Original Article

A Comparative Study on Functional Outcomes of 5th Metatarsal Fractures Treated with Various Modalities in a Tertiary Care Hospital, Telangana

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Abstract

Background: Fifth metatarsal fractures are common fractures reported in orthopedic clinics. There are different modalities of treatment; however, the optimal treatment is still debated. Zone 2 and zone 3 fractures are challenging because of limited blood supply and hence prone to delayed union. The treatment options range from casting and CAM boots to screw fixation. Local comparative data are sparse. The current study aimed to determine the functional outcomes of three modalities of treatment in cases presenting to our hospital. **Material and Methods:** This prospective comparative study was conducted on 60 cases with fifth metatarsal fractures that were treated with below-knee cast immobilization, functional weight-bearing in a CAM boot, or surgical fixation. The Foot Function Index (FFI) was recorded at 2 weeks, 6 weeks, and 6 months, and the AOFAS midfoot score at 6 weeks and 6 months. Groups were compared using appropriate statistical analysis. **Results:** The mean age was 35.4 years (range 19-62), and 35 patients (58.3%) were men. The mean FFI was 22.45 ± 5.03 with immobilization, 12.55 ± 3.64 with weight-bearing, and 9.15 ± 0.87 with surgery, and the mean AOFAS score was 79.65 ± 6.26, 88.85 ± 3.58, and 91.60 ± 2.21, respectively. Excellent outcomes occurred in 95% of surgical patients, 65% of weight-bearing patients, and none of the immobilized patients ($p < 0.001$). The difference between weight-bearing and surgery was small in Zone 1, Zone 2 and shaft fractures but larger in Zone 3. One non-union occurred in the immobilization group. **Conclusion:** Surgical fixation gave the best functional outcomes, particularly in Zone 3 fractures. Functional weight-bearing in a CAM boot gave good results and may be a reasonable alternative to surgery in Zone 1, Zone 2 and shaft fractures. Cast immobilization gave the poorest recovery. Larger randomized studies with longer follow-up are needed.

Keywords: Fifth metatarsal fractures, Foot Function Index, AOFAS midfoot score, Internal fracture fixation, Cast immobilization, Orthotic devices.

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Introduction

Metatarsal fractures are a common type of foot injury. They account for about 5–6% of all fractures in adults. The commonly involved bone in such fractures is the fifth metatarsal bone.[1,2] These injuries occur with the same frequency in all age groups. Typically, they result from inversion injuries, direct trauma, falls from height, road traffic accidents, or repetitive loading. Since the lateral column of the foot bears a large share of weight during gait, even minor fractures can impair walking, work, footwear use, and other activities if there is poor management. Fifth metatarsal fractures are heterogeneous. Jones first described fractures at the metaphyseal–diaphyseal junction in 1902.[3] and Dameron later separated proximal injuries into tuberosity avulsion, metaphyseal–diaphyseal junction, and proximal diaphyseal stress fractures.[4] Lawrence and Botte proposed a three-zone classification, which remains widely used.[5] Zone 1 injuries are tuberosity avulsions, Zone 2 fractures involve the metaphyseal–diaphyseal junction, and Zone 3 fractures are proximal diaphyseal stress injuries. Further classifications and treatment algorithms have been proposed.[6] Clinically, the anatomical zone involved is important because the proximal diaphysis has a relatively closed intraosseous blood supply. Therefore, zone 2 and zone 3 fractures can lead to delayed union, non-union, and refracture.[7] Management depends on the fracture pattern, displacement, the patient's activity demands, and surgeon preference. Zone 1 avulsion fractures usually heal well with symptomatic treatment, such as a compression bandage, a hard-soled shoe, or a short period of cast immobilization.[5,8] Conservative treatment of Zone 2 and 3 fractures, in contrast, requires prolonged non-weight-bearing and carries a notable risk of delayed healing.[9] Intramedullary screw fixation has therefore become popular, especially for athletes and active individuals, as it allows earlier return to activity.[10] However, surgery brings its own concerns, including screw failure, refracture, hardware irritation, and nonunion requiring revision with bone grafting.[11,12] Displaced or comminuted fractures and

