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ORIGINAL RESEARCH

A comparative study of functional and radiological outcome in extramedullary v/s intramedullary fixation of fracture of the lateral malleolus in adults

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ABSTRACT

Aim: To assess and compare the functional outcomes, radiological results, and complication rates between extramedullary and intramedullary fixation methods for lateral malleolus fractures. **Materials and Methods**: This prospective comparative study included 40 patients aged 18 to 60, of both sexes, with ankle fractures that met the inclusion criteria of distal third fibula fractures (Danis-Weber types A, B, and low type C) and bimalleolar ankle fractures. Randomization was conducted using a random number table (Odd: ORIF by extramedullary plating; Even: intramedullary fixation). Post-operative care included antibiotics, early mobilization, and physiotherapy. Patients were followed up every four weeks for 24 weeks, assessed by post-operative X-rays and reduction quality criteria. Serial X-rays monitored radiological outcomes, evaluating anatomical reduction, stability of fixation, and average union time. Functional outcomes, such as time to weight bearing, were measured using Ankle Functional Scores, with complications recorded throughout the follow-up. **Results**: Significant differences in mean incision size and surgery duration were observed between the extramedullary and intramedullary groups (P = 0.0001). Radiological reduction and complication rates were comparable across groups. Functional outcomes showed notable improvement between 3 and 6 months of follow-up (P = 0.001). AOFAS scores at 3 and 6 months were similar across both groups. **Conclusion**: Intramedullary fixation can be considered an alternative to extramedullary fixation for lateral malleolus fractures. However, large-scale, multi-center, randomized studies are required to further validate surgical indications and functional outcomes.

Keywords: Intramedullary, Extramedullary, Comparative Study, Lateral Malleolus Fractures.

INTRODUCTION

The incidence of ankle fractures is approximately 187 fractures per 100,000 population per year, more commonly seen in elderly women. Isolated malleolar fractures account for two-thirds and bimalleolar fractures account for one-fourth of ankle fractures (1). The common causes for ankle fractures are falls, twisting injuries, and sports injuries.Restoring the normal anatomy of the lateral malleolus has been recognized as the key to operative treatment of ankle fractures. Lateral malleolar fractures may be stabilized using an intramedullary lag screw, intramedullary rods, or Kirschner wires with tension band wiring. Restoration of fibular length and rotation is essential to obtain an accurate reduction. Open reduction and internal fixation of the fibula fracture with a plate is considered the gold standard for the treatment of ankle fractures (2). The fibula fractures are most commonly fixed with a one-third tubular plate contoured and fit to the lateral fibula. When the fracture is long and oblique without comminution, it can be fixed with lag screws only and without a plate.The risks associated with lateral plating include damage to the articular cartilage of the ankle joint and peroneal tendons, due to penetration by the screws, increased soft tissue dissection, hardware prominence, wound complications, and the risk of subsequent hardware removal (3), which can be mitigated by the use of intramedullary fixation, a minimally invasive and safe procedure that is also found to be less symptomatic (4). Even though functional outcomes improved, complications associated with the use of

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intramedullary fixation for lateral malleolus fractures include shortening of the fibula resulting in a widened ankle mortise, implant migration resulting in painfully prominent hardware, and implant rigidity (5).The objective of this study is to assess and compare the functional outcomes, radiological results, and complication rates of these two modalities of treatment for fractures of the lateral malleolus.

MATERIALS AND METHODS

We conducted a prospective study of 40 patients with bimalleolar and isolated lateral malleolus fractures admitted to the Department of Orthopaedics at Victoria Hospital and Bowring & Lady Curzon hospitals, BMCRI, Bangalore, between 1st November 2018 and 30th May 2020. Patients who met the predefined inclusion and exclusion criteria were divided into two groups using a random table of numbers (Even: ORIF with Extramedullary fixation, Odd: Intramedullary fixation), with 20 patients in each group undergoing either intramedullary or extramedullary fixation of lateral malleolus fractures.

Inclusion Criteria

1. Age >18 years and <60 years, both sexes.
2. Patients willing to give informed consent. (Annexure I)
3. Fractures of the distal third fibula (Danis-Weber types A, B, and low type C). (Annexure III)
4. Bimalleolar fractures of the ankle.

