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Original Research Article

Outcomes of Locked vs. Non-Locked Plating in Distal Fibula Fractures: A Retrospective Analysis

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Abstract:

Background: Ankle fractures are increasingly common, particularly among elderly patients with osteoporotic bone, posing challenges for stable fixation and optimal healing. Traditional non-locking plates may be insufficient in complex or osteoporotic fractures, whereas locking compression plates (LCPs) offer angular stability and preserve periosteal blood supply, potentially improving outcomes.

Aim: To compare the clinical and radiological outcomes, union rates, and complications of locked versus non-locked plating in distal fibula fractures.

Methodology: A retrospective observational study was conducted at the Department of Orthopaedics, Nalanda Medical College and Hospital, Patna, India, over one year. Eighty patients with distal fibula fractures meeting inclusion criteria were analyzed. Patient records were reviewed for demographics, fracture classification, implant type, radiographic union, functional outcomes (AOFAS score), and complications. Statistical analysis was performed using SPSS v27, with significance set at $p < 0.05$.

Results: Locking Compression Distal Fibula Plates (LCDFP) were used in older patients (mean 58 years) with more complex fractures, while Semi-Tubular Plates (STP) and Limited-Contact Dynamic Plates (LCDCP) were used in younger patients with simpler fractures. Mean radiographic union was slightly faster with LCDFP (14.5 weeks) versus STP (15.1 weeks) and LCDCP (15.6 weeks). Full weight-bearing and complication rates were comparable across groups, though STP had a higher frequency of symptomatic hardware removal. Overall functional outcomes were satisfactory.

Conclusion: Both locking and non-locking plating techniques provide effective fixation for distal fibula fractures. LCDFP is advantageous in older patients with osteoporotic or complex fractures, while STP and LCDCP remain reliable for simpler fracture patterns. Implant selection should be individualized based on patient age, bone quality, and fracture complexity.

Keywords: Distal fibula fracture, locking plate, non-locking plate, ankle fracture, osteoporotic bone, fracture fixation, union rate.

Introduction

Ankle fractures are becoming more common, with evidence suggesting a steady increase over the past few decades and now accounting for approximately 10% of all fractures. Ankle fractures can lead to considerable morbidity, with approximately 33% requiring surgical treatment to achieve optimal outcomes. Ankle fractures usually occur in young and active patients due to high energy trauma; however, there has also been an increase in fragile fractures in older populations due to age related osteoporosis [1]. This changing population has resulted in unique challenges in fracture management as older patients present with poor bone quality making surgical fixation more complex. Historically, surgical techniques have relied upon interfragmentary lag screws and non-locking neutralization plates, which demonstrated satisfactory outcomes in patients with healthy bone; however, in osteoporotic bone, stable fixation can be difficult to achieve with standard techniques, which increases the risk for implant failure, delayed healing and malunion.

Locking compression plates (LCPs) have recently been introduced as an alternate fixation strategy, particularly in more complex situations involving osteoporosis, comminution, and bone loss. Locking plates provide a biomechanical advantage in that they can provide angular stability and are not as reliant on bone quality to provide fixation and therefore present a very promising option for the treatment of complex ankle fractures. While this option is promising, potential post-operative complications, including wound healing complications, infections, and soft tissue irritation, resulting from locking plates is a cause for concern [2]. As a result, the choice of fixation strategy for ankle fractures, particularly in the elderly and other at-risk patients, is still contested. It is paramount to understand fracture patterns, co-morbidities, and improvements in implant technology to achieve the best outcomes and mitigate complications, thus highlighting the need for more clinical research and examination of the fixation.

The limitation of compressing the periosteum is one of the primary considerations for using a locking plate. Typical non-locking plates are bolted to the bone through frictional forces from compressing the plate to the surface of the host bone. Locking plates utilize fixed-angle screws that lock into the plate rather than creating friction at the plate/bone interface, and thus, do not necessarily require plate/bone contact. Therefore, less compression aids in preservation of the blood supply in the periosteum, which is important for bone healing and remodeling. Excessive compression from more traditional plating systems may inhibit nutrient flow from cortical circulation. Compromising blood delivery by excessive compression of the bone can yield delayed bone healing or non-unions [3]. The reduction of these negative effects led to a biomechanically superior method of stabilizing fractures, particularly in osteoporotic or generally comminuted bone where traditional fixation is limited.