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fractures of the neck and shaft may be treated with K-wires, plating, tension band wiring, or other fixation methods. Evidence comparing these options remains limited and is mostly drawn from small series. [6,13] Outcome measurement has also varied between studies. Although radiological union is important, patients are more likely to be worried about pain, function, and resumption of activities. Use of validated instruments like the American Orthopaedic Foot and Ankle Society (AOFAS) scores enables objective comparisons between functional outcomes of different treatment groups.[14] The majority of published literature comes from Western populations, with patient profile, injury mechanism, footwear, workload, and care availability varying greatly from the Indian population. Tertiary care hospitals among the Telangana hospitals receive the maximum number of foot injuries due to road traffic accidents (RTAs), falls, and manual labour, and patients present late or after traditional bone-setting. There are limited local data on the performance of different treatment modalities, and treatment decisions are frequently based on extrapolating evidence. This study therefore compares the functional outcomes of fifth metatarsal fractures treated with different modalities in a tertiary care hospital in Telangana. By assessing functional scores, union, and complications across treatment groups, we aim to provide region-specific evidence to help orthopaedic surgeons select the most appropriate management for their patients.

Materials and Methods

This prospective comparative study was conducted in the Department of Orthopaedics & Govt Medical College and Hospital, Siddipet, Telangana, a tertiary care teaching hospital in Telangana. Institutional Ethical approval was obtained for the study. Written informed consent was obtained from all participants.

Inclusion criteria

1. All radiologically confirmed fractures of the fifth metatarsal during the study period.
2. Aged 18 years and above
3. Males and Females.
4. Willing to participate in the study by signing informed consent
5. Available for follow-up visits

Exclusion criteria

1. Open fractures,
2. pathological fractures,
3. neuropathic feet,
4. peripheral vascular insufficiency,
5. local infection,
6. Polytrauma or associated ipsilateral lower limb injuries,

Participants' fractures were classified into Zone 1 (tuberosity avulsion), Zone 2 (metaphyseal–diaphyseal junction), and Zone 3 (proximal diaphyseal stress fracture) according to Lawrence and Botte.[5]

Clinical and radiological evaluation: Detailed history and clinical examination, both local and systemic, were performed at presentation. Radiographic evaluation was guided by the Ottawa Foot Rules, which recommend imaging in midfoot pain when there is bony tenderness at the base of the fifth metatarsal or the navicular, or inability to bear weight for four steps.[15] Weight-bearing anteroposterior, lateral, and 30° or 45° oblique foot radiographs were obtained. Because avulsion fractures at the tuberosity tip are frequently missed on standard foot views.[6] an anteroposterior ankle view including the base of the fifth metatarsal was added when required. Magnetic resonance imaging or computed tomography was used in equivocal cases, for suspected stress fractures, and for delayed union or nonunion. Baseline and pre-operative investigations were performed as required.

Treatment groups: Patients were allocated to one of the following groups according to fracture type, displacement, associated injuries, patient activity level, and patient preference.

Group A: below-knee plaster of Paris cast. Under fluoroscopic guidance, reduction was achieved by traction and counter-traction where required. Soft cotton padding was applied from the metatarsal heads to just below the tibial tuberosity, followed by 6-inch plaster of Paris rolls. Non-weight-bearing was maintained for 6 weeks, with total immobilization in the below-knee plaster of Paris cast for 6 weeks, followed by gradual weight-bearing as tolerated based on clinical and radiological evidence of fracture healing.

Group B: controlled ankle motion (CAM) boot. A removable CAM boot was prescribed, with weight-bearing restricted for the initial 2 weeks, followed by gradual progression to partial and then full weight-bearing as tolerated, with CAM boot immobilization continued for 6 weeks, depending on clinical and radiological evidence of fracture healing, with active ankle and subtalar mobilisation permitted out of the boot.

Group C: operative fixation (closed or open reduction with internal fixation). Surgery was considered for avulsion fractures displaced more than 3 mm or comminuted, fragments involving more than 30% of the cuboid–metatarsal articulation, displaced Zone 2 fractures, acute Zone 2 fractures in active individuals, delayed union, Zone 3 stress fractures, and shaft fractures with displacement exceeding 3–4 mm or plantar angulation exceeding 10° after failed closed reduction. [3–6] Surgery was performed under spinal anaesthesia with the patient supine. Where possible, percutaneous fixation was used. Open cases used a lateral approach, with an incision starting just proximal to the base of the fifth metatarsal and extending distally at the junction of dorsal and plantar skin, with identification and protection of the sural nerve branches. Fixation was by an intramedullary or bicortical lag screw (3.5 or 4.5 mm, chosen according to canal size), with additional screws for long oblique or spiral patterns. Screw position and length were confirmed fluoroscopically. Wounds were closed in layers.

