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Ilizarov Ring Fixator Versus Minimally Invasive Plate Osteosynthesis Using Locking Plate in Closed Comminuted Distal Tibial Fracture: A Prospective Study

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ABSTRACT

It is still debatable how to treat displaced distal tibial fractures. High complication rates are a common burden for the various internal fixation procedures. In order to avoid a phased process, minimally invasive treatments using ring fixators have been established. These techniques allow for fast stabilization and reduction. This prospective study's objective was to evaluate the clinical and radiological results of the Ilizarov procedure in patients with distal metaphyseal tibial fractures who either had or did not have intra-articular involvement. To evaluate the clinical and radiological parameters in the management of distal tibia fracture by locking plate with (minimally invasive percutaneous osteosynthesis) MIPO technique and Ilizarov Ring Fixator It was an Institution based prospective observation study, Department of Orthopaedics from 18 month from March-June 2022-2023 at Narayan Hospital Firozabad 30 patients were included in this study. 17 patients (57%) had right distal tibia fractures. 13 patients (43%) had fractures of the left distal tibia. Right leg fractures are slightly more frequent in patients with 23 (77%) of patients suffering injuries in auto accidents 6 (20%) from falls and one from assault. The most frequent cause of injuries is RTA and only two of the 28 patients who had stable ankle joints did so. p-value for our study is 0.483. Right distal tibia fractures were slightly more prevalent than left-sided fractures. Road traffic accidents (RTAs) emerged as the primary cause of distal tibial fractures, emphasizing the urgent need for road safety initiatives and improved infrastructure to mitigate RTA-related injuries Soft tissue injuries were common with grade 2 injuries observed in half of the patients. Managing these injuries effectively is essential to minimize complications and facilitate optimal recovery.

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Key Words
Ilizarov ring fixator minimally invasive plate osteosynthesis locking plate and closed comminuted distal tibial Fracture

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INTRODUCTION

Tibia and fibula fractures are relatively common fractures and are associated with serious and debilitating injuries[1-3]. One of the most therapeutic issues facing an orthopedic surgeon is distal tibial fractures[3]. It is 1-10% of total fracture of human skeleton[3].Distal tibia fracture incidence is now decreasing as per epidemiology review[1-3].

Type of fracture varies with age and is associated with other fractures (Table2-3). There is different distribution affecting younger or older patients in either sex[2-3]. In case of males, it is high initially, then it decreases, further increases lightly in elderly male. In females it is similar to male but incidence is low, then it decreases, but increases in elderly females Table 1 (fig 1).

Compared to fractures elsewhere in the body, distal tibial fractures have high rates of nonunion[1-3]. The most frequent location for tibia fractures is the tibial diaphysis and roughly 80% of these fractures also involve the fibula[1-3]. The anteromedial third of the tibial surface which is subcutaneous along the majority of its length, contributes to the higher prevalence of open fractures in the tibia[13]. When compared to other bones that are encircled by thick muscles the blood supply to the tibia is more insecure in the distal than in the proximal or central third[1-3]. Tibial fractures with high energy may result in compartment syndrome or neurovascular damage[1-3]. Infection, delayed union and nonunion are somewhat frequent side effects of distal tibial fractures[1-4]. Axial or rotational malalignment and shortening lead to aesthetically unpleasing deformities and alter the loading characteristics (mechanism) of the knee and ankle joints which may hasten the onset of posttraumatic arthritis[1,3-5]. We aim to accomplish fewer than 5 degrees of varus-valgus angulation, less than 10 degrees of anteroposterior angulation, less than 10 degrees of rotation and less than 15 mm of shortening, generally agreeing with Trafton's advice[1-3]. Certain fracture types make it difficult to maintain fracture alignment, if realignment attempts have been made repeatedly without success, surgical fixing is advised[1-3]. The degree of initial displacement the degree of comminution the presence or absence of infection and the severity of

