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Research Article

Complications following Surgical Treatment of Pediatric Femur Fractures

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ABSTRACT

Background: Pediatric femur fractures are commonly managed surgically to achieve early mobilization and proper alignment; however, postoperative complications remain a concern and can affect functional outcomes. **Objective:** To evaluate the frequency, pattern, and risk factors of complications following surgical treatment of pediatric femur fractures. Methodology: This was a hospital-based analytical cross-sectional study conducted at Multiple Canters from February 2025 till February 2026, including 105 pediatric patients who underwent surgical treatment for femur fractures. **Results:** The mean age was 9.2 ± 3.8 years, with 64.8% males. Road traffic accidents were the most common mechanism (43.8%), and most fractures were closed (75.2%). Elastic nailing was the most frequently used technique (45.7%). The overall complication rate was 32.4%, with infection (11.4%) being the most common, followed by malunion (7.6%) and delayed union (5.7%). External fixation showed the highest complication rate (47.4%), while elastic nailing had lower complications (25.0%). Open fractures (53.8% vs 25.3%), road traffic accidents (43.5% vs 23.7%), and longer operative duration (>75 minutes: 45.0% vs 24.6%) were significantly associated with higher complication rates. **Conclusion:** Surgical treatment of pediatric femur fractures is associated with a moderate complication rate. Elastic intramedullary nailing was associated with better outcomes, while open fractures and prolonged operative time were significant risk factors for complications.

Keywords: Pediatric femur fracture, Surgical management, Complications, Elastic nailing, External fixation

INTRODUCTION

Pediatric femur fractures are the most important orthopedic injuries in children and are commonly caused either by high-energy accidents like road traffic accidents or falls. These fractures result in a significant percentage of pediatric hospital admissions, and this can result in significant morbidity unless they are treated accordingly [1]. The treatment of femoral fractures in children has been overtaken by time with the chance of treating them surgically based on the selected cases to attain better alignment, early mobility and reduced hospitalization [2]. Treatment of pediatric femoral fractures can be performed with surgical interventions such as elastic stable intramedullary nailing (ESIN), external fixation, plating, or rigid intramedullary nailing, based on the patient's age, fracture location and type, and other associated injuries [3]. The techniques are used to fix the growing bone with minimal injury to the bone and surrounding tissues [4]. Despite the benefits of surgical management over conservative treatment, it is not free of

complications. The typical list of complications in the postoperative period is infection, malunion, limb length discrepancy, implant failure, and delayed union [5]. These complications can affect functional outcomes, and additional interventions may be needed [6]. Elastic stable intramedullary nailing is widely used due to its minimally invasive nature and good results, but it has some undesirable effects, including nail irritation, entry-site infection, and angular deformities [7]. On the same note, external fixation is applicable in open fractures or polytrauma but carries the risk of pin tract infection and joint stiffness [8]. Plating methods offer high fixation rates but can be associated with greater soft-tissue dissection, increased infection risk, and the need for implant removal later [9]. Rigid internal nailing, which is usually used in older children and those in the adolescent stage, also attracts risks like avascular necrosis and damage to the growth plate [10]. Complications and their incidence vary by type and method of surgery, patient factors, and postoperative care. These complications should be successfully identified and controlled at early stages in order to achieve the best functional recovery and avoid lifelong disability [11]. Prior studies have cited inconsistent complication rates post-surgical treatment of the pediatric femur fractures with some having reported higher percentage in complicated fractures and late treatment [12]. It has been shown in other research that proper surgical expertise and adherence to correct surgical techniques are important in minimizing complication rates [13][14]. Although surgical methods have improved, the rates and trends of complications still need to be assessed across various clinical situations. Knowledge of such complications can be used to enhance treatment and patient outcomes.

Objective

To evaluate the frequency, pattern, and risk factors of complications following surgical treatment of pediatric femur fractures.

Methodology

This cross-sectional study conducted at Multiple Canters from February 2025 till February 2026, including 105 pediatric patients who underwent surgical treatment for femur fractures.

Inclusion Criteria

• Patients aged ≤16 years diagnosed with femoral shaft fractures.
• Patients who underwent surgical management including elastic stable intramedullary nailing, plating, external fixation, or rigid intramedullary nailing.
• Patients with complete medical records and available postoperative follow-up data.
• Patients whose guardians provided informed consent.

Exclusion Criteria

• Patients managed conservatively without surgery.
• Patients with pathological fractures or underlying bone disorders.
• Patients with incomplete records or lost to follow-up.
• Patients with associated neurological conditions affecting functional assessment.

