Review

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Growth plate injury in children: Review of literature on PubMed

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Abstract

Growth plate injury is a debilitating condition for children. To our knowledge, there is currently no systematic review regarding the complication of epiphyseal injury. Thus, the authors would like to conduct a systematic review regarding this topic. The following strategy was used: the terms used on the PubMed search engine were "growth plate injuries complications." Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to perform the comprehensive data collection. The initial PubMed search yielded 341 titles and 81 articles included according to the inclusion criteria, but 20 articles were eliminated according to the exclusion criteria. The final total number of articles was 61. The epiphyseal injury usually ends with a good functional outcome, although some serious complication risk remains.

Keywords

Complication, epiphyseal injury, growth plate, outcome

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Introduction

Growth plate injury is a debilitating condition for children. Physeal injuries are common among children and comprise 15%–30% of all bony injuries. Injuries involving the epiphyseal plate create unique diagnostic and therapeutic challenges. Consequently, the surgeon, who has the twin role of treating the child and advising the parents, must have a thorough understanding of the prognosis for a given epiphyseal plate injury in a particular child.[1] Therefore, Epidemiologic study is needed for critical step toward bettering treatment options and developing preventive measures to combat this debilitating condition.[2] Salter-Harris fractures are described exclusively in children and do not occur in the well-developed bones of adults. In general, upper extremity injuries are more common than lower-extremity injuries.[3]

Of the five most common Salter-Harris fracture types, type II is the most common (75%), followed by types III (10%), IV (10%), type I (5%), and lastly, type V, which is very rare. Males are more likely to be affected because they have an increased tendency to engage in high-risk activities. Girls are affected at a younger age (11–12 years) than boys (12–14 years).[4,5]

The epiphyseal injury usually resolves without complication. However, this entity may pose serious complications such as premature physeal closure, bone bridge formation, deformity, and limb-length discrepancy.[4,6]

To our knowledge, there is currently no systematic review regarding the complication of epiphyseal injury. Thus, the authors would like to conduct a systematic review regarding this topic.

Methods

The following strategy was used: the terms used on the PubMed search engine were "growth plate injuries complications." Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to perform the comprehensive data collection. A bibliometric evaluation was done on all the search results. After searching with those keywords, the authors conducted a review of abstracts to select the appropriate journals. Then, the authors extracted the necessary data from the selected journals to be further analyzed to retrieve

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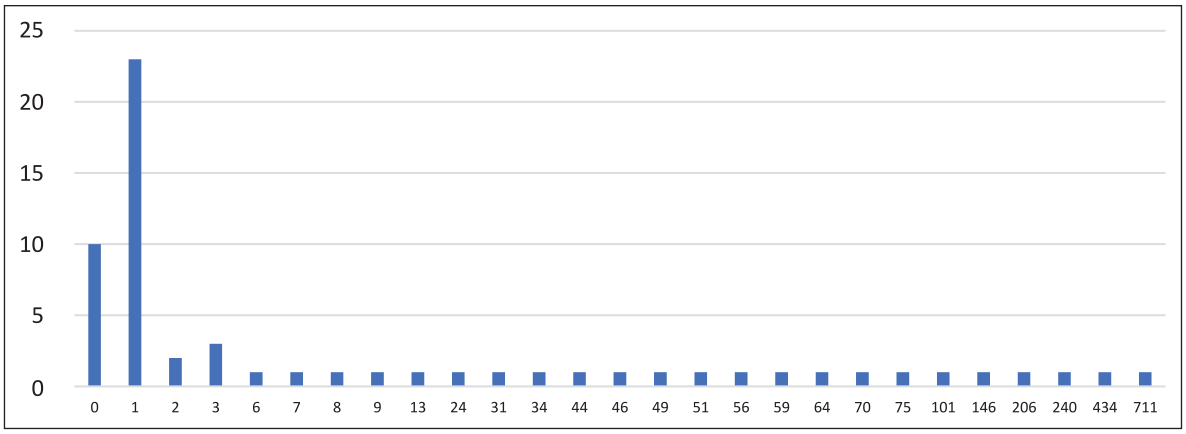

Figure 1. Number of size.