Post-operative care. A padded compressive dressing was applied, with rest, ice, and elevation. Weight-bearing was restricted for six weeks until radiographic healing, after which weight-bearing was allowed as tolerated. Radiographs at six weeks confirmed union, and the orthosis was then gradually discontinued.

Follow-up and outcome measures: Clinical follow-up was at 4, 8, and 12 weeks and 6 months, assessing pain, wound status or signs of infection, and functional status. Radiographic follow-up was at 8 weeks and 6 months, with additional imaging if clinically indicated. Union was defined as [bridging

callus/cortical continuity on at least three cortices] with absence of tenderness at the fracture site. Complications (intra-operative, early and late) were recorded, including infection, hardware prominence, sural nerve injury, malunion, delayed union, non-union and refracture.

The primary outcome was functional status at final follow-up, measured by the American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot Score (14): a 100-point scale comprising pain (40 points), function (45 points) and alignment (15 points). Function covers activity limitation and support (10), footwear (5), maximum walking distance (10), walking surfaces (10) and gait abnormality (10). Scores were graded as excellent (90–100), good (80–89), fair (70–79), or poor (<70).

Foot Function Index (FFI) (16): a self-administered 23-item questionnaire in three subscales: pain (9 items), disability (9 items), and activity limitation (5 items). Each item is scored from 0 to 10; subscale and total scores are expressed as percentages (0–100), and higher scores indicate poorer function.

Secondary outcomes were time to radiological union, time to return to work or previous activity, and complication rates.

Statistical analysis: All the available data were uploaded to Microsoft Excel and analysed using SPSS version 26 in Windows format. Continuous variables were presented as mean ± standard deviation or median (interquartile range) according to distribution, and categorical variables as frequencies and percentages. Groups were compared using one-way ANOVA for continuous variables and Fisher's exact test for categorical variables, with post-hoc comparison where appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of n=60 patients with fifth metatarsal fractures were enrolled, 15 in each fracture category (Zone 1, Zone 2, Zone 3, and shaft). Within each category, 5 patients were treated with below-knee cast immobilization, 5 with functional weight-bearing in a CAM boot, and 5 surgically, giving 20 patients per treatment group. All 60 patients completed follow-up. The demographic profile and injury characteristics are given in [Table 1]. The mean age was 35.4 years (range 19–62). The 31–40-year group was the largest (33.3%), followed by the 21–30-year group (28.3%), so 61.6% of patients were aged 21–40. There were 35 men (58.3%) and 25 women (41.7%), a male-to-female ratio of 1.4:1. Men outnumbered women in the 21–40-year groups (24 of 37), whereas women predominated above 50 years (5 of 7). The left foot was involved in 33 patients (55.0%) and the right in 27 (45.0%). Left-sided injuries were more frequent in Zone 3 (10 of 15) and shaft fractures (9 of 15), while Zone 1 and Zone 2 were almost evenly split.

Table 1: Demographic and injury characteristics of the study population (N = 60)

Characteristic	Zone 1	Zone 2	Zone 3	Shaft	Total, n (%)
Age group (years)					
≤20	1	0	1	2	4 (6.7)
21–30	5	7	2	3	17 (28.3)
31–40	4	4	6	6	20 (33.3)
41–50	3	3	4	2	12 (20.0)
≥51	2	1	2	2	7 (11.7)
Sex					
Male	9	8	10	8	35 (58.3)
Female	6	7	5	7	25 (41.7)
Side of injury					
Right	8	8	5	6	27 (45.0)
Left	7	7	10	9	33 (55.0)
Total	15	15	15	15	60 (100)

The foot function index scores are given in [Table 2]. FFI scores fell steadily in every group from 2 weeks to 6 months, which indicates progressive recovery (within-group $p < 0.001$ for all groups). At 2 weeks, the mean FFI was highest (worst) in the immobilization group (60.55 ± 8.56), followed by the weight-bearing group (48.50 ± 3.44) and the surgery group (39.95 ± 3.73). This ranking persisted at 6 weeks (41.95, 25.30 and 17.60) and at 6 months (22.45, 12.55 and 9.15). Overall, the mean FFI improved from 49.7 ± 10.2 at 2 weeks to 28.3 ± 11.8 at 6 weeks and 14.7 ± 6.7 at 6 months. The surgery group also showed the least variability, with a standard deviation below 1 point at 6 months. Between-group differences were significant at all three time points.