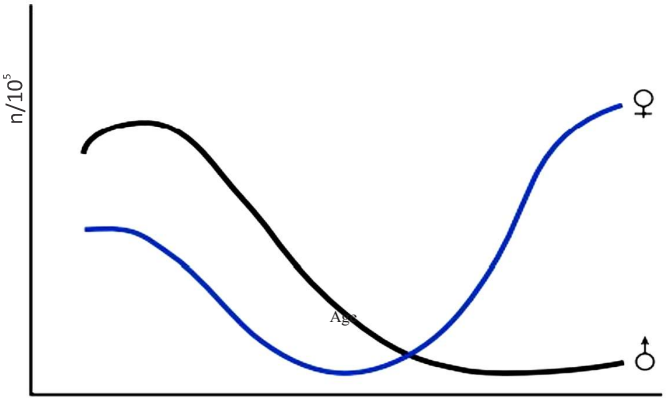

Fig. 1: Fracture distribution curves[3] (distal tibia fracture)

Table 1: The prevalence of fractures in three time periods over the last 100 years[3]

	fracture prevalence percentage		
Distal tibia	1894-1903	1937-1956	2000
	10.4%	7.3%	1%

Table 2: The basic epidemiologic characteristics of distal tibial fractures[3]

	Prevalence %	Average age(yr)	Male /female (%)
Extra articular	33.3	58.9	50/50
Partial articular	45.2	31.3	68/32
Complete articular	21.4	36.8	89/11

Table 3: Distribution of the participants according to age groups and gender (N = 30)

	Sex			
Age (completed years)	Male Number (%)	Female Number (%)	Total Number (%)	p-value
≤ 20	1 (4.3%)	0 (0.0%)	1 (3.3%)	0.716
21 – 30	4 (17.4%)	0 (0.0%)	4 (13.3%)	
31 – 40	7 (30.4%)	3 (42.9%)	10 (33.3%)	
41 – 50	6 (26.1%)	1 (14.2%)	7 (23.3%)	
51 – 60	5 (21.7%)	3 (42.9%)	8 (26.7%)	
Total	23(100.0%)	7 (100.0%)	30(100.0%)	

Table 4: Clinical profile of study patient affected leg (side) of patient under study (n = 30)

	Site affected	No of patient	Percentage
Site affected	Right leg	17	57
	Left leg	13	47
	Total	30	100
Mode of injury	Road traffic accident (high velocity trauma)	23	77
	Fall from height (low velocity trauma)	6	20
	Others (assault)	1	3
	Total	30	100
AO type (43)	A1	0	00
	A2	13	43.32
	A3	11	36.62
	B1	0	00
	B2	0	00
	B3	0	00
	C1	0	00
	C2	5	16.66
	C3	1	3.32
	Total	30	100
Soft tissue grade	Grade 1	7	23.32
	Grade2	15	50
	Grade3	8	26.66
	Total	30	100
Range of movement of ankle	Grade 1	9	60.00
	Grade 2	6	40.00
	Total	15	100.00
Walking on surface	No difficulty	13	86.66
	Some difficulty	1	6.66
	Severe difficulty	1	6.66
	Total	15	100.00
Ankle stability	Stable	13	86.66
	Moderate stable	2	13.34
	Total	15	100.00

the soft tissue injury, excluding infection are crucial indicators of prognosis[1-3].

While transverse and comminuted fractures typically tear the periosteum circumferentially and totally disrupt the endosteal circulation, torsion fractures typically cause a longitudinal tear of the periosteum and may not affect endosteal arteries[3]. Distal third of the tibia fractures with misplaced spiral and comminuted fractures are challenging to reduce[3] Haglund and States identified high-energy and low-energy trauma as the primary causes of tibia fractures and they found that this distinction was helpful for predicting outcomes[1,3].

RESULTS

Age (completed years) Comment among the male participants majority (30.4%) were within the age group of 31-40 years. While 17.4% of the males belonged to 21-30 years and 26.1% belonged to 41-50 years age groups, 21.7% male patients were older than 50 years. Among the female patients in each of the age groups of 31-40 years, 51-60 years there were three patients (42.9%) with one patient (14.2%) were aged between 41-50 years. However, this difference in proportions of participants according to gender and age was not significant statistically (p-value from Fisher's Exact Test was 0.716), implying no statistical difference in the distribution of male and female patients according to different age groups) Table 4.