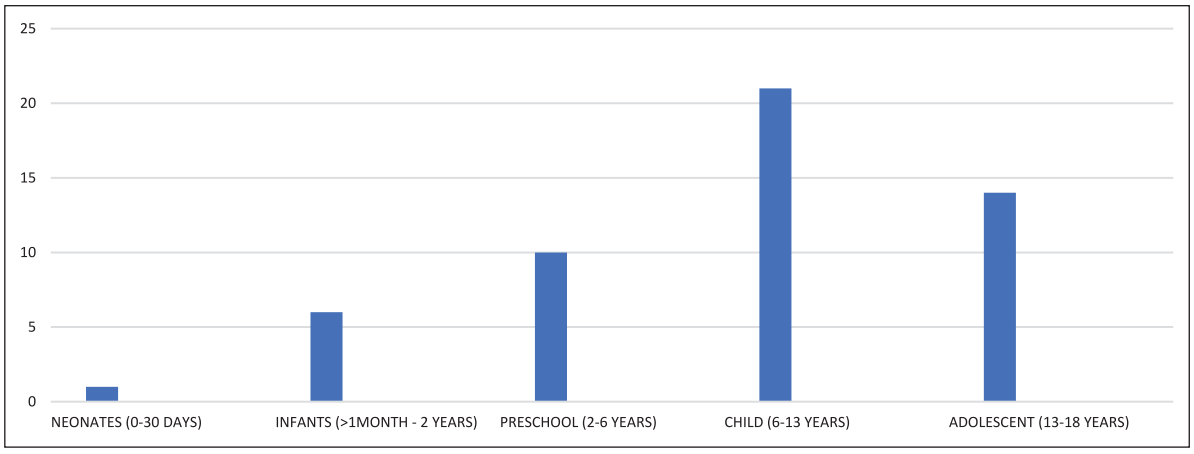

Figure 2. Age of patients.

good database and high quality of study, the search method refer to this article.[7]

This research includes these types of studies: case report, case series, cohort, and systematic review. The exclusion criteria were non-English journals, animal studies, journals regarding injury related to surgical procedures, and those regarding injury to body parts other than upper and lower extremities. Microsoft Excel was used to create a database, the demographic data from PubMed were loaded, analyzed, and visualized using this software.

Results

The initial PubMed search yielded 341 titles with 81 articles included according to the inclusion criteria, but 20 articles were eliminated according to the exclusion criteria. The final total number of articles was 61.

Number of patients

The number of patients included in all 61 articles were 2520 patients. The largest study included 711 patients. There are 10 articles which did not analyze any patients because they are secondary articles (review article, systematic review, or meta-analysis). There are 23 case reports which described 1 case per article, and there are numerous other case series with more than 1 patient described. Figure 1 depicts the number of articles with their corresponding sample size.

Age of the patients

From the 61 articles, the age of the patients was highly variable. We made a group of age from neonates (0–30 days), infants (>1 month–2 years), preschool (2–6 years), child (6–13 years), adolescents (13–18 years). There is one journal from journal was study about growth plate injury in neonates. Other than that, there was six study analyzing growth plate injury in infants. In all other studies, the oldest age of included samples was 17 years old. Figure 2 depicts the age of the patients in all studies included.

Injury site

The most common injury site mentioned were the distal femur was mentioned in 10 articles. Meanwhile, proximal tibia and distal tibia-fibula growth plate, each site was

