



Profiles of Children with Lower Extremity Fracture at Saiful Anwar Malang Regional General Hospital from January 2016 to August 2020

Panji Sananta*^{id}, Rizky Julana^{id}, Muhammad Alwy Sugiarto^{id}

Department of Orthopaedic and Traumatology, Faculty of Medicine, Universitas Brawijaya, Saiful Anwar General Hospital, Malang, Indonesia

Abstract

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***Correspondence:** Panji Sananta, Department of Orthopaedic and Traumatology, Saiful Anwar General Hospital, Malang, Indonesia.

E-mail: panjisananta@ub.ac.id

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BACKGROUND: Musculoskeletal injuries in children are a common cause of 25% of children's hospitalization. The previous research stated that five pediatric fractures had significant long-term consequences such as disability and activity restriction. In Indonesia, epidemiology studies have discussed the incidence of fracture in general sites, but only a few reported lower limb fractures.

AIM: The authors expect this research to be used for lower extremities fractures in children's epidemiologic descriptions.

METHODS: Between January 2016 and September 2020, we included 247 children under 18 years old based on inclusion criteria. The prevalence and fractures were reviewed for detail, such as sex, age, mechanism of injury, location of the fracture, and treatment. Data were analyzed using SPSS version 26.

RESULTS: The most common injuries occur at 13–18 years old with 164 children (66.4%). Most of them were caused by traffic accidents, 210 cases (85.0%). Consequently, femur fractures are the most common fractures due to traffic accidents 53.8% ($p < 0.005$). From common fracture sites in this study, plating is the common to use procedure than the others (52.3%).

CONCLUSION: Therefore, we can conclude that MVA was the most common injury in children, and especially for fracture femur relevant with increasing age, and plating methods are common to use method for this fracture.

Introduction

Musculoskeletal injuries in children are common, causing 25% of children's hospitalization. One of the prevalent injuries is a traumatic fracture [1]. It serves as the main source of morbidity, disability, socioeconomic burden, and mortality. Approximately 10 million children are treated for injuries every year, and more than 9000 children die in the United States due to trauma [2]. Childhood injuries are common. The previous research stated that approximately 25% of children had a trauma injury annually, and five pediatric fractures had significant long-term consequences such as activity restriction [3]. Landin was a leader in a pediatric population based on fracture epidemiology. He reported age- and sex-related fracture patterns in 8682 cases from Malmö, Sweden, during 30 years. The most common fracture found was distal forearm fracture [4], [5].

On the other hand, the previous research conducted by Chaibi *et al.* and Liu *et al.* focused on the epidemiology of lower extremity fractures in children. From their studies, the most common fracture site was tibial [6], [7]. About 20% of all fractures that happened in children were in lower extremities [6]. In Indonesia, there

have been epidemiology studies that discussed the incidence of fracture in general sites, but there are not many that reported lower limb fractures [8], [9]. Because of scarce studies, the authors decided to perform this study to further learn about gender, age, mechanism of injury, and treatment characteristics of pediatric patients with lower extremity fractures at a tertiary hospital. Children and adults had significantly different fractures features. Therefore, their management was different [1].

With these results, the authors expect this research to be used for lower extremities fractures in children's epidemiologic descriptions, especially in a developing country like Indonesia. It can also be used as a reference to improve management (planning, implementation, monitoring, and assessment) and health services in the lower extremity fracture.

Methods

The Ethical Committee of the Medical Research Faculty of Universitas Brawijaya had approved all

protocols. All subsequent experiments were carried out according to the relevant guidelines and regulations.

We performed a retrospective cross-sectional study based on all pediatric trauma injuries registered to the RSUD Dr. Syaiful Anwar, a tertiary referral hospital in Indonesia, emergency room.

Study population

Between January 2016 and September 2020, we included 774 children (0–18 years old) admitted to our hospitals with traumatic fractures at any location and caused by any mechanism of injury.