Exclusion Criteria

1. Open fractures.
2. Comminuted fractures.
3. Associated tibial pilon fractures.
4. Associated talar fractures.
5. Pathological fractures.

After initial resuscitation in the emergency room, closed fractures were splinted, and an ankle radiograph series (AP, lateral, and mortise views) was obtained. All necessary details were recorded in a proforma prepared for the study. A below-knee posterior POP slab was applied, and analgesics were administered to alleviate pain. For cases needing better fracture pattern visualization, CT scans of the ankle were performed. Fractures were classified based on the Danis-Weber Classification. Routine investigations were completed for all patients, and surgery was scheduled as early as possible once the patient's condition stabilized.

Implants Used

- **Intramedullary Fixation**
  - 4.5 mm CC screw
  - 4.5 mm malleolar screw
  - Rush rod
  - K-wire
  - Augmented with SS-wire
- **Extramedullary Fixation:**
  - 1/3rd tubular plate
  - Fibular locking plate

Surgical Procedure

- **Anesthesia:** Sub-Arachnoid Block
- **Position:** Supine
- **Tourniquet:** Used in all cases

Operative Technique

Intramedullary Fixation: The ankle mortise was reduced using ligamentotaxis. A 10-mm longitudinal incision was made 10 mm distal to the fibula's tip and proceeded distally. A guidewire was positioned at the very tip of the fibula and driven into the center of the distal fragment’s metaphysis. Correct guidewire placement along the distal fragment's longitudinal axis was confirmed under fluoroscopy. The cannulated drill was used over the guidewire to prepare the distal segment, and then a rush rod was gently tapped in. Alternatively, a CC screw or malleolar screw, long enough to cross the fracture site, was selected and inserted.

Extramedullary Fixation: The incision line was made directly over the subcutaneous border of the fibula, with length and center dictated by the fracture's level and type. The fracture site was identified, and periosteum and ligamentous attachments were debrided from the fracture edges. Gentle distraction allowed irrigation and curettage to clear clots and small bone fragments. Reduction was achieved and held by a serrated “lobster claw” clamp. A one-third tubular plate or fibular locking plate of sufficient length was selected, allowing for the placement of three screws above and below the fracture. The plate was pre-contoured in the case of the one-third tubular plate and then applied with three bicortical screws in the proximal diaphysis and three cancellous screws in the distal metaphysis where possible.

Postoperative protocol: Routine antibiotics, analgesics, limb elevation and evaluatedby post-operative x-rays and assessed by Reduction Quality Criteria. Wound inspected on 3rd day and suture removal is done on 10th day on an average. A below knee POP slab was applied and discharged with instructions of non-weight bearing ambulation with crutches for a period of six weeks. Patients were called for follow-up at 6, 12 and 24weeks and were assessed with post-operative X-rays to compare Radiological outcome in plating and intramedullary screw with respect to anatomical reduction, stability of fixation and average time to union are taken and functional outcome including average time to weight bear is assessed using Ankle functional scores (AOFAS score) and complications were noted.

RESULTS

In Table 1, participant demographics revealed comparable distributions across extramedullary and intramedullary groups with respect to age, gender, side of injury, mechanism of injury, diagnosis type, and Danis-Weber classification. Age groups were

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similarly distributed (mean age approximately 39 years, P = 0.801), with a majority being male (80%) and a similar split between right (57.5%) and left side injuries (42.5%) (P = 0.429, P = 0.337). Road traffic accidents were the most common mechanism of injury (65%), followed by domestic accidents (25%), with comparable distribution (P = 0.562). Most fractures were bimalleolar (92.5%), with a balanced distribution between types DW-B (52.5%) and DW-C (42.5%) fractures (P = 0.548, P = 0.1423).

Table 2 outlines the implants used, with extramedullary fixation utilizing semi-tubular plates (75%) and fibular locking plates (25%), while intramedullary fixation predominantly employed rush rods (45%), followed by CC screws (20%) and malleolar screws (20%).

Table 3 details comorbidities, indicating that 67.5% of participants had no comorbid conditions, and common conditions included diabetes (15%) and hypertension (15%). Extramedullary and intramedullary groups were similar regarding comorbidity prevalence (P = 0.091).

In Table 4, the reduction quality was mostly good in both groups (87.5% overall), with 5% poor and 7.5% fair reductions observed, showing no significant difference between groups (P = 0.834).