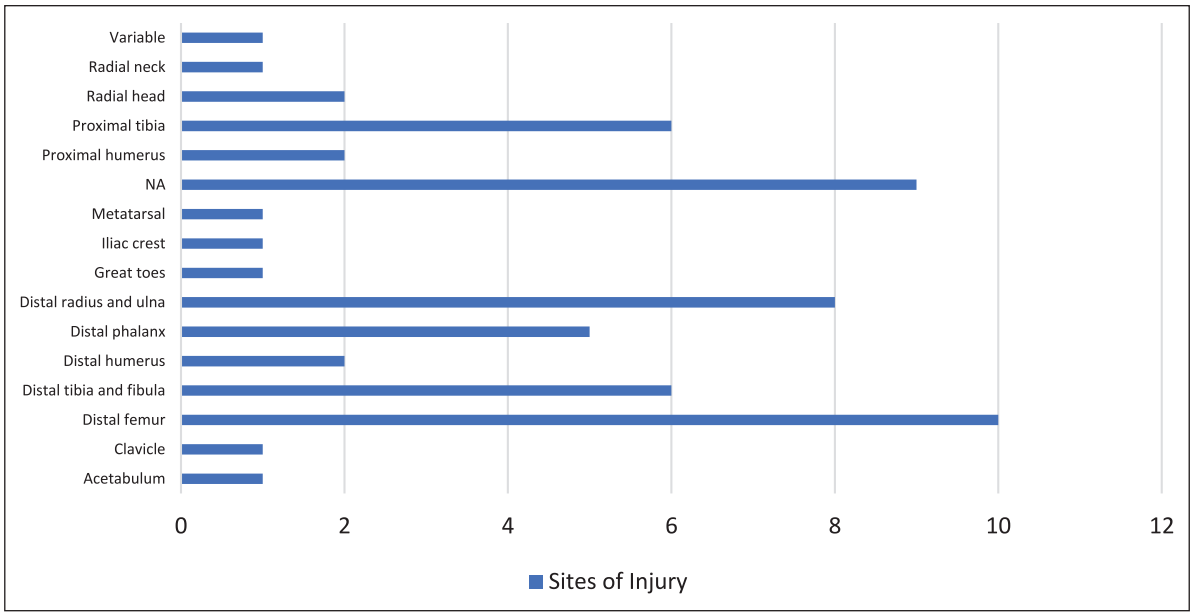

Figure 3. Sites of injury.

mentioned in six articles. The distal radius and ulna studies of growth plate injury were eight articles. The other sites were highly variable, including clavicle, great toes, iliac crest, acetabulum, fingers, and toes. Nine studies did not mention any specific site because they are secondary articles. Figure 3 depicts the injury sites mentioned in the included articles.

Salter-Harris classification

The Salter-Harris classification of the injuries mentioned in the articles were also highly variable because the high number of case reports and case series included in this systematic review. However, Salter-Harris type II injury is the most common type mentioned injury. There are 13 articles which did not specifically mention the Salter-Harris classification of the injuries in their studies. Most of the articles didn't mention specifically the number of patients that being studied. Five hundred and sixty-three of patient that studied with the Salter-Harris type II injury. Figure 4 depicts the Salter-Harris classification mentioned in the studies.

Mechanism of injury (MOI)

The most common MOI are trauma ($n=13$) but all the articles didn't mentioned the specific mechanism, sports-related injury ($n=10$), and domestic fall ($n=9$). There is one study describing growth plate injury caused by osteomyelitis. There are 12 articles which did not mention the specific MOI, most of them are secondary articles. Figure 5 depicts the MOI mentioned in the studies.

Treatment

The most mentioned treatment method is conservative treatment using cast as a means of immobilization. Twenty-two studies mentioned variable therapy of both operative and non-operative method, the articles did not mentioned specifically. The other treatment that common is screw and wiring. Figure 6 depicts the mode of treatment mentioned in the studies.

Result and complications

From all the articles, 25 articles mentioned good functional outcome of the injuries mentioned in their study. Limb-length discrepancy is mentioned in three articles, and in one article, it was associated with genu valgum. Deformity, growth disturbance, and premature physeal closure (PPC) were mentioned each in one article. Twenty-one other articles mentioned their conclusion as a recommendation, and one study was evaluating the prevalence of a certain type of injury. Figure 7 depicts the results and complications mentioned in the study.