Inclusion criteria were children under 18 years old with lower limb fractures due to all kinds of trauma mechanisms, such as falling from 1 m or less altitude, traffic accidents, being penetrated by sharp objects, and others from January 2016 to September 2020. Exclusion criteria were fractures at other locations besides the lower limb, such as an upper limb, spine, pelvis, and any laceration/soft-tissue injuries. Children who presented with any specific pathologic process that affects bone and mineral metabolism and refused an orthopedic screening were also excluded from the study. The epidemiology data were obtained from the hospital medical records. We established a definitive diagnosis of the lower limb traumatic fracture using X-rays and computed tomography scans in all fracture causes.

Age, gender, mechanism of injury, type of fracture, and treatment data were recorded. We use the AO classification system to classify femoral and leg fractures [6]. Fractures treatment included splint/bracing, closed reduction with a cast, CRPP, ORIF, plating, and others.

Statistical analysis

All statistical analyses were performed using SPSS version 26.0. We used Pearson Chi-square tests to assess the frequency differences and independent samples t-tests to assess continuous variables differences.

Results

From 774 pediatric patients who presented with traumatic injury, we excluded 527 patients who did not meet the inclusion criteria. Therefore, we analyzed 247 children in this study. There were 169 (68.4%) boys and 78 (31.6%) girls with a lower limb fracture. The mean age was 13 years and 9 months (ranging from 1 month to 18 years). The patients' age distribution from Figure 1 in order was age <3 years 2%, age 3–6 years 12.6%, age 7–12 years 19%, and 13–18 years old accounted 66.4% which is incidence peaked in both male and female patients.

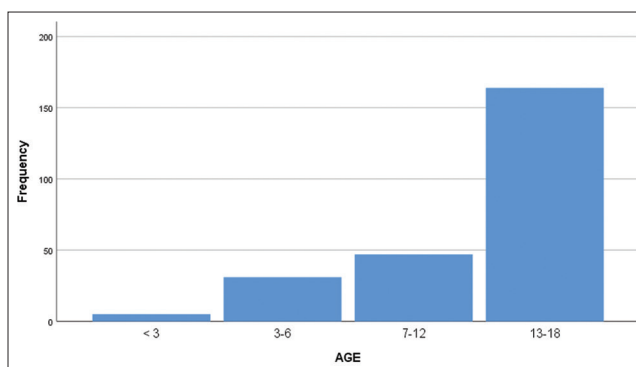


Figure 1: Age study population

According to Table 1, the most common etiology was traffic accidents (motor vehicle accidents), 210 patients (85%), followed by falling from a height of more than 1 m, 15 patients (6.1%), struck by a sharp object, falling from a height <1 m, and other causes, 6 patients (2.4%) each. The least cause was sport-related injury, accounted for 4 patients (1.6%).

Table 1: Overview of epidemiology studies of fractures in children

| First author | Age group | Study period | Most common fracture | Location |
|--------------|-----------|--------------|----------------------|-------------|
| Landin | 0–16 | 1950–1979 | Distal forearm (23%) | Sweden |
| Liu | 0–18 | 2001–2010 | Tibia (40.2%) | China |
| Chaibi | 0–16 | 2017–2018 | Tibia (38%) | Switzerland |
| Wijaya | 12–18 | 2016–2017 | Radius-ulna (12.7%) | Indonesia |
| Sananta | 0–18 | 2016–2020 | Radius-ulna (21.2%) | Indonesia |

Researchers looked for the relationship between the mechanism of injury with age and fracture location. The results showed $p = 0.006$ and 0.040 , respectively. Both $p < 0.05$ indicated a statistically significant relationship between the mechanism of injury with age and fracture location.

Table 2 shows that the most age group with fractures due to fell from a height <1 m was ages 3–6 years old, with 3 children (50%), followed by ages 7–12 years old, 2 children (33.3%), and ages 13–18 years old, 1 child (16.7%). For fractures due to fell from a height of more than 1 m, 9 children (60%) aged 13–18 years old, 3 children (20%) aged 3–6 years old, and another 3 children (20%) aged 7–12 years old.

