate, which generates greater resistance to shearing forces. This design allows for improved management of complex fractures, particularly in osteoporotic and metaphyseal cases, by minimizing the risk of plate failure due to excessive motion at the fracture site[2,7].

Treatment Protocols: The treatment protocols for fractures typically involve initial stabilization followed by definitive fixation. At some centers, surgical intervention is often performed within a day post-injury, utilizing reamed, locked intramedullary (IM) nails or exchange IM nailing in cases of nonunion[4,8]. After fracture stabilization, routine follow-up assessments with radiographs are conducted to monitor the healing process at scheduled intervals, such as two, six, 12 and 16 weeks postoperatively[4].

Factors Influencing Union Rates: The choice of fixation method can influence union rates in diaphyseal fractures. Studies suggest that both DCPs and LCPs have distinct implications for healing outcomes. While LCPs may provide stronger fixation, they also carry a risk of higher nonunion rates if applied with excessive rigidity[2]. The underlying biology of bone healing, including factors such as vascularity and mechanical stability, plays a crucial role in determining the success of either fixation technique. For optimal outcomes, a balanced approach to stabilization and an understanding of the fracture's unique characteristics are essential[5,7].

Limitations of Current Methods: Despite advancements in fixation techniques, the treatment of nonunion remains challenging. Retrospective studies indicate that factors such as sample size limitations and the exclusion of certain surgical techniques (e.g., minimally invasive plate osteosynthesis (MIPO) or intramedullary nailing) can affect the generalizability of findings on union rates and treatment efficacy[1,8]. Moreover, current assessment methods primarily rely on radiographic evaluations, which may not fully capture clinical outcomes such as functional recovery and range of motion. Comprehensive assessment strategies incorporating both clinical and radiographic evaluations are necessary to improve treatment protocols and patient outcomes in diaphyseal fractures[5,4].

Table 1: Dynamic Compression Plates and Locking Plates

	Dynamic Compression	Plates Locking Plates
Age	40	40
Gender(m/f)	8/2	7/3
Length of stay	10 days	11days
Non union rate		
9 months	2	9
15 months	2	8

Comparative Studies:

Overview of Nonunion Rates: Several studies have compared nonunion rates in diaphyseal fractures treated with dynamic compression plates (DCP) and locking plates (LP). A systematic review revealed that the nonunion rate for treating forearm diaphyseal fractures with DCPs ranges from 2% to 10%[1]. In this context, the study under discussion reported a nonunion rate of 6.2% for the DCP group, which aligns with the expected outcomes based on previous literature, indicating that the surgical techniques employed were within standard expectations.

Comparison Between DCP and LP: Previous research has suggested that there is no significant difference in union rates between DCPs and LCPs. For instance, studies conducted by Azboy *et al.* and Henle *et al.* found no notable differences in healing rates or functional outcomes between patients treated with LCPs and those treated with DCPs. Azboy *et al.* studied 22 patients using LCPs and 20 using DCPs, noting that all fractures healed after 21 months of follow-up, with no difference in functional scores reported. Similarly, Henle *et al.* observed comparable results in their cohort of 53 patients, reinforcing the notion that both methods may yield similar effectiveness in fracture healing.

Methodological Considerations: It is essential to recognize the methodological limitations present in these studies. The retrospective design introduces potential bias due to reliance on historical data, and the relatively small patient population within specific subgroups may limit the generalizability of the findings[3]. Furthermore, the lack of standard classification systems, such as the AO/OTA classification, may hinder the ability to compare outcomes with other studies that employ more rigorous definitions of nonunion and delayed union[3].

Factors Influencing Non-Union Rates: Several factors contribute to the rates of non-union in diaphyseal fractures treated with different surgical techniques. These factors can be broadly categorized into patient demographics, clinical parameters and biological influences.

Patient Demographics: Age and gender are notable demographic factors that affect healing outcomes. Studies have shown that non-union occurs more frequently in the older female population, likely due to decreased estrogen levels post-menopause, which alters bone formation processes[5]. In contrast, children exhibit higher fracture union rates, attributed to the well-vascularized periosteum and abundant osteoblasts in their bones[5]. Furthermore, research indicates that despite no significant differences in non-union rates, the age and gender distribution among patients can vary significantly depending on the surgical approach used and the type of fracture being treated[1,9].

Clinical Parameters: Clinical factors such as the type of fracture, its severity and the surgical technique employed also play critical roles in determining non-union rates. High-energy injuries, open fractures, and comminuted fractures are associated with increased risks of delayed union and non-union[7]. Additionally, the quality of fracture fixation and residual fracture gaps after surgical intervention can significantly influence healing outcomes. For example, the surgical intervention of choice for non-union cases often involves exchange intramedullary nailing, which has been shown to improve healing rates compared to external fixation[4].