Discussion

There are various of studies included in this study, ranging from secondary articles, case report, case series, and retrospective study. Thus, the variation of patient number is very high, ranging from 1 patient to 711 patients. In the previous study conducted on all pediatric fractures presented to hospitals in Edinburgh, Scotland, the incidence of fractures was 20.2/1000/year, and 61 percent of fractures in youngsters were male. Fracture incidence increases with age and the most common causes of lower limb fractures are twisting injuries and motor vehicle collisions.[8] This is relevant to the result of this study that, the age of the patients was mostly men and below 17 years old with the incidence increases with age. To enhance the

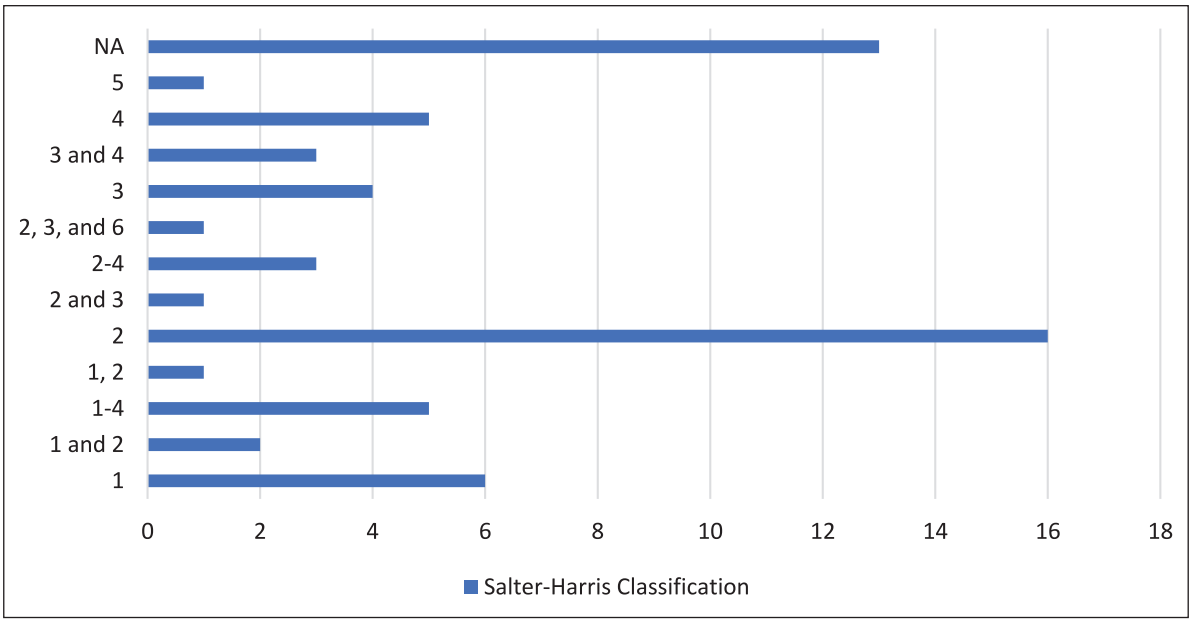

Figure 4. Salter-Harris classification.