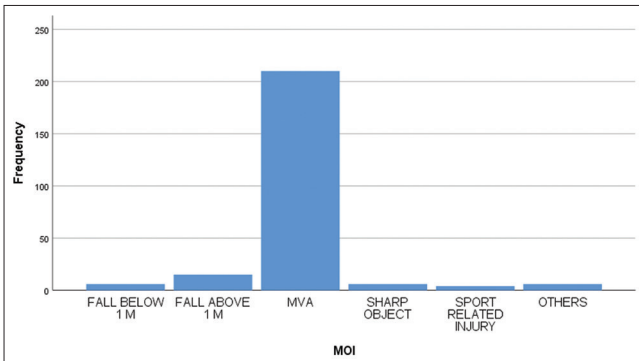
Motor vehicle accidents were held responsible for 85% of all fractures in children (Figure 2). These events were dominant in the 13–18 years old group, reported as many as 145 children (69%). This number was followed by the 7–12-year-old group, 41 children (19.5%) and the under 7-year-old group, 20 children (9.5%). Furthermore, being struck by a sharp object mostly occurred in children aged 3–6 years old (50%) followed by the age of 13–18 years old (33.3%). All sport-related injuries happened only in children ages 13–18 years old. Other fracture causes accounted for 3 children (50%) aged 13–18 years old.

Meanwhile, falls from a height of 1 m causes three children (50 %) suffering femur fractures, two children (33.3 %) suffering tibia/fibula fractures, and one child (16.7 %) suffering a foot/ankle fracture. Then, in cases of falling from a height of more than 1 m, femur fractures occurred in 8 children (53%), tibia/fibula

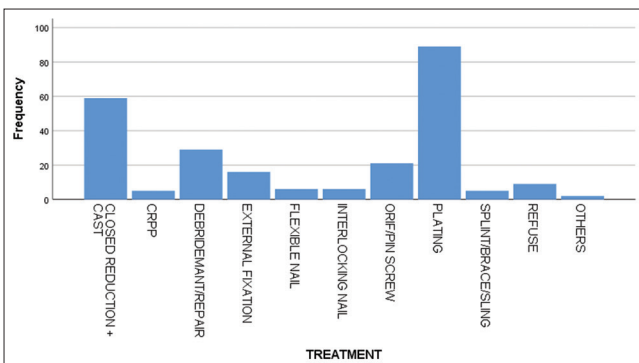
Table 2: Etiology of patients with traumatic lower limb fractures

| Etiology | Fall<1 m | Fall>1 m | MVA | Struck by a sharp object | Sport-related injury | Others | Total | Sig |
|----------------|-----------|-------------|---------------|--------------------------|----------------------|-----------|---------------|-------|
| Total | 6 (2.4) | 15 (6.1) | 210 (85.0) | 6 (2.4) | 4 (1.6) | 6 (2.4) | 247 (100) | |
| Male/female | 3/3 (1.0) | 11/4 (2.75) | 144/66 (2.18) | 4/2 (2.0) | 3/1 (3.0) | 4/2 (2.0) | 169/78 (2.17) | 0.944 |
| Age | | | | | | | | |
| <3 | 0 (0) | 0 (0) | 4 (1.9) | 0 (0) | 0 (0) | 1 (16.7) | 5 (2.0) | 0.006 |
| 3–6 | 3 (50.0) | 3 (20.0) | 20 (9.5) | 3 (50.0) | 0 (0) | 2 (33.3) | 31 (12.6) | |
| 7–12 | 2 (33.3) | 3 (20.0) | 41 (19.5) | 1 (16.7) | 0 (0) | 0 (0) | 47 (19.0) | |
| 13–18 | 1 (16.7) | 9 (60.0) | 145 (69.0) | 2 (33.3) | 4 (100) | 3 (50.0) | 164 (66.4) | |
| Total | 6 (100) | 15 (100) | 210 (100) | 6 (100) | 4 (100) | 6 (100) | 247 (100) | |
| Fracture sites | | | | | | | | |
| Femur | 3 (50.0) | 8 (53.3) | 113 (53.8) | 1 (16.7) | 1 (25.0) | 4 (66.7) | 130 (52.6) | 0.040 |
| Tibia/fibula | 2 (33.3) | 4 (26.7) | 60 (28.6) | 0 (0) | 1 (25.0) | 1 (16.7) | 68 (27.5) | |
| Foot/ankle | 1 (16.7) | 3 (20.0) | 37 (17.6) | 5 (83.3) | 2 (50.0) | 1 (16.7) | 49 (19.8) | |
| Total | 6 (100) | 15 (100) | 210 (100) | 6 (100) | 4 (100) | 6 (100) | 247 (100) | |