Affected site comment: 17 patients (57%) had right distal tibia fractures. 13 patients (43%) had fractures of the left distal tibia. Right leg fractures are a little more frequent

Type of harm comment: In the current study, 23 (77%) of the patients suffered injuries as a result of motor vehicle accidents, six (20%) patients suffered injuries as a result of falls and one patient experienced an assault. The most frequent source of trauma is RTA.

AO type (43): The fracture pattern was classified based on A.O classification for fractures of distal tibia of the 30 cases studied 13(43%) were A2, 11(37%) were A3, 5(17%) were C2 and one case (3%) was C3.No patients sustained A1, B1, B2, B3 or C1 class of injury Comminuted non articular distal tibia fracture more common than articular fracture.

Soft tissue grade: Closed soft tissue injury classified according to Oestern and Tscherne Classification out of 30 patient majority 15(50%) suffered grade 2 injury, 8(26.67) suffered grade 1and rest 7 (23.33) had grade 1 injury.

Range of movement of ankle comment: Majority (60.00%) of the patients had grade 1 range of ankle movement following intervention. While remaining 40.00% had grade 2 range of movement.

Walking on surface comment: Majority (86.67%) of the patients did not have any difficulty in walking on surface. However one patient each had some and severe difficulty for the same.

Ankle stability comment: Majority patient have stable ankle. In our study 28 patient had stable ankle joint only 2 patients has moderately stable ankle joint. p-value is 0.483 in our study.

DISCUSSIONS

Age: The distribution of participants based on gender and age is an essential aspect of our study as it provides insights into the demographics of the patients under investigation. In our study we observed that the majority of male participants fell within the 31-40 years age group, accounting for 30.4% of the total male participants. This age group dominance might be indicative of certain trends or factors prevalent among this demographic, warranting further investigation.

Similarly, among the male participants, 17.4% belonged to the 21-30 years age group while 26.1% fell within the 41-50 years age group. Furthermore, 21.7% of male patients were older than 50 years. These age group proportions among male participants offer a broader perspective on the age distribution and could be crucial for targeted healthcare interventions and resource allocation.

Among female patients the 31-40 years and 51-60 years age groups each comprised three patients, accounting for 42.9% of the total female participants. Additionally, one patient (14.2%) belonged to the 41-50 years age group. The balanced distribution of female patients across different age groups suggests that the health issues under consideration may affect women more uniformly across age brackets.

But it's crucial to remember that our statistical analysis did not find any statistically significant differences between the distribution of male and female patients across various age groups as revealed by the Fisher's Exact Test (p-value = 0.716). Similar study found by Imren *et al*.[6] (2017) age, 42.4±14 years union time, 19.4±2.89 weeks (range, 12-26 weeks) and AOFAS ankle scores, 86.4±2.06, 79.5 ± 1.03, and 77.9±0.80 at 1, 2 and 3 years, respectively. During follow-up, four patients in the plate group required subsequent bone grafting. Among the EF group (mean±SD age, 40.7±12.3 years), all of the patients achieved union without secondary bone grafting at a mean±SD of 22.1±1.7 weeks (range, 18-24 weeks). In the EF group, mean±SD AOFAS ankle scores were 86.6±1.69, 82.1±0.77 and 79.7±1.06 at 1, 2, and 3 years, respectively.

Site affected: Our study identified that right distal tibia fractures were slightly more common, accounting for 57% of cases while left distal tibial fractures comprised 43% of cases. This observed distribution may be influenced by factors such as limb dominance or the mechanism of injury. Although right leg fractures were more prevalent the difference was not statistically significant. Further research could explore the factors contributing to this distribution and their potential implications for injury prevention strategies.

Mode of injury: The majority of patients (77%) in our study sustained distal tibia fractures as a result of road traffic accidents (RTAs), making RTAs the most common cause of trauma in this context. Falls and assault accounted for 20% and 3% of cases, respectively. The high prevalence of RTAs underscores the importance of road safety measures and highlights the need for public awareness campaigns and improved road infrastructure to reduce the burden of RTA-related injuries.