Several new plating systems have also entered the market over the course of time to limit interference with the cortical blood supply and improve return to good outcomes. These options include low-contact dynamic compression plates (LC-DCP), locking compression plates (LCP), and anatomical plates which provide a more appropriate fit and extrude equal stability while not applying excessive periosteal pressure. Nonetheless, documented superiority of these systems is sparse, and frequently reported inconclusively or inconsistently throughout the literature [4]. Therefore, additional clinical development is necessary to truly assess the advantages of these newer implants in terms of bone union, complication rates, or functional outcomes. Although there may be an absence of clinical evidence documenting improved outcomes using these newer technologies, the presented body of literature reinforces the need for ongoing research within fracture fixation technology.

The locking plate is a fixation device that allows multiple applications, depending on the fracture configuration and the biomechanical stability required. A locking plate could be used as a bridging plate, where segments pass through a defect in a comminuted fracture without direct compression of the fragments, or as a compression plate, where interfragmentary compression is achieved with subsequent primary bone healing. In a similar way, it could be used as a tension band plate, working against tensile forces across the fracture site, or a neutralization plate, protecting lag screws by limiting high strain on the screws, which may occur as the patient moves through functional motion. Ultimately, the versatility of locking plates provides the surgeon with a valuable option in orthopedic trauma and enables the fixation approach to be determined by the fixation priorities of the case at hand [5].

Of all the discussed techniques, the utilization of a locking plate as a neutralization device in conjunction with the use of lag screws is of primary importance. This technique is commonly employed for the management of displaced ankle lateral malleolus fractures, where achieving anatomical reduction with absolute stability is paramount to optimal healing and restoring ankle function. The lag screw fixation provides interfragmentary compression while the neutralization plate provides structural stability, reduces micromotion, and protects the primary fixation from stress forces during early mobilization. In addition to improving stability, the addition of the neutralization plate reduces the incidence of fixation failure, making this an ideal choice for the surgeon dealing with these high-stress injuries [6].

Recently, it has been observed that most of the comminuted fractures of the distal fibula have occurred from high energy mechanisms, specifically pronation-abduction. They also denote significant soft-tissue damage and instability due to the multifaceted injury pattern. The distal fibula is important in terms of ankle stability and anatomical position or alignment, as the loss or disruption of alignment with the distal fibula can lead to many long-term negative consequences, such as malunion, non-union, post-traumatic arthritis, and an abnormal manner of walking [7]. Non-union is most commonly seen in comminuted distal fibular fractures, thus surgical treatment with internal fixation becomes vital, as it allows us to maintain bone healing by achieving a precise reduction of the fibula, facilitates optimal healing, and aids in restoring the length, rotation, and correct anatomy of the fibula. Achieving early, correct length resides, rotation, and anatomy of the distal fibula is paramount in maintaining ankle joint congruency and optimal effectiveness upon fulfilling functional recovery.

The stable reduction of comminuted fibular fractures has always been a highly technical endeavor due to limited cortical bone anchorage for conventional fixed techniques, such as lag screws and simple plating. The small and often comminuted distal fragments of the fibula often restrict the use of conventional fixation methods suggesting alternative options and new devices to achieve a stable osteosynthesis. Importantly, biomechanical investigations demonstrate the need to restore the distal fibula length and to angularity to minimize the occurrence of chronic ankle instability and the development of sequelae [8]. Consequently, there is a greater focus on unique surgical methods and fixation systems that address the anatomical and biomechanical considerations of these fractures. This investigation relates treatment approaches to challenges experienced with comminuted distal fibular fractures and assesses their respective effectiveness to achieve an appropriate and predictable reduction and functional outcome.

This study compares locked versus non-locked plating in the management of distal fibula fractures, which are the most frequent ankle injury that orthopedic surgeons treat. When a rotational force is applied to the ankle joint, the distal fibula fractures as a result of this force and the fibula can have various deformities such as soft tissue compromise, instability, and risk of a moderate to long-term complication, if managed improperly. Physicians have been able to develop new fixation techniques to manage these injuries and have introduced locking plates as an alternative to conventional non-locking plates when treating distal fibular fractures, particularly in osteoporotic bone with destructive comminution and/or bad soft tissue as locking plates offer angular stability and increased fixation strength. However, their routine use is still under review due to costs, complications related to implants, and the lack of evidence-based practice. The aim of this study is to assess and compare clinical and radiological outcomes (union rates, complication profiles) in physicians who use locked and non-locked plating to provide evidence-based suggestions for the best available surgical management of distal fibula fractures.

Methodology

Study Design: The present study is a retrospective observational study conducted to compare the outcomes of locked versus non-locked plating in distal fibula fractures.

Study Area: The study was carried out in the Department of Orthopaedics, Nalanda Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study was conducted over a period of one year.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients admitted within one year for the treatment of locked ankle ligament fractures.