MVA: Motor vehicle accident

**Figure 2: Mechanism of injury for lower extremity fracture**

fractures in 4 children (26.7%), and foot/ankle fractures in 3 children (17.6%). Motor vehicle accident (MVA), which occurred in 210 children, resulted in 113 (53.8%) femur fractures, 60 (28.6%) tibia/fibula fractures, and 37 (17.6%) foot/ankle fractures.

**Figure 3: Treatment for fracture in lower limb. Almost 68% of all patients underwent plating surgery**

In addition, based on Table 3, the most common fractures in children under the age of 18 were femur accounted for 130 children (52.6%). In the second place, tibia/fibula fractures accounted for 68 children

Table 3: Characteristics of traumatic fracture according to age groups

| Age range | <3 | 3–6 | 7–12 | 13–18 | Total | Sig |
|---------------|------------|--------------|--------------|---------------|---------------|-------|
| Total | 5 (2.0) | 31 (12.6) | 47 (19.0) | 164 (66.4) | 247 (100) | |
| Male/female | 2/3 (0.67) | 19/12 (1.58) | 31/16 (1.93) | 117/47 (2.49) | 169/78 (2.16) | 0.337 |
| Fracture site | | | | | | |
| Femur | 3 (60.0) | 22 (71.0) | 32 (52.5) | 73 (48.7) | 130 (52.6) | 0.479 |
| Tibia/fibula | 0 (0) | 6 (19.4) | 20 (32.8) | 42 (28.0) | 68 (27.5) | |
| Foot/ankle | 2 (40.0) | 3 (9.7) | 9 (14.8) | 35 (23.3) | 49 (19.8) | |
| Total | 5 (2.0) | 31 (12.6) | 47 (19.0) | 164 (66.4) | 247 (100) | |

(27.5%), and finally, foot/ankle fractures accounted for 49 children (19.8%). From these data, we described those children under 3 years old mostly had a femur fracture, 3 children (60%), followed by a foot/ankle fracture, 2 children. Femur fractures were also known as the most common injury sites in children aged 3–6 years old (22 children – 71%) followed by tibia/fibula fractures (19.4%) and foot/ankle fractures in 3 children (9.7%). In the aged of 7–12 years old, femur fractures accounted as the most prevalent injuries in 32 children (52.5%) followed by tibia/fibula fractures in 20 children (32.8%) and ankle/foot fractures in 9 children (14.8%). Finally, in children aged 12–18 years, femur fractures occurred in 130 children (52.6%), tibia/fibula fracture in 42 children (27.5%), and foot-ankle fracture in 35 children (19.8%).