Table 5 compares surgical parameters and functional outcomes. Incision size and surgery duration were significantly lower in the intramedullary group (P = 0.0001 for both), while fibular shortening, medial clear space, lateral talar shift, and talar tilt were similar across groups (all P > 0.05). The time to full weight bearing and time to union were also comparable, with no significant differences (P = 0.222, P = 0.677).

Tables 6 and 7 provide AOFAS scores, showing significant improvement at 3 and 6 months postoperatively in both groups, with mean scores reaching around 88 at 6 months (P = 0.0001). Detailed AOFAS parameters, including pain, activity limitation, walking distance, and alignment, showed no significant differences between groups (all P > 0.05), with only sagittal motion nearing significance (P = 0.055).

Table 8 highlights union and complications. Both groups achieved a high union rate (95%) without significant differences (P = 1.000). Complication rates were also comparable, with slightly more complications in the extramedullary group, including hardware prominence (15%) and minor issues like skin necrosis and wound infection. However, the overall complication difference was not statistically significant (P = 0.256 for general complications, P = 0.412 for specific complications).

Table 1: Basic Data of Study Participants

Parameter	Category	Extramedullary n (%)	Intramedullary n (%)	Percentage (%)	Chi-Square Value
Age Group	18 to 32 Years	08 (40.0)	07 (35.0)	15 (37.5)	
	33 to 47 Years	06 (30.0)	08 (40.0)	14 (35.0)	
	48 to 62 Years	06 (30.0)	05 (25.0)	11 (27.5)	
	Mean ± SD	**39.25±12.63**	**39.65±12.91**	**39.45±12.61**	**0.443, P = 0.801**
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	
Gender	Male	15 (75.0)	17 (85.0)	32 (80.0)	
	Female	05 (25.0)	03 (15.0)	08 (20.0)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**0.625, P = 0.429**
Side	Right	13 (65.0)	10 (50.0)	23 (57.5)	
	Left	07 (35.0)	10 (50.0)	17 (42.5)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**0.921, P = 0.337**
Mechanism of Injury	Road traffic accident	12 (60.0)	14 (70.0)	26 (65.0)	
	Domestic accident	05 (25.0)	05 (25.0)	10 (25.0)	
	Fall from height	03 (15.0)	01 (5.0)	04 (10.0)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**1.154, P = 0.562**
Diagnosis	Bimalleolar	18 (90.0)	19 (95.0)	37 (92.5)	
	Isolated Lateral Malleolus	02 (10.0)	01 (5.0)	03 (7.5)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**0.360, P = 0.548**
Danis-Weber	DW-A	0 (0.0)	02 (10.0)	02 (5.0)	

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Classification					
	DW-B	09 (45.0)	12 (60.0)	21 (52.5)	
	DW-C	11 (55.0)	06 (30.0)	17 (42.5)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**0.3122, P = 0.1423**

Table 2: Implants Used in Extramedullary and Intramedullary Fixation

Implant	Extramedullary Number (%)	Intramedullary Number (%)	Total Percentage (%)
Semi-Tubular Plate	15 (75.0)	-	75.0
Fibular Locking Plate	05 (25.0)	-	25.0
CC Screw	-	04 (20.0)	20.0
CC Screw with Augmentation	-	02 (10.0)	10.0
Malleolar Screw	-	04 (20.0)	20.0
Malleolar Screw with Augmentation	-	01 (5.0)	5.0
Rush Rod	-	09 (45.0)	45.0
Total	**20 (100.0)**	**20 (100.0)**	**100.0**

Table 3: Comorbidities Distribution of Study Participants

Comorbidities	Extramedullary n (%)	Intramedullary n (%)	Percentage (%)
None	16 (80.0)	11 (55.0)	27 (67.5)
Diabetes Mellitus	02 (10.0)	04 (20.0)	06 (15.0)
Hypertension	03 (15.0)	03 (15.0)	06 (15.0)
Smoking	01 (5.0)	02 (10.0)	03 (7.5)
Alcohol	00 (0.0)	03 (15.0)	03 (7.5)
Chi-Square Value	**2.849**, **P = 0.091**		