Table 2: Foot Function Index (FFI) scores by treatment group at follow-up

Treatment group	n	2 weeks	6 weeks	6 months	p (within group) *
Immobilization	20	60.55 ± 8.56	41.95 ± 9.79	22.45 ± 5.03	<0.001
Functional weight-bearing (CAM boot)	20	48.50 ± 3.44	25.30 ± 3.61	12.55 ± 3.64	<0.001
Surgery	20	39.95 ± 3.73	17.60 ± 1.31	9.15 ± 0.87	<0.001
Overall	60	49.7 ± 10.2	28.3 ± 11.8	14.7 ± 6.7	<0.001
p (between groups) †		[<0.001]	[<0.001]	[<0.001]	
*[Repeated-measures ANOVA]. † [Kruskal–Wallis test]					

AOFAS midfoot scores are presented in [Table 3]. AOFAS scores rose between 6 weeks and 6 months in all groups (p

< 0.001). The surgery group scored highest at both time points (78.65 ± 7.59 and 91.60 ± 2.21), followed by the weight-bearing group (72.85 ± 8.32 and 88.85 ± 3.58) and the immobilization group (61.65 ± 4.35 and 79.65 ± 6.26). At 6 months, the surgery group's mean score fell in the "excellent" range, the weight-bearing groups were close to it, and the immobilization groups were "fair". The overall mean improved from 71.05 ± 9.85 to 86.70 ± 6.70.

Table 3: AOFAS midfoot score by treatment group at follow-up

Treatment group	n	6 weeks	6 months	p (within group)
Immobilization	20	61.65 ± 4.35	79.65 ± 6.26	<0.001
Functional weight-bearing (CAM boot)	20	72.85 ± 8.32	88.85 ± 3.58	<0.001
Surgery	20	78.65 ± 7.59	91.60 ± 2.21	<0.001
Overall	60	71.05 ± 9.85	86.70 ± 6.70	<0.001
p (between groups)		[<0.001]	[<0.001]	

Values are mean ± SD. Higher scores indicate better function (maximum 100).

Categorical functional outcome is presented in [Table 4]. Using the AOFAS grading at 6 months, 32 patients (53.3%) had an excellent outcome, 18 (30.0%) good, and 10 (16.7%) fair. No patient had a poor outcome. In the surgery group, 19 of 20 patients (95.0%) had an excellent result and one (5.0%) a good result. In the weight-bearing group, 13 (65.0%) were excellent, and 7 (35.0%) were good. In the immobilization group, none were excellent, 10 (50.0%) were good, and 10 (50.0%) were fair. The distribution of outcome grades differed significantly between treatment groups ($\chi^2 = 44.69$, df = 4, $p < 0.001$).

Table 4: Functional outcome grade (AOFAS) at 6 months by treatment group

Treatment group	Excellent (90–100)	Good (80–89)	Fair (70–79)	Poor (<70)	Total
Immobilization	0 (0.0)	10 (50.0)	10 (50.0)	0 (0.0)	20
Functional weight-bearing (CAM boot)	13 (65.0)	7 (35.0)	0 (0.0)	0 (0.0)	20
Surgery	19 (95.0)	1 (5.0)	0 (0.0)	0 (0.0)	20
Total	32 (53.3)	18 (30.0)	10 (16.7)	0 (0.0)	60

Values are n (%), with percentages calculated within each treatment group. $\chi^2 = 44.69$, df = 4, $p < 0.001$.

Outcomes by fracture type are presented in [Table 5]. Within each fracture category, with 5 patients per treatment arm, results were descriptive only. In every category, FFI fell, and AOFAS rose over time irrespective of treatment. The worst early scores occurred with immobilization, for example, an FFI of 71.8 in Zone 2 at 2 weeks and an AOFAS of 59.0 in Zone 3 at 6 weeks. The best scores occurred with surgery, with an FFI of 8.8 in Zone 3 and shaft fractures and an AOFAS of 92.4 in shaft fractures at 6 months. At 6 months, the difference between weight-bearing and surgery was small in Zone 1 (AOFAS 90.6 vs 90.8), Zone 2 (90.8 vs 91.8), and shaft fractures (90.6 vs 92.4). It was larger in Zone 3 (83.4 vs 91.4). Immobilised Zone 2 and Zone 3 fractures recovered the least, with 6-month AOFAS scores of 74.4 and 73.8 and FFI scores of 23.6 and 29.2.