Table 4: Choice of treatment based on the injury location

| Fracture side | Femur | Tibia/fibula | Ankle | Total | Sig. |
|-----------------------|-------------|--------------|-------------|--------------|-------|
| Total | 130 | 68 | 49 | 247 | 0.479 |
| Male/female | 91/39 (2.3) | 48/20 (2.4) | 30/19 (1.5) | 169/78 (2.2) | |
| Treatment | | | | | |
| Closed reduction | 26 (20.0) | 28 (42.2) | 5 (10.2) | 59 (23.9) | 0.000 |
| CRPP | 1 (0.8) | 2 (2.9) | 2 (4.1) | 5 (2.0) | |
| Debridement/repair | 5 (3.8) | 4 (5.9) | 20 (40.8) | 29 (11.7) | |
| External fixation | 8 (6.2) | 8 (11.8) | 0 (0.0) | 16 (6.5) | |
| Flexible nail | 6 (4.6) | 0 (0.0) | 0 (0.0) | 6 (2.4) | |
| Interlocking nail | 4 (3.1) | 2 (2.9) | 0 (0.0) | 6 (2.4) | |
| ORIF/pin screw | 6 (4.6) | 1 (1.5) | 14 (28.6) | 21 (8.5) | |
| Plating | 68 (52.3) | 18 (26.5) | 3 (6.1) | 89 (36.0) | |
| Splinting/brace/sling | 0 (0.0) | 0 (0.0) | 5 (10.2) | 5 (2.0) | |
| Refuse | 5 (3.8) | 4 (5.9) | 0 (0.0) | 9 (3.6) | |
| Others | 1 (0.8) | 1 (1.5) | 0 (0.0) | 2 (0.8) | |
| Total | 130 (100) | 68 (100) | 49 (100) | 247 (100) | |

In femoral fractures (Table 4), the plating was generally used in 68 cases (52.3%), closed reduction in 26 cases (20%), external fixation in 8 cases (6.2%), and flexible nailing in 6 cases (4.6%). Then, in tibia/fibula fractures, closed reduction was performed in 28 cases (42.2%), which was the common treatment choice. Plating and external fixation were used in 18 cases (26.5%) and 8 (6.2%), respectively. At last, for ankle fractures, the most frequent therapy was debridement/repair in 20 cases (40.8%), ORIF/pin screw in 14 cases (28.6%), and closed reduction and splinting/bracing/sling in 5 cases (10.2%) each (Figure 3).

Table 5 presents that in the group of children under 3 years old, treatment which performed mostly was closed reduction 3 cases (60%) and debridement/repair 2 cases (40%). Then, in children aged 3–6 years old, closed reduction was done in 20 cases (64.5%), the most widely used method followed by plating in five cases (16.1%). In children aged 7–12 years old, the most widely used therapy was a closed reduction,

Table 5: Choice of treatment based on age groups

| Age range | <3 | 3–6 | 7–12 | 13–18 | Total | Sig. |
|-----------------------|------------|--------------|--------------|---------------|---------------|-------|
| Total | 5 (2.0) | 31 (12.6) | 47 (19.0) | 164 (66.4) | 247 (100) | 0.337 |
| Male/female | 2/3 (0.67) | 19/12 (1.58) | 31/16 (1.93) | 117/47 (2.49) | 169/78 (2.16) | |
| Treatment | | | | | | 0.000 |
| Closed reduction | 3 (60.0) | 20 (64.5) | 18 (38.3) | 18 (11.0) | 59 (23.9) | |
| CRPP | 0 (0.0) | 2 (6.5) | 2 (4.3) | 1 (0.6) | 5 (2.0) | |
| Debridement/repair | 2 (40.0) | 2 (6.5) | 6 (12.8) | 19 (11.6) | 29 (11.7) | |
| External fixation | 0 (0.0) | 0 (0.0) | 3 (6.4) | 13 (7.9) | 16 (6.5) | |
| Flexible nail | 0 (0.0) | 1 (3.2) | 5 (10.6) | 0 (0.0) | 6 (2.4) | |
| Interlocking nail | 0 (0.0) | 0 (0.0) | 1 (2.1) | 5 (3.0) | 6 (2.4) | |
| ORIF/pin screw | 0 (0.0) | 1 (3.2) | 3 (6.4) | 17 (10.4) | 21 (8.5) | |
| Plating | 0 (0.0) | 5 (16.1) | 7 (14.9) | 77 (47.0) | 89 (36.0) | |
| Splinting/brace/sling | 0 (0.0) | 0 (0.0) | 1 (2.1) | 4 (2.4) | 5 (2.0) | |
| Refuse | 0 (0.0) | 0 (0.0) | 1 (2.1) | 8 (4.9) | 9 (3.6) | |
| Others | 0 (0.0) | 0 (0.0) | 0 (0.0) | 2 (1.2) | 2 (0.8) | |
| Total | 5 (100) | 31 (100) | 47 (100) | 164 (100) | 247 (100) | |

performed in 18 cases (28.3%), plating in 7 cases (14.9%), and debridement/repair in 6 cases (12.8%). For the 13–18-year-old group, ORIF/pin screw was the chosen therapeutic option in 77 cases (47%), debridement in 19 cases (11.6%), and closed reduction in 18 cases (11.0%).