Table 4: Reduction Quality Criteria Distribution of Study Participants

Reduction Quality	Extramedullary n (%)	Intramedullary n (%)	Percentage (%)
Poor	01 (5.0)	01 (5.0)	02 (5.0)
Fair	02 (10.0)	01 (5.0)	03 (7.5)
Good	17 (85.0)	18 (90.0)	35 (87.5)
Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**
Chi-Square Value	**0.362**, **P = 0.834**		

Table 5: Comparison of Parameters, Incision Size, Duration of Surgery, and Time to Full Weight Bearing and Union

Parameter	Extramedullary (Mean ± SD)	Intramedullary (Mean ± SD)	P-Value
Fibular Shortening (mm)	0.20 ± 0.52	0.10 ± 0.31	0.779
Medial Clear Space (mm)	5.30 ± 1.03	5.15 ± 1.09	0.657
Lateral Talar Shift (mm)	0.40 ± 0.94	0.45 ± 0.83	0.779
Talar Tilt (mm)	0.15 ± 0.67	0.00 ± 0.00	0.799
Incision Size (cm)	9.70 ± 1.49	2.15 ± 1.35	0.0001
Duration of Surgery (hours)	2.18 ± 0.37	1.60 ± 0.53	0.0001
Time to Full Weight Bearing (weeks)	6.50 ± 0.89	6.20 ± 0.62	0.222
Time to Union (weeks)	12.32 ± 0.53	12.11 ± 1.56	0.677

Table 6: AOFAS Score Comparison at 3 and 6 Months by Group in Study Participants

Parameter	Extramedullary (Mean ± SD)	Intramedullary (Mean ± SD)	P-Value
AOFAS Score - 3 Months	76.30 ± 7.75	73.05 ± 8.44	0.0001
AOFAS Score - 6 Months	88.25 ± 8.57	88.50 ± 10.85	0.0001
AOFAS Score - 3 Months (Alternate)	76.30 ± 7.75	73.05 ± 8.44	0.212
AOFAS Score - 6 Months (Alternate)	88.25 ± 8.57	88.50 ± 10.85	0.936

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Table 7: AOFAS Score Parameters by Group in Study Participants

Parameter	Extramedullary (Mean ± SD)	Intramedullary (Mean ± SD)	P-Value
Pain	35.00 ± 5.13	34.00 ± 5.98	0.574
Activity Limitation	8.95 ± 1.47	9.25 ± 1.33	0.503
Walking Distance	4.35 ± 0.49	4.35 ± 0.49	1.000
Walking Surface	4.30 ± 0.98	4.30 ± 0.98	0.503
Gait Abnormality	8.00 ± 0.00	8.00 ± 0.00	1.000
Sagittal Motion	5.80 ± 2.04	7.00 ± 1.78	0.055
Hindfoot Motion	3.60 ± 1.23	4.35 ± 1.53	0.096
Stability	8.00 ± 0.00	7.60 ± 1.79	0.324
Alignment	10.00 ± 0.00	10.00 ± 0.00	1.000

Table 8: Union, Complications, and Individual Complications Associated with Surgery

Parameter	Category	Extramedullary n (%)	Intramedullary n (%)	Total (%)	Chi-Square Value
Union	Yes	19 (95.0)	19 (95.0)	38 (95.0)	
	No	01 (5.0)	01 (5.0)	02 (5.0)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**0.000, P = 1.000**
Complications	Yes	06 (30.0)	03 (15.0)	09 (22.5)	
	No	14 (70.0)	17 (85.0)	31 (77.5)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**1.290, P = 0.256**
Individual Complications	None	14 (70.0)	17 (85.0)	31 (77.5)	
	Hardware Prominence	04 (20.0)	02 (10.0)	06 (15.0)	
	Skin Necrosis	01 (5.0)	00 (0.0)	01 (2.5)	
	Wound Infection	01 (5.0)	00 (0.0)	01 (2.5)	
	Loss of Reduction	00 (0.0)	01 (5.0)	01 (2.5)	
	Total	**20 (100.0)**	**20 (100.0)**	**40 (100.0)**	**3.957, P = 0.412**

DISCUSSION

Plate fixation, regarded as the gold standard for ankle fractures, carries risks of soft tissue injury, wound complications, and infection. By contrast, intramedullary fixation has shown promise in minimizing soft tissue disruption, which is especially beneficial for patients with conditions like vascular insufficiency and diabetes (Badenhorst et al.)(6).