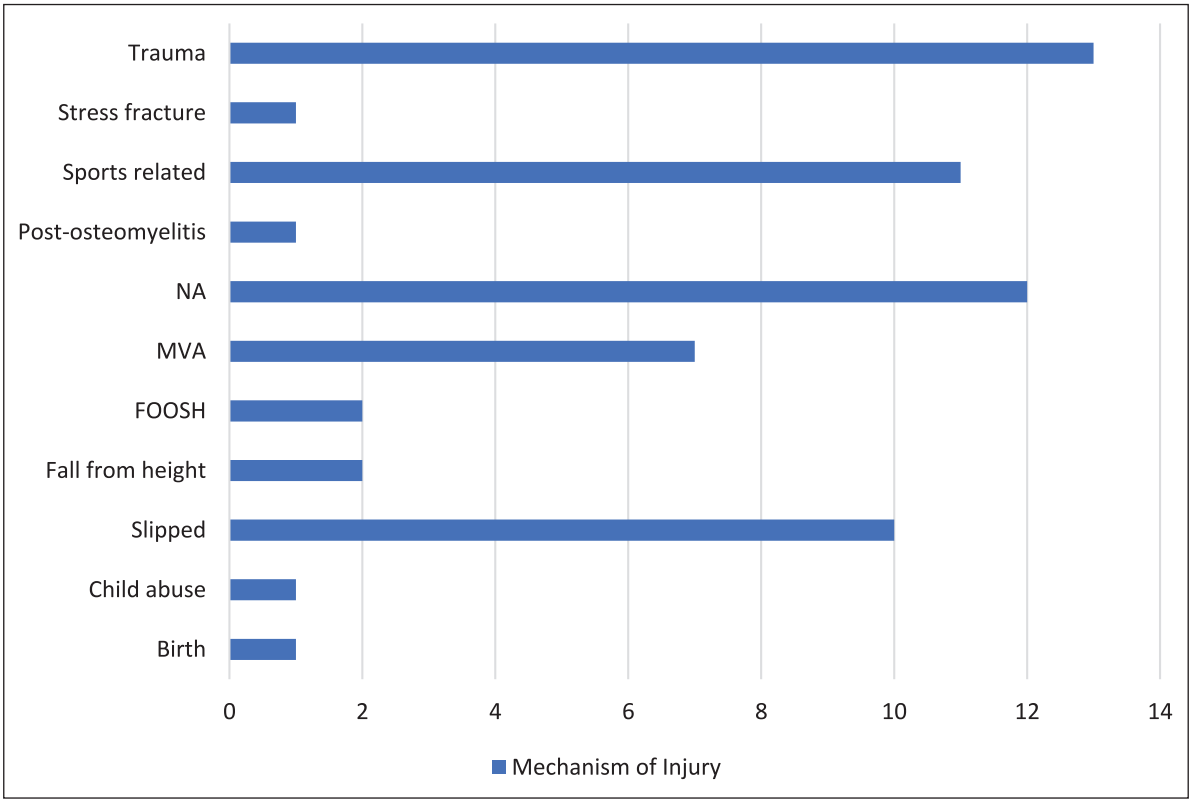

Figure 5. Mechanism of injury.

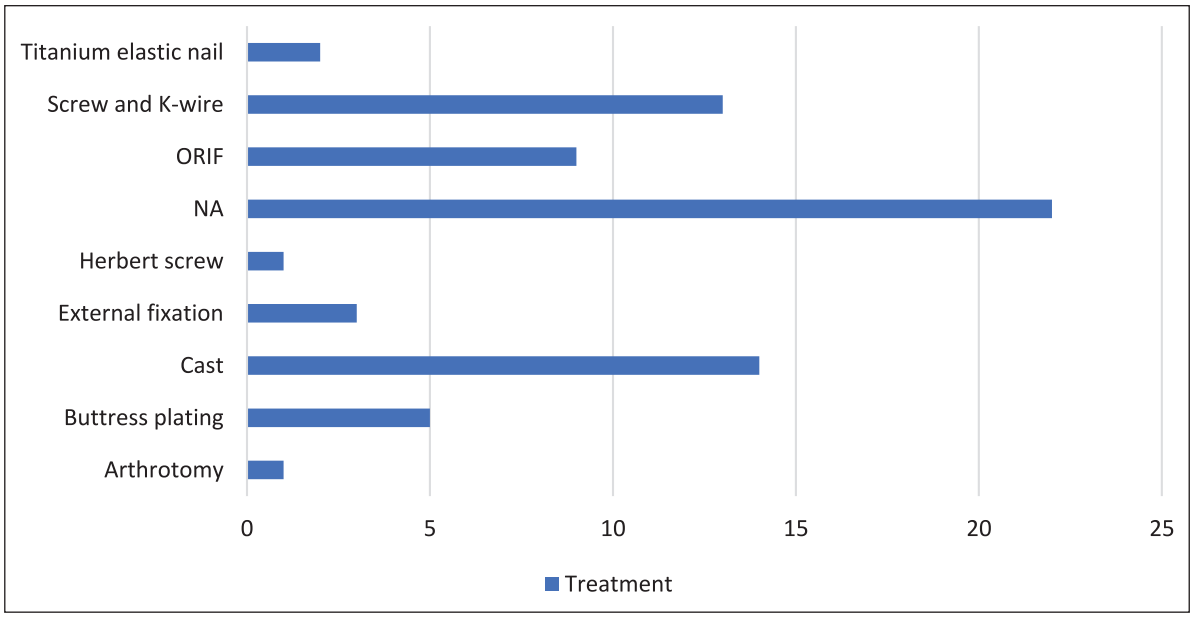

Figure 6. Treatment.