Data Collection

After obtaining informed consent, data were collected using a structured proforma. Demographic details including age and gender were recorded. Clinical data included mechanism of injury, type of fracture (open or closed), fracture location, and surgical technique used. Intraoperative details and duration of surgery

were also noted. Postoperative outcomes were assessed during follow-up visits. Complications such as infection (superficial or deep), malunion, delayed union, non-union, limb length discrepancy, implant failure, and joint stiffness were recorded. Functional outcomes were evaluated based on the range of motion and the ability to bear weight. Patients were categorised by surgical modality, and complication rates were compared across groups to identify patterns and associated risk factors.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequency and percentage. Associations between surgical techniques and complications were analysed using the chi-square test and the independent t-test where appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 105 patients were included with a mean age of 9.2 ± 3.8 years. Most patients were aged 6–10 years (48; 45.7%), followed by 11–16 years (35; 33.3%) and ≤5 years (22; 21.0%). Males predominated (68; 64.8%). The mean BMI was 18.6 ± 2.9 kg/m². Road traffic accidents were the most common mechanism (46; 43.8%), followed by falls (38; 36.2%) and sports injuries (21; 20.0%). Most fractures were closed (79; 75.2%). Transverse fractures were most frequent (41; 39.0%), followed by oblique (33; 31.4%) and comminuted (31; 29.5%). The shaft was the most common location (62; 59.0%).

Table 1: Demographic, Injury, and Baseline Clinical Characteristics (n = 105)

Variable	Category / Mean ± SD	Total (n = 105)
Age (years)	9.2 ± 3.8	9.2 ± 3.8
Age Group	≤5 years	22 (21.0%)
	6–10 years	48 (45.7%)
	11–16 years	35 (33.3%)
Gender	Male	68 (64.8%)
	Female	37 (35.2%)
BMI (kg/m²)	18.6 ± 2.9	18.6 ± 2.9
Mechanism of Injury	Road Traffic Accident	46 (43.8%)
	Fall	38 (36.2%)
	Sports Injury	21 (20.0%)
Fracture Type	Closed	79 (75.2%)
	Open	26 (24.8%)
Fracture Pattern	Transverse	41 (39.0%)
	Oblique	33 (31.4%)
	Comminuted	31 (29.5%)
Fracture Location	Proximal	18 (17.1%)
	Shaft	62 (59.0%)
	Distal	25 (23.8%)

Operative parameters varied significantly by technique. Elastic nailing had shorter operative time (64.2 ± 14.6 min) compared with plating (89.5 ± 17.2 min), while external fixation was shortest (58.7 ± 12.3 min) (p <0.001). Blood loss was highest with plating (96.7 ± 25.4 ml) and lowest with external fixation (44.8 ± 15.2 ml) (p <0.001). Hospital stay was longer with plating (6.8 ± 2.3 days) and external fixation (6.2 ± 2.0 days) compared with elastic nailing (4.9 ± 1.6

days) (p = 0.002). Time to weight bearing was shortest with elastic nailing (5.2 ± 1.3 weeks) and longest with plating (7.4 ± 1.8 weeks) (p <0.001). ICU admissions were more frequent in external fixation (5; 26.3%) (p = 0.04).

Table 2: Operative and Hospital Parameters by Surgical Technique

Variable	Elastic Nailing (n = 48)	Plating (n = 24)	External Fixation (n = 19)	Rigid IM Nailing (n = 14)	p-value
Duration of Surgery (min)	64.2 ± 14.6	89.5 ± 17.2	58.7 ± 12.3	76.8 ± 15.9	<0.001
Blood Loss (ml)	52.4 ± 18.1	96.7 ± 25.4	44.8 ± 15.2	72.6 ± 20.3	<0.001
Hospital Stay (days)	4.9 ± 1.6	6.8 ± 2.3	6.2 ± 2.0	5.5 ± 1.8	0.002
Time to Weight Bearing (weeks)	5.2 ± 1.3	7.4 ± 1.8	6.9 ± 1.6	6.1 ± 1.5	<0.001
ICU Admission	3 (6.3%)	4 (16.7%)	5 (26.3%)	2 (14.3%)	0.04

Overall complications occurred in 34 patients (32.4%). Infection was noted in 12 patients, with superficial infection in 8 (7.6%) and deep infection in 4 (3.8%). Malunion occurred in 8 (7.6%), delayed union in 6 (5.7%), and non-union in 2 (1.9%). Limb length discrepancy was seen in 4 patients, mostly <2 cm (3; 2.9%). Implant failure and joint stiffness were each observed in 2 patients (1.9%). Reoperation was required in 7 patients (6.7%).