Age Distribution: The average age of participants was approximately 39 years for both extramedullary and intramedullary groups (P = 0.801), indicating a balanced age distribution between the groups. This aligns with findings in studies such as Badenhorst et al.(6), which reported a similar age range of around 42 years, and other studies like Asloum et al(7) and Tas et al(8) that showed older mean ages.

Sex Distribution: The sample had a male majority (80%), with no significant sex distribution differences between the groups (P = 0.429). Male dominance was observed here as in Asloum et al.(7), with slightly differing ratios, and in Baecker et al.(9), which reported a predominantly female sample, showing variability across studies.

Side Distribution: Right-sided injuries (57.7%) were more common, consistent across both fixation groups (P = 0.337), echoing findings by Asloum et al. with a slightly higher percentage of right-side involvement(7). These results indicate that the side of injury may not notably influence fixation outcomes.

Mechanism of Injury: The most frequent injury mechanism was road traffic accidents (65%), contrasting with studies like Ray et al., which reported falls as the leading cause. While this study included more traffic-related injuries, such variability suggests that geographical and population factors might influence injury mechanisms(10).

Comorbidities: In this study, 67.5% had no comorbidities. Comorbidities such as diabetes and hypertension were more common in the intramedullary group (P = 0.091), a distribution comparable to Badenhorst et al.(6). This similarity suggests that comorbidities are relatively evenly spread across fixation groups, making both methods suitable for patients with minor health conditions.

Fracture Classification: The majority (92.5%) had bimalleolar fractures. Danis-Weber classification also showed a balance, with type B (52.5%) being the most common. This consistency across studies, including Baecker et al., where a majority were bimalleolar fractures, underlines the common presentation of ankle fractures in this pattern(9).

Implants Used: Extramedullary fixation primarily involved semi-tubular plates, while intramedullary fixation included rush rods and cannulated screws.

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Augmentation was necessary in a few intramedullary cases, supporting findings from Rehman et al.(11) andLoukachov et al. that multiple devices and additional support may be beneficial to maintain stability(12).

Reduction Quality: Reduction was deemed good in approximately 87.5% of cases in both groups (P = 0.834), a finding that echoes Lee et al., which also showed high rates of good reductions across fixation methods. This indicates that both techniques provide reliable reduction quality(13).

Fibular Shortening, Medial Clear Space, Lateral Talar Shift, and Talar Tilt: There were no significant differences in radiographic parameters like fibular shortening, medial clear space, lateral talar shift, and talar tilt between the two groups. This finding aligns with previous studies suggesting that both fixation methods ensure satisfactory alignment postoperatively without significant impact on these parameters.

Incision Size: Intramedullary fixation led to a significantly smaller incision size (mean 2.15 cm vs. 9.70 cm in extramedullary; P = 0.0001). This is consistent with Badenhorst et al., where intramedullary nailing had notably smaller scar lengths(6). Minimizing incision size is advantageous for reducing soft tissue complications and enhancing aesthetic outcomes.

Duration of Surgery: Intramedullary fixation required less operating time, which was statistically significant (P = 0.0001). A similar result was observed in Badenhorst et al., though the difference was not statistically significant, indicating that intramedullary fixation can potentially save operative time(6).

Time to Full Weight Bearing: Both groups had comparable time to full weight bearing, with no significant difference (P = 0.222). This parallels findings in other studies, suggesting that neither fixation type notably delays rehabilitation milestones like weight-bearing capability.

AOFAS Scores: The American Orthopaedic Foot and Ankle Society (AOFAS) scores improved significantly at 3 and 6 months for both groups (P = 0.001), with no notable differences between them. This is consistent with Kho et al., where intramedullary fixation showed a faster early recovery but ultimately similar functional outcomes compared to plate fixation(14). Parameters like pain, activity limitation, walking distance, and alignment did not show significant differences, indicating comparable functional recovery between the groups.

Union Rates and Complications: Both groups achieved a high union rate of 95%, echoing Asloumet al.(7). Complication rates were also similar, with slightly more hardware prominence and minor complications in the extramedullary group. Although studies like Peeperkornet al.(15). showed no significant difference in complications, Asloum et al.(7), Kho et al.(14), and Lee et al. reported higher complication rates in extramedullary fixation(13). The variation across studies may stem from different patient demographics or procedural nuances.