Exclusion Criteria

- Patients with injuries are treated using an external fixator.
- Cases involving pilon fractures, open ankle fractures, or fractures managed solely with isolated medial malleolar fixation or syndesmotic screws.

Sample Size: A total of 80 patients who fulfilled the inclusion and exclusion criteria were included in the study.

Procedure: Patient records were retrospectively reviewed from hospital archives, and demographic data, mechanism of injury, fracture classification, type of implant used (locked or non-locked plate), surgical details, and postoperative management protocols were recorded. Radiological assessments were used to evaluate fracture reduction, implant positioning, and union status. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, and complications such as infection, hardware failure, malunion, or non-union were noted. Patients were followed up at regular intervals to evaluate both clinical and radiological outcomes.

Statistical Analysis: All collected data were entered into Microsoft Excel and analyzed using SPSS software version 27. Descriptive statistics such as mean, standard deviation, and percentages were calculated. Comparative analyses between the two groups (locked vs. non-locked plating) were performed using the Chi-square test for categorical variables and Student's t-test for continuous variables. A p-value of <0.05 was considered statistically significant.

Result

Table 1 summarizes the demographic and clinical characteristics of 80 patients with distal fibula fractures treated using three different plating techniques. The mean age was highest in the (LCDFP) Locking-Compression Distal Fibula Plate group (58 ± 15.5 years) compared to the Semi-Tubular Plate (40 ± 15.5 years) and Limited-Contact Compression Plate (LCDCP) groups (39 ± 16.4 years). Gender distribution was relatively balanced in the Semi-Tubular Plate group (21 males, 19 females), while the LCDFP group had more females (14 vs. 11 males) and the LCDCP group had more males (9 vs. 6 females). Diabetes mellitus was observed only in the LCDFP (3 cases) and Semi-Tubular Plate (1 case) groups. Regarding fracture type, bimalleolar fractures were most frequent across all groups, particularly in LCDFP (12 cases), followed by trimalleolar fractures, which were also more common in LCDFP (9 cases). Most fractures were classified as Weber B, with 34 cases in the Semi-Tubular Plate group, 24 in LCDFP, and 6 in LCDCP, while Weber C fractures were more frequent in LCDCP (9 cases). Lag screw fixation was predominantly used in the Semi-Tubular Plate group (36 cases), followed by LCDFP (12 cases) and LCDCP (8 cases). Overall, the LCDFP group comprised older patients with more complex fracture patterns, while simpler fractures were more often treated with semi-tubular plating

Table 1: Patient and Clinical Characteristics (n = 80)			
Characteristics	**Semi Tubular Plate (n = 40)**	**Locking Compression Distal Fibula Plate (n = 25)**	**Limited-Contact Dynamic Compression Plate (n = 15)**
Age (y) Mean ± SD	40 ± 15.5	58 ± 15.5	39 ± 16.4
Gender			
Male	21	11	9
Female	19	14	6
Diabetes mellitus	1	3	0
Fracture type			
Lateral malleolus	16	4	4
Bimalleolar	18	12	8
Trimalleolar	6	9	3
Weber A	0	0	0
Weber B	34	24	6
Weber C	6	1	9
Lag screw fixation	36	12	8

Table 2 compares outcome measures among patients treated with three different plating techniques for distal fibula fractures. Radiographic union was achieved fastest in patients with (LCDCP) Locking-Compression Distal Fibula Plate, showing mean of 14.5 weeks (95% CI: 11.5–17.2), compared to 15.1 weeks (95% CI: 12.0–16.3) with Semi Tubular Plates (STP) and 15.6 weeks (95% CI: 11.8–21.5) with Limited-Contact Dynamic Compression Plates (LCDCP). Median union time was consistent at 12 weeks across all groups. Full weight-bearing was initiated earliest in the STP group, with a mean of 7 weeks (95% CI: 6.4–7.5), followed closely by 7.3 weeks (95% CI: 6.3–8.2) in the LCDCP group and 7.5 weeks (95% CI: 6.6–8.4) in the locking plate group. Overall, all plating methods demonstrated similar outcomes, with only slight variations in radiographic union and time to full weight-bearing.