Discussion

Several studies explained the incidence of fractures in children. Some of them also described the lower limb fractures incidence in children. However, epidemiology trends, overall patterns, and treatment options have not been studied in Indonesia. This study evaluated fractures due to trauma in 247 children under 18 years old from 2016 to 2020.

Based on gender, the previous studies showed that boys were more likely to sustain a fracture than girls [1], [5], in line with this study that resulted in twice incidence of fractures in boys than girls. Male predominance recorded in the most research related to more action and engagement in harmful physical activities than girls. These tendencies were observed in most countries, especially in Indonesia, China, and Swiss, usually in children aged 13–18 years old [10].

Motor vehicle accidents were the most common fracture causes, according to the previous researches. The most common causes were MVCs (47.0%) followed by low falls (26.0%) [7]. From this study, we found that 210 patients (85%) fractured due to traffic accidents (MVA), with the highest percentage in 13–18 years old, followed by falling from a height of more than 1 m in 15 patients (6.1%). The incidence of fractures caused by MVA increased with age. It had a significance value <0.05 , so it can be concluded that motor vehicle accidents had a relationship with children's fractures. From some previous study confirmed this result, which stated that fractures in children occurred predominantly due to traffic accidents. The high incidence of femur fractures was most likely due to high-energy trauma, resulting in MVA mechanism as the most common

type of injury [1]. Similarly, in a previous study, they discovered that the number of femur fractures increased with increasing age [3], [7], [10].

Choice of therapy is an important aspect of epidemiological research because it could describe the quality of health services and the optimal therapeutic option. In this study, the most common fractures were femoral fractures, which occurred in up to 130 cases and were mostly detected in children aged 13–18 years. The most common treatment methods for femoral fractures were plating in 68 children (52.3%) and closed reduction in 26 children (20%). Plating was the preferred method. It was supported by a study conducted by Sutphen *et al.* in 2016 that stated submuscular plating led to decreased union time, increased complete weight-bearing, and decreased risk of complications [11]. Then, the second most common lower limb fractures were tibia/fibula fractures. The treatment of choice for this fracture type was a closed reduction in 28 children (42.2%) and plating in 6 children (26.5%), considering closed reduction is the most common treatment in an uncomplicated tibial fracture. In general, closed reduction and cast immobilization were more effective than other treatments [12]. Surgical intervention was recommended for open, irreducible fractures that have failed a non-operative therapy, accompanied by compartment syndrome, or in the patient who had multiple injuries [13]. Finally, fractures that occurred in the ankle were the least type among the others. The chosen treatment was debridement/repair in 20 children (40.8%) and ORIF in 14 children (28.6%). Limb salvage and timely fracture union were possible in children with complex lower limb trauma. Early intervention with appropriate debridement, skeletal stabilization, and early soft-tissue coverage in children result satisfactory outcomes [14].

Conclusion

This study has shown that the incidence of lower limb fractures in children was similar as the age increased, with the most frequent cause was traffic accidents. It was held responsible for most

femur fractures. Abandoning the fracture leads to the risk of disability and disrupting the child's future. The therapeutic options selected from this study can be taken into consideration for therapy options.

The limitation of this study included fractures of more than 1 site, which was different from other studies that ensured only examined a single fracture, such as isolated femur fracture or tibia fracture, this would be a fruitful area for further work. Ethnic and gene factors were not explored in this study, it also can be used as a basis for further epidemiological research.

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