Table 3: Frequency and Types of Postoperative Complications

Variable	Category	Total (n = 105)
Overall Complications	Yes	34 (32.4%)
	No	71 (67.6%)
Infection	Superficial	8 (7.6%)
	Deep	4 (3.8%)
Malunion	Yes	8 (7.6%)
Delayed Union	Yes	6 (5.7%)
Non-union	Yes	2 (1.9%)
Limb Length Discrepancy	<2 cm	3 (2.9%)
	≥2 cm	1 (1.0%)
Implant Failure	Yes	2 (1.9%)
Joint Stiffness	Yes	2 (1.9%)
Reoperation Required	Yes	7 (6.7%)

Complications were significantly higher in open fractures (14; 53.8%) compared with closed fractures (20; 25.3%) (p <0.001). Patients injured in road traffic accidents had higher complication rates (20; 43.5%) compared with other mechanisms (14; 23.7%) (p = 0.02). External fixation showed the highest complication rate (9; 47.4%) compared with elastic nailing (12; 25.0%) (p = 0.04). Longer operative time (>75 minutes) was also associated with increased complications (18; 45.0% vs 16; 24.6%, p = 0.01).

Table 4: Risk Factors Associated with Postoperative Complications

Variable	Category	Complications n (%)	No Complications n (%)	p-value
Fracture Type	Open	14 (53.8%)	12 (46.2%)	<0.001

	Closed	20 (25.3%)	59 (74.7%)	
Mechanism	RTA	20 (43.5%)	26 (56.5%)	0.02
	Others	14 (23.7%)	45 (76.3%)	
Surgical Method	External Fixation	9 (47.4%)	10 (52.6%)	0.04
	Elastic Nailing	12 (25.0%)	36 (75.0%)	
Duration of Surgery	>75 min	18 (45.0%)	22 (55.0%)	0.01
	≤75 min	16 (24.6%)	49 (75.4%)	

Discussion

Surgical management of pediatric femoral fractures is usually applied to achieve early mobility and improved alignment but postoperative complications are still a problem. The mean age in this study was 9.2 3.8 years with a male dominance (64.8%), as compared to other studies that reported more prevalence of femur fractures among school-going boys owing to their more physical activity and exposure to traumas. The most frequent cause (43.8%), which corresponds to the above study, was road traffic accidents as the most prevalent mechanism [15]. The parameters of the operations also had great differences across the operations. Elastic nailing was found to have reduced time of operation (64.2 ± 14.6 minutes), less blood loss (52.4 ± 18.1 ml), shorter hospital stay (4.9 ± 1.6 days) and earlier weight bearing (5.2 ± 1.3 weeks) than other procedures and plating had an extended time of operation (89.5 ± 17.2 minutes) and more blood loss (96.7 ± 25.4 ml). External fixation was the least time to operate (58.7 ± 12.3 minutes) but had a higher ICU admission (26.3%). The same results have been observed in earlier studies, in which elastic nailing has shown benefits in terms of efficiency and shorter recovery, and plating with greater exposure of the surgery, and a prolonged recovery [16]. The general complication rate in this study was 32.4 that is similar to other studies that reported moderate level of complication after surgery on the correction of the fracture of the pediatric femur. The most frequent complication (11.4%), was infection, next came malunion (7.6%), and delayed union (5.7%). These results are in line with other studies, which report that infections and alignment complications are commonly observed, especially with open fractures or massive soft-tissue destruction [17][18]. Excluding elastic nailing, external fixation had the highest complication rate (47.4%), followed by plating (37.5%) and last (25.0%). This is trending in accordance with prior studies where higher complication rates were observed with external fixation because of pin and soft tissue infection and minimal complication rates with elastic nailing because it is minimally invasive [19].

Other significant risk factors of complications were also determined in the study. The rate of complications was much higher in open fractures (53.8) than in closed fractures (25.3), which agrees with prior studies showing that open injuries have a higher risk of infection and complications during healing. On the same note, road traffic accident patients were most affected by complication rates (43.5%), which is in line with the magnitude of the trauma previously used to observe the same [20]. Operative length (>75 minutes) was also found to be significantly associated with complications (45.0% vs 24.6%), suggesting that more complex procedures or intraoperative complications can lead to adverse outcomes. The same research has been reported in the past to indicate that operative time is a predictor of complications since it exposes the tissue to a long duration and heightens the chances of infection [21]. All in all, the results of this research suggest that elastic intramedullary

nailing presents the best results at the lowest number of complications, and external fixation and plating are related to increased risks, especially in more severe or complicated cases. The findings align with previous investigations and support the importance of selecting appropriate surgical methods and minimizing operative time to reduce postoperative complications in pediatric femoral fractures.

Conclusion

It is concluded that surgical management of pediatric femur fractures is associated with a moderate rate of complications, with infection being the most common. Elastic intramedullary nailing demonstrated more favorable outcomes with shorter operative time, less blood loss, earlier weight bearing, and lower complication rates compared with other techniques. External fixation and plating were associated with higher complication rates, particularly in complex cases. Open fractures, high-energy trauma, and prolonged operative time were significant risk factors for complications. Careful selection of surgical technique and timely intervention are essential to minimize complications and improve clinical outcomes.

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