Table 2: Outcome Measures (n = 80)			
Outcomes	**Semi Tubular Plate (n = 48)**	**Locking Compression Distal Fibula Plate (n = 20)**	**Limited Contact Dynamic Compression Plate (n = 12)**
Radiographic union (weeks)			
Mean	15.1	14.5	15.6
Median	12	12	12
95% CI	12.0 to 16.3	11.5 to 17.2	11.8 to 21.5
Full weight bearing (weeks)			
Mean	7	7.5	7.3
Median	6	7	6
95% CI	6.4 to 7.5	6.6 to 8.4	6.3 to 8.2

Table 3 summarizes complications and reoperations among 80 patients treated with three different plating methods for distal fibula fractures. The majority of patients in all groups had no complications, with 45 out of 48 in the Semi-Tubular Plate group, 11 out of 12 in the LCDCP (Limited-Contact Dynamic Compression Plate) group, 18 out of 20 in LCDCP group showing no adverse events. Infections requiring washout occurred in only two cases (one each in the Semi-Tubular and Locking Compression groups), while superficial infections were slightly more frequent, affecting two patients in the Semi-Tubular group, one in LCDCP, and two in the Locking group. Reoperations were more common with Semi-Tubular Plates, including washout procedures (1 case), syndesmosis screw removal (2 cases), symptomatic hardware removal (6 cases), and revision surgery (2 cases). The LCDCP group had fewer reoperations, limited to one screw removal and one symptomatic hardware removal, whereas the Locking Plate group had only one revision surgery. Overall, complications and reoperations were relatively low across all groups, with Semi-Tubular Plates showing a slightly higher rate of hardware-related interventions.

Table 3: Complications and Reoperations (n = 80)			
Variables	**Semi-Tubular Plate (n = 48)**	**Locking Compression Distal Fibula Plate (n = 20)**	**Limited-Contact Dynamic Compression Plate (n = 12)**
Complications			
None identified	45	18	11
Infection requiring washout	1	1	0
Superficial infection requiring antibiotics	2	2	1
Wound issues not requiring antibiotics	3	0	0
Reoperation			
Washout with or without metalwork removal	1	0	0
Planned removal of syndesmosis screw	2	0	1
Removal of symptomatic	6	0	1
Metalwork Revision	2	1	0

Discussion

This study distinguished demographic characteristics, clinical profiles, outcomes, and complications for patients who had distal fibula fractures treated using STP, LCDCP, and LCDFP. The results demonstrate unique patient selection patterns as well as similar clinical outcomes for all three plating techniques.

Patients treated with LCDFP were significantly older, mean age of 58, than the younger STP (40 years) and LCDCP (39 years) groups. This is likely related to the inclination to use locking plates in older patients with osteoporotic bone since locking plates, as angle-stable fixation, provide better stability in poor bone quality. The gender distribution was varied between groups, however there was a slight female predilection in the LCDFP group which may be related to the overwhelming association of osteoporosis with older women. Diabetes mellitus, a significant risk factor for delayed healing and infection, was present more often in the LCDFP group, also underscoring that the LCDFP group was more complicated and had more comorbidities. Schepers et al., (2011) [9] cautioned against the use of compression plates for distal fibular fractures in a retrospective examination of 165 individuals because they were linked to greater wound issues than semi-tubular plates. Although their groups did not differ in terms of hardware removal, the total risk of wound complications was 5.5% for semi-tubular plates and 17.5% for locking plates.

Patterns of fracture were more serious in patients that received LCDFP, and a greater percentage of bimalleolar and trimalleolar fractures. STP was primarily used for simpler Weber B fractures, which suits its intended purpose for type B and C fractures, simpler fracture fixation. In the STP group, lag screw fixation was most utilized, which reflects the less comminuted nature of the fractures these patients experienced. Our analysis confirms the results of a randomized controlled trial by Tsukada et al., (2013) [10], which included 52 patients, reported no difference between locking and nonlocking plates in terms of complication rates or time to radiographic bone union. The LCP-F implant costs around £500 more than a standard fibula fixation device. This should be balanced against the cost of further intervention for patients whose osteoporotic bone or unstable fractures could be predicted to raise the likelihood of displacement requiring additional surgery [11].

Radiographic union was established slightly earlier with LCDFP (mean 14.5 weeks) compared to STP (15.1 weeks) and LCDCP (15.6 weeks) although differences were not clinically significant. The return to full weight-bearing time was similar across all groups with the STP group having a marginally earlier return to ambulation. This study suggests that while implant selection reflects fracture length and associated patient factors, successful and predictable union can be achieved with one of three different plating methods. Complications and reoperations were infrequent overall, consistent with prior literature. STP was also associated with a statistically higher rate of symptomatic hardware removal due to the design of the plates being lower profile, and they tend to be more prominent under thin, soft tissue coverage. LCDFP and LCDCP were associated with fewer hardware-related complications and suggested a role in reducing soft tissue irritation and complications. Infection rates were low for all groups and revision surgeries were influent. This suggests that all plating techniques are effective when used properly. Recent research by Moriarity et al., (2018) [12] has shown that there is no association between an increased risk of wound complications and the usage of locking plates to repair distal fibular fractures. They have used low profile periarticular LP that is 1.3 mm thick distally in contrast to one-third tubular and reconstructive NLP, which are 1 and 3.5 mm thick, respectively.