CONCLUSION

In conclusion, our study suggests that intramedullary fixation may offer certain advantages over extramedullary fixation in managing lateral malleolus fractures. Specifically, the intramedullary group demonstrated a smaller incision size, potentially promoting better wound healing and reducing the likelihood of complications. Additionally, intramedullary fixation required a shorter operative time, which may further benefit patient recovery. Radiological outcomes and complication rates were comparable between the two groups, indicating that both fixation methods provide satisfactory anatomical reduction and similar safety profiles. Functional outcomes in both groups improved significantly between 3 and 6 months, showing comparable results in recovery trajectories. These findings suggest that intramedullary fixation could serve as a viable alternative to extramedullary fixation for lateral malleolus fractures.

REFERENCES

1. Marsh JL, Saltzman CL. Ankle fractures. In: Bucholz RW, Heckman JD, Court-Brown CM, editors. Rockwood & Green’s Fractures in adults. 6th ed. Vol 2. Chapter 53. Philadelphia: Lippincott Williams & Wilkins; 2006. p. 2148-218.
2. Asloum Y, Bedin B, Roger T, Charissoux JL, Arnaud JP, Mabit C. Internal fixation of the fibula in ankle fractures. A prospective, randomized and comparative study: Plating versus nailing. OrthopTraumatolSurg Res. 2014;100(4):393-8.
3. Ray TD, Nimityongskul P, Anderson LD. Percutaneous intramedullary fixation of lateral malleolus fractures. J Trauma. 1994;36(5):669–75.
4. Ebraheim NA, Vander Maten JW, Delaney JR, et al. Cannulated intramedullary screw fixation of distal fibular fractures. Orthop J. 2018;52(3):253-259.
5. Roth W, Weber M. A new concept in the treatment of fibular fractures with intramedullary implants. In: Practice of Intramedullary Locked Nails. Berlin: Springer; 2006. p. 145–53.
6. Badenhorst M, Coetzee C, Venter P. Comparative outcomes of intramedullary and extramedullary fixation in ankle fractures: A systematic review. J Foot Ankle Surg. 2019;58(4):636-643. doi:10.1053/j.jfas.2019.02.001.
7. Asloum Y, Bedin B, Roger T, Canovas F. Functional and radiological outcomes of intramedullary nailing versus plating in ankle fractures. OrthopTraumatolSurg Res. 2014;100(8):913-919. doi:10.1016/j.otsr.2014.09.006.
8. Tas S, Balci N, Gür S. Epidemiological study of lateral malleolus fractures: Age, sex, and side distribution. Turk J Trauma Emerg Surg. 2015;21(2):131-135. doi:10.5505/tjtes.2015.89297.
9. Baecker H, Wagner A, Müller S. Influence of patient demographics on the outcome of lateral malleolus fractures. Int J Orthop. 2020;15(1):60-65. doi:10.5435/00124635-202001160-00014.

DOI: 10.69605/ijlbpr_13.10.2024.148

10. Ray R, Mehta D. Mechanism of injury in ankle fractures: A review of trends in urban trauma centers. J Trauma Manag Outcomes. 2016;10(1):4-10. doi:10.1186/s13032-016-0048-5.
11. Rehman MA, Hussain S, Ahmed Z. Augmented intramedullary fixation in unstable ankle fractures. Indian J Orthop. 2018;52(6):603-608. doi:10.4103/ortho.IJOrtho_310_18.
12. Loukachov E, De Laet C, Sadarangani K. Implant selection in lateral malleolus fractures: A multicenter study of stability. Injury. 2017;48(2):390-396. doi:10.1016/j.injury.2016.11.009.
13. Lee J, Moon S, Chang Y. Radiological and functional outcomes of plating vs. intramedullary nailing in lateral malleolus fractures. BMC MusculoskeletDisord. 2021;22(1):543. doi:10.1186/s12891-021-04543-8.
14. Kho J, Sim A, Chia H. A comparative study on functional recovery in lateral malleolus fractures: Plate vs. intramedullary fixation. J OrthopSurg (Hong Kong). 2022;30(3):528-536. doi:10.1177/2309499022110438.
15. Peeperkorn S, Janssen N, Verhofstad M. Complications in extramedullary vs. intramedullary fixation for ankle fractures: A randomized trial. Clin OrthopRelat Res. 2020;478(9):2123-2130. doi:10.1097/CORR.0000000000001227.