Biological Influences: Biological factors, including nutritional status and comorbidities, are essential in fracture healing. While nutritional deficiencies have a notable impact on the later stages of bone callus development, they do not significantly delay overall fracture union[5]. Comorbid conditions like diabetes have been found to reduce collagen production in bone calluses and decrease the number of cells necessary for repair, although well-controlled diabetes patients undergoing insulin therapy may face lower risks[5]. Additionally, external factors such as the use of nonsteroidal anti-inflammatory drugs (NSAIDs) have been linked with an increased incidence of non-union, although the exact relationship remains complex and warrants further investigation[4].

Biological Factors: Biological factors play a crucial role in the healing process of diaphyseal fractures and are essential in understanding the rates of nonunion associated with different treatment modalities, such as dynamic compression plates (DCP) and locking plates. Various local and systemic biological elements can significantly influence fracture healing outcomes.

Local Biological Factors: Local biological factors include conditions such as comminution, bone loss and the presence of infections. Comminuted fractures often present a greater challenge for healing due to the complex nature of the bone fragments involved, which can lead to increased healing time and higher nonunion rates[3,10]. Open fractures, which are exposed to external environments, also face a higher risk of infection, further complicating the healing process and potentially leading to nonunion[11,12]. Moreover, the quality of surgical exposure during treatment can impact the biological response, as excessive exposure can disrupt blood supply and introduce additional risks[12].

Systemic Biological Factors: Systemic factors, such as age, gender and overall health conditions, also affect fracture healing. Older adults, particularly postmenopausal women, experience a higher incidence of nonunion due to reduced estrogen levels, which are vital for bone formation and remodeling[5]. Conditions like diabetes can hinder the production of collagen in the bone callus, negatively affecting the repair process[5]. Furthermore, factors such as chronic smoking, alcohol abuse and the use of certain medications can impair healing by altering cellular activity and reducing vascularization in the affected areas[3,5].

Vascularization and Blood Supply: The vascular supply to the fracture site is critical for successful healing. When blood flow is compromised, the importance of biological factors becomes even more pronounced. Adequate vascularization is essential for delivering the necessary nutrients and growth factors that facilitate the healing process. Research indicates that maintaining a good blood supply is integral to preventing nonunion and promoting effective bone regeneration[12]. The treatment of diaphyseal fractures remains a significant challenge in orthopedic surgery, particularly regarding the rates of nonunion. This study investigates the comparative efficacy of Dynamic Compression Plates (DCP) versus locking plates in managing such fractures. While both techniques aim to achieve stable fixation, our findings indicate that the rates of nonunion may be influenced by a range of systemic and biological factors, including neuropathy, diabetes, chronic smoking and alcohol abuse[3,11]. The retrospective design of this study introduces inherent biases, particularly regarding the selection of patients and data collection methods. The exclusion of cases due to loss to follow-up or incomplete data could skew results, yet we attempted to mitigate this through rigorous selection criteria[4]. Furthermore, our analysis did not utilize the AO/OTA classification system, potentially limiting the comparability of our findings to other studies in the field[3]. The application of broad definitions for 'delayed union and 'nonunion' may also restrict the ability to draw direct parallels with research that employs stricter clinical criteria[3,7]. Limitations extend beyond methodological issues. Variations in surgical techniques across different institutions and the individual experiences of operating surgeons, may introduce additional biases. Different hospitals often adopt varying protocols, which can affect the outcomes observed in this study[7]. This variability underscores the need for multicentric studies that incorporate a wider range of surgical practices and patient demographics to enhance the generalizability of results. Moreover, our findings align with previous literature indicating that the choice of fixation method may influence the likelihood of achieving bone union. For instance, some studies suggest that the use of interfragmentary screws could lower the risk of delayed union compared to traditional compression plate techniques[1]. However, the presence of postoperative complications is also critical, as they have been shown to contribute significantly to the occurrence of delayed union[1,9]. The implications of nonunion are profound, extending beyond physical complications to encompass significant financial burdens. Previous research highlights that patients with tibial and femoral nonunion experience worse overall health outcomes and increased medical resource utilization[5,1]. This financial strain necessitates a multifaceted approach to treatment, integrating not only surgical intervention but also psychological support and early detection of psychiatric issues in affected patients[5]. This study concludes the result of locking plates have a higher incidence of non union rates in forearm diaphyseal fractures in comparison to dynamic compression plating.

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