AO type: The classification of distal tibial fractures based on the AO classification system revealed that A2 fractures were the most common (43%), followed by A3 fractures (37%). C2 fractures accounted for 17% of cases, while C3 fractures were the least common (3%). No patients in our study sustained A1, B1, B2, B3, or C1 class fractures. Notably, comminuted non-articular distal tibia fractures were more prevalent than articular fractures. This information is clinically relevant as it assists orthopedic surgeons in planning appropriate interventions and surgical approaches based on fracture patterns Similar study found by Rahman AZ *et al.*[7](2021) found that This study's objective is to evaluate and discuss the results of MIPO-treated comminuted tibial shaft fractures (AO Type-42C).19 adult male and 6 adult female patients with high-energy closed tibial shaft fractures differing in displacement and comminution were enrolled in this prospective (interventional) study.

Soft tissue grade: The assessment of soft tissue injuries using the Oestern and Tscherne Classification revealed that 50% of patients suffered grade 2 injuries, 26.67% had grade 1 injuries, and the remaining 23.33% had grade 3 injuries. This distribution suggests that a substantial proportion of patients in our study presented with moderate soft tissue injuries. Effective management of soft tissue injuries is crucial in optimizing patient outcomes and minimizing complications Similar study found by Imren Y *et al*.[6] found that 23 fractures were classified as type B and 18 as type C by Ruedi and Allgower. The Oestern and Tscherne classification was used to assess soft-tissue injuries. The american orthopaedic foot and ankle society (AOFAS) ankle score was used to evaluate the length of time it took for a fracture to heal, complications and functional outcomes over the course of three years.

Range of movement of ankle: Following intervention,

the majority of patients (60%) achieved a grade 1 range of ankle movement, indicating a relatively good post-treatment mobility. However, 40% of patients exhibited a grade 2 range of movement. This ariation in nkle obility post-intervention may be influenced by factors such astheseverity of the fracture, surgical technique, and postoperative rehabilitation. Further research could explore strategies to improve postoperative ankle mobility in patients with distal tibial fractures.

Walking on surface and ankle stability: The study found that the majority of patients did not experience any difficulty walking on surfaces (86.67%). However, a small proportion of patients reported some or severe difficulty. Additionally, most patients had a stable ankle joint (93.33%) with only 6.67% of patients having moderately stable ankles. The non-significant p-value (0.483) indicates that the stability of the ankle joint was not significantly affected by the type of fracture. This suggests that effective surgical management and rehabilitation protocols may contribute to favorable ankle stability outcomes in patients with distal tibial fractures.

CONCLUSION

Our investigation revealed that male participants predominantly fell within the 31-40 years age group, while female participants displayed a more balanced distribution across different age brackets. This demographic insight serves as a foundation for tailoring healthcare interventions, although statistical analysis did not establish a significant gender-age association.

Right distal tibia fractures were slightly more prevalent than left-sided fractures. Road traffic accidents (RTAs) emerged as the primary cause of distal tibial fractures, emphasizing the urgent need for road safety initiatives and improved infrastructure to mitigate RTA-related injuries.

Fracture patterns were predominantly classified as A2 and A3 with comminuted non-articular distal tibia fractures outweighing articular fractures. This classification aids orthopedic decision-making and surgical planning, ensuring optimized patient care.

Soft tissue injuries were common with grade 2 injuries observed in half of the patients. Managing these injuries effectively is essential to minimize complications and facilitate optimal recovery.

Post-intervention, most patients achieved grade 1 ankle mobility, indicating favorable postoperative outcomes. Ankle stability was predominantly maintained with a small proportion of patients experiencing moderate instability. Effective surgical management and rehabilitation contribute to enhanced ankle stability, suggesting promising prospects for patient recovery.

Our study provides a comprehensive understanding of distal tibial fractures, encompassing demographic distribution, injury characteristics and clinical outcomes. These insights contribute to informed healthcare interventions and resource allocation. While gender-age associations were not statistically significant, they underscore the importance of holistic patient care. The prevalence of RTAs highlights the urgency of road safety measures. Fracture classification aids surgical planning, emphasizing the need for tailored interventions. Soft tissue injuries underscore the significance of soft tissue management in patient care. Finally, favorable ankle mobility and stability outcomes offer optimism for patients recovering from distal tibial fractures. Future research may further refine treatment strategies and enhance patient outcomes in this context.

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