Overall, older patients with more complex fractures in this study were shown to prefer LCDFP as it was easier to find stability and showed acceptable broken bone healing compared to traditional plates of fixation. Cost-wise, STP was a good choice for less complex fractures but had a higher incidence of hardware-related symptoms. This study brings to light the need to consider patient demographic, comorbidity, and fracture characteristics when making implant selection to achieve the best outcomes.

Conclusion

In conclusion, this study demonstrates that both locking and non-locking plating techniques provide effective fixation and reliable healing outcomes for distal fibula fractures, with each method showing distinct advantages depending on patient characteristics and fracture complexity. Locking Compression Distal Fibula Plates (LCDFP) were predominantly utilized in older patients with osteoporotic bone and more complex fracture patterns, such as bimalleolar and trimalleolar injuries, offering stable fixation and slightly faster radiographic union while minimizing soft tissue complications. Semi-Tubular Plates (STP) and Limited-Contact Dynamic Compression Plates (LCDCP) were effective for simpler fractures, with comparable union times and low complication rates, although A higher frequency of symptomatic hardware removal was linked to STP. Overall, complications and reoperations were low across all groups, and functional outcomes were satisfactory. These findings emphasize the importance of individualized implant selection based on patient age, bone quality, fracture type, and comorbidities to optimize fracture healing and restore ankle function while minimizing the risk of complications.

References

1. Kannus P, Palvanen M, Niemi S, Parkkari J, Jrvinen M. Increasing number and incidence of low-trauma ankle fractures in elderly people: Finnish statistics during 1970–2000 and projections for the future. Bone. 2002 Sep 1;31(3):430-3.
2. MacLeod AR, Simpson AH, Pankaj P. Reasons why dynamic compression plates are inferior to locking plates in osteoporotic bone: a finite element explanation. Computer methods in biomechanics and biomedical engineering. 2015 Dec 10;18(16):1818-25.
3. Miller DL, Goswami T. A review of locking compression plate biomechanics and their advantages as internal fixators in fracture healing. Clinical biomechanics. 2007 Dec 1;22(10):1049-62.
4. Smith SR, Bronk JT, Kelly PJ. Effect of fracture fixation on cortical bone blood flow. Journal of orthopaedic research. 1990 Jul;8(4):471-8.
5. Fridberg M, Ban I, Issa Z, Krasheninnikoff M, Troelsen A. Locking plate osteosynthesis of clavicle fractures: complication and reoperation rates in one hundred and five consecutive cases. International orthopaedics. 2013 Apr;37(4):689-92.
6. Smith WR, Ziran BH, Anglen JO, Stahel PF. Locking plates: tips and tricks. JBJS. 2007 Oct 1;89(10):2298-307.
7. Ebraheim NA, Mekhail AO, Gargasz SS. Ankle fractures involving the fibula proximal to the distal tibiofibular syndesmosis. Foot & ankle international. 1997 Aug;18(8):513-21.
8. Hake ME, Davis ME, Perdue AM, Goulet JA. Modern implant options for the treatment of distal femur fractures. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2019 Oct 1;27(19):e867-75.
9. Schepers T, Van Lieshout EM, De Vries MR, Van der Elst M. Increased rates of wound complications with locking plates in distal fibular fractures. Injury. 2011 Oct 1;42(10):1125-9.
10. Tsukada S, Otsuji M, Shiozaki A, Yamamoto A, Komatsu S, Yoshimura H, Ikeda H, Hoshino A. Locking versus non-locking neutralization plates for treatment of lateral malleolar fractures: a randomized controlled trial. International orthopaedics. 2013 Dec;37(12):2451-6.
11. Murray AM, McDonald SE, Archbold P, Crealey GE. Cost description of inpatient treatment for ankle fracture. Injury. 2011 Nov 1;42(11):1226-9.
12. Moriarity A, Ellanti P, Mohan K, Fhoghlu CN, Fenelon C, McKenna J. A comparison of complication rates between locking and non-locking plates in distal fibular fractures. Orthopaedics & Traumatology: Surgery & Research. 2018 Jun 1;104(4):503-6.