Pediatric Distal Third Tibial Shaft Fractures: A Comparison of Surgical Fixation Methods and Incidence of Concomitant Physeal Fractures

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BACKGROUND

Outcomes of surgically treated pediatric tibial shaft fractures have been evaluated, though a gap remains stratifying these injuries by location within the tibial shaft. The distal third of the tibia is prone to fracture deformity and the mismatch of the intramedullary canal at the meta-diaphyseal junction can make it difficult to obtain an appropriate reduction with elastic nailing. A comparison of elastic nailing and plating of these injuries has not been documented in the literature. Additionally, adult distal third tibial shaft fractures have a frequent association with ipsilateral ankle injuries, occurring in 4-39% of patients.[1-2] Such an association remains to be further studied in pediatric patients.

PURPOSE

- Compare treatment outcomes of operatively treated pediatric distal third tibial shaft fractures fixed with elastic nailing or open reduction and plating
- Evaluate the incidence of concurrent distal tibia physeal fractures

METHODS

- Retrospective review of skeletally immature patients undergoing surgical treatment of distal third tibial shaft fractures at Level 1 children's hospital from 2010-2020
- Exclusion criteria: history of genetic or metabolic condition affecting fracture healing, pathologic fracture, stress fracture, open fracture requiring soft tissue flap coverage, closed tibial physes
- Patient demographic and fracture characteristic data was collected
- Categorical data was evaluated using Fisher exact tests
- Continuous data was evaluated using 2-tailed t-test
- P-values for significand set at 0.05

Table 1. Demographic Data for Associated Distal Tibia Physeal Injuries

	Presence of Non-Contiguous Ipsilateral Physeal Fracture		
	Associated Physeal Fx n=14	No Physeal Fx n=29	P value
Age, years (range)	13.8 (12-15.4)	12.6 (8.9-15.1)	**0.023**
Sex			0.646
Male	13 (92.9%)	24 (82.8%)	
Female	1 (7.1%)	5 (17.2%)	
BMI, kg/m² (range)	22.6 (16.3-32.6)	21.6 (14.5-36.5)	0.567
Shaft Fx Pattern			
Transverse	0 (0%)	10 (34.5%)	**0.018**
Oblique	4 (28.6%)	7 (24.1%)	1.00
Spiral	10 (71.4%)	8 (27.6%)	**0.009**
Comminuted	0 (0%)	4 (13.8%)	0.286
Mechanism of Injury			
Crush Injury	0 (0%)	3 (10.3%)	0.539
Fall	6 (42.9%)	8 (27.6%)	0.488
Motorized Vehicle	1 (7.1%)	8 (27.6%)	0.231
Sports Related	7 (50%)	10 (34.5%)	0.507
Fixation of Tibial Shaft Fx			
Elastic Nails	9 (64.3%)	19 (65.5%)	1.00
ORIF w/ plate	1 (7.1%)	8 (27.6%)	0.231
Rigid IMN	2 (14.3%)	1 (3.4%)	0.243
ORIF w/ screws	1 (7.1%)	1 (3.4%)	0.550
Cast	1 (7.1%)	0 (0%)	0.326
Fixation of Physeal Fx			
Cast	4 (28.6%)	-	
ORIF w/ plate	1 (7.1%)	-	
ORIF w/ screws	9 (64.3%)	-	

BMI = body mass index; Fx = fracture; ° = degrees; mm = millimeter; % = percentage; ORIF = open reduction internal fixation; IMN = intramedullary nail; w/ = with; assoc. = associated

Table 2. Patient Outcomes by Tibial Shaft Fracture Fixation Method

	Method of Tibial Shaft Fracture Fixation		
	Elastic Nails n=28	ORIF w/ Plate n=9	P value
Time from Injury to Surgery, days	3.7 (0-19)	3.7 (0-12)	0.981
Length of Hospital Stay, days	1.2 (0-5)	1.8 (0-10)	0.400
Time of Cast/Splint Immobilization, days (range)	45.7 (11-76)	36.3 (16-69)	0.170
Total Time Immobilized, days	88.7 (74-104)	91.5 (53-114)	0.760
Time to WBAT, days (range)	66.9 (31-145)	79.1 (44-111)	0.272
Time to Fx Union, days (range)	107.3 (49-253)	112.1 (39-175)	0.798
Postop Fx Alignment			
Coronal, ° (range)	3.3 (1-9)	1.6 (0-4)	**0.026**
Sagittal, ° (range)	3.2 (0-9)	2.3 (0-5)	0.278
Translation, % (range)	14.7 (0-31)	0	**0.003**
Shortening, mm (range)	4.5 (0-23.7)	0	**0.040**
Final Fx Alignment			
Coronal, ° (range)	3 (1-7)	2.6 (1-8)	0.551
Sagittal, ° (range)	3 (0-9)	2.8 (0-6)	0.758
Malunion Rate	2/28 (7.1%)	1/9 (11.1%)	1.00
ROH Rate	16/28 (57.1%)	3/9 (33.3%)	0.269
Time to ROH, days (range)	264.6 (32.4-707.7)	422.5 (222-572.8)	0.178
Complications	3 (10.7%)	2 (22.2%)	0.577

ORIF = open reduction internal fixation; d=days; WBAT = weightbearing as tolerated; Fx = fracture; mm = millimeter; ° = degrees; ROH = removal of hardware; % = percentage

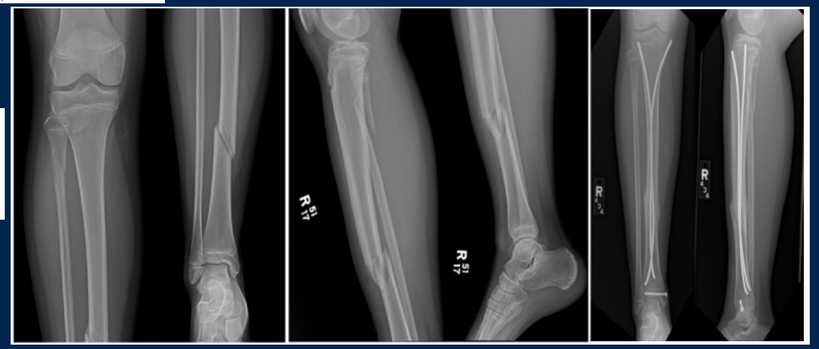

Figure 1: Injury AP and Lateral tibia radiographs showing an oblique distal tibial shaft fracture with associated Salter Harris III physeal fracture. AP and Lateral tibia radiographs 3 months postop from elastic nailing and screw fixation of the physeal fracture.

RESULTS

- 43 of 214 surgically treated tibial shaft fractures during the study period were distal third fractures
- Ipsilateral physeal fracture present in 14/43 patients (32.6%)
- Associated with spiral fracture pattern (10/14, 71.4%, p=0.009)
- Presence of physeal fracture did not affect outcomes
- Comparison of elastic nailing and open reduction and plating revealed no difference in time to union, time of immobilization, or time to weightbearing
- Elastic nailing associated with increased coronal angulation, translation, and shortening on initial postop imaging, though no differences in rates of malunion at final follow up

CONCLUSION

At final follow up, there were no statistically significant differences in treatment outcomes of distal third tibial shaft fractures based on fixation method. Our cohort of operatively treated distal third tibial shaft fractures had a high rate of associated non-contiguous distal tibia physeal fractures. We recommend careful evaluation of the ankle for concurrent physeal injuries in patients with distal third tibial shaft fractures requiring operative treatment.

REFERENCES

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