Table 5: Mean FFI and AOFAS scores by fracture type and treatment

Fracture type	Treatment	FFI 2 weeks	FFI 6 weeks	FFI 6 months	AOFAS 6 weeks	AOFAS 6 months
Zone 1	Immobilization	60.4	39.4	18.8	60.8	83.4
	Weight-bearing	50.6	29.6	10.6	79.0	90.6
	Surgery	38.6	16.6	9.0	84.0	90.8
Zone 2	Immobilization	71.8	54.8	23.6	59.2	74.4
	Weight-bearing	49.2	22.8	11.0	81.4	90.8
	Surgery	45.4	18.2	10.0	87.2	91.8
Zone 3	Immobilization	60.8	44.2	29.2	59.0	73.8
	Weight-bearing	50.4	25.8	18.4	61.4	83.4
	Surgery	38.8	17.6	8.8	72.2	91.4
Shaft	Immobilization	49.2	29.4	18.2	67.6	87.0
	Weight-bearing	43.8	23.0	10.2	69.6	90.6
	Surgery	37.0	18.0	8.8	71.2	92.4

Values are means. FFI: lower is better. AOFAS: higher is better.

Complications included one patient with a Zone 1 fracture treated by immobilization (5.0% of that group; 1.7% overall) who developed non-union at 6 months.

Discussion

This comparative study of 60 fifth metatarsal fractures found that all three treatment modalities improved function over six months, but surgical fixation gave the best results. The mean AOFAS score at six months was 91.6 in the surgery group, 88.9 with functional weight-bearing in a CAM boot, and 79.7 with cast immobilization. FFI scores followed the same order at every time point. The functional gap was widest early in recovery, which fits the known advantage of stable fixation and early mobilization. [10,13] Our finding that 95% of surgical patients reached an excellent outcome is consistent with earlier work on acute Jones fractures. Mologne et al. reported faster union and earlier return to activity with early screw fixation than with casting, along with a higher rate of nonunion in the cast group.[10] Porter et al. similarly reported good clinical healing and return to sport after

intramedullary screw fixation in athletes.[17] Poorer results with immobilization in Zone 2 and Zone 3 fractures are biologically plausible. The proximal diaphysis has a limited intraosseous blood supply, which predisposes it to delayed healing.[7] and nonoperative treatment of these fractures has long been associated with prolonged disability and nonunion. [9,18] The one nonunion in our series occurred after immobilization, although it was in a Zone 1 fracture, which usually heals well, and a single event does not allow conclusions. Functional weight-bearing performed better than cast immobilization in every fracture category and came close to surgery in Zone 1, Zone 2, and shaft fractures. For Zone 1 avulsion fractures, earlier studies found that a soft dressing or protected weight-bearing gave recovery equal to or faster than casting. [8,19] Removable boots may also allow earlier mobilization and ankle exercises, which may explain our results, although we did not measure this directly. The difference between weight-bearing and surgery was largest in Zone 3 (AOFAS 83.4 versus 91.4), where stress-type fractures are known to heal slowly without fixation.[6] Surgery is therefore best reserved for Zone 2 and 3 fractures, especially in active patients, while Zone 1 and many shaft fractures can reasonably be treated without it.[9,5] Surgery carries risks that our short follow-up may have missed. Reported complications include screw failure, refracture, hardware irritation, sural nerve injury, and non-union requiring revision. [11,12] We recorded no surgical complications, but six months is too short to detect late refracture or hardware problems.

The limitations of the current study were due to a modest sample size of 20 patients per group and only five per treatment within each fracture type. Therefore, the study was not powered for comparisons, the allocations were not randomized, and selection bias could have occurred. The follow-up time was six months, and the AOFAS midfoot score combines clinician-rated and patient-reported items, so it may be less sensitive than patient-reported measures alone. The radiological union and time to return to normal work were not analyzed separately.

Conclusion

This study, within its limitations, has found all three treatment modalities improved function over six months in fifth metatarsal fractures, but outcomes differed. Surgical fixation gave the best Foot Function Index and AOFAS scores, with 95% excellent results. Functional weight-bearing in a CAM boot produced good results, approaching surgery in Zone 1, Zone 2, and shaft fractures without operative risks. Cast immobilization gave the poorest recovery, particularly in Zone 2 and Zone 3 fractures. Surgery showed the clearest advantage in Zone 3 fractures. Larger randomized studies with longer follow-up are needed.

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Conflicts of interest

There are no conflicts of interest.

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