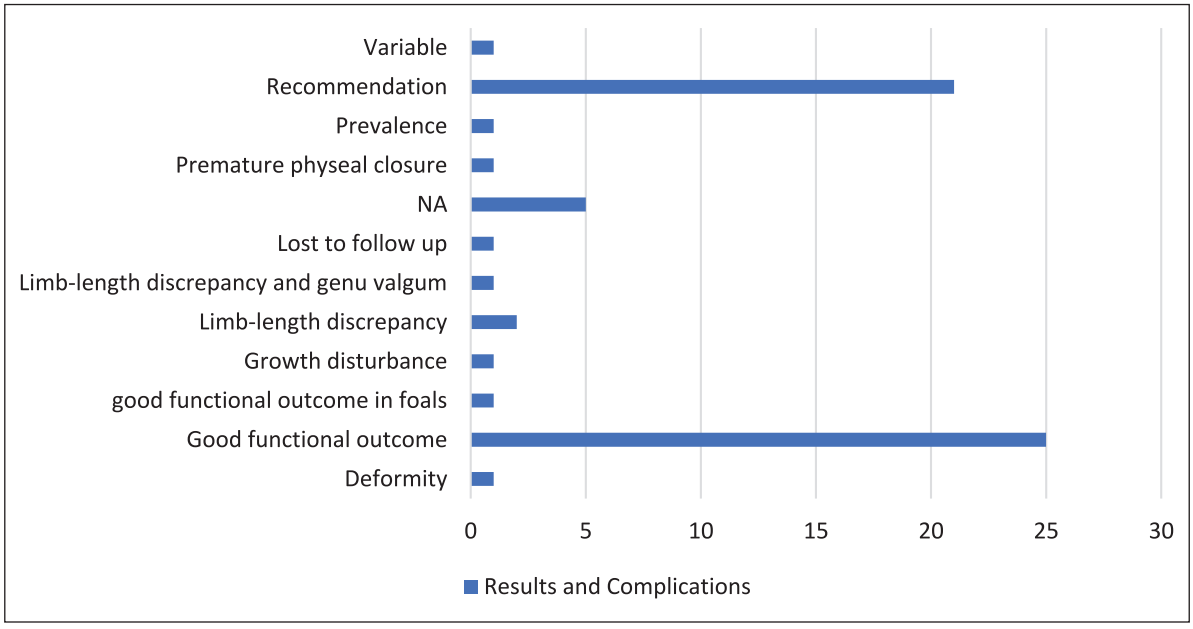

Figure 7. Result and complications.

discussions in this study more understandable, we divided them into two categories: upper limb injuries and lower limb injuries.

Upper Limb Injury

In this study, on upper limb injury, it was also found that the fracture site occurred mostly in the distal radius and ulna. fracture distal radius Distal radius fractures have a substantial influence on the health and well-being of young adults, despite the fact that they are more common in children and the elderly.[9] The incidence of fractures of the distal radius ulna increases with age.[10]

Several studies stated that the best management of the distal radius and ulna in children is conservative management. It can use casting and arm slings which can provide good outcomes.[11–14] Even in rare cases such as the ulnar diaphysis fracture of the neck of the radius, conservative therapy is quite effective and good outcomes are reported[11], and in others cases aFracture montegia type 1 equivalent fracture that underwent management using manual reduction and plaster cast immobilization give promising

functional outcome.[15] Despite of, epiphyseal involvement will greatly affect the outcome of a therapy. In some cases of fractures that required surgery, several studies have found that surgical outcome can induce long-term osteoarthritis in old age.[12,16]

Lower Limb Injury

Most fractures are always accompanied by epiphyseal injury.[8,17] Therefore, This is also understandable because the articles were discussing physeal injury, which can only occur before physeal closure.[18] There is one article which discusses injury in both children and adult. most common injury site mentioned was distal femur and distal tibia fibula with trauma and sports-related causes being the most common causes of injury to the growth plate. Pediatric ankle fracture is quite common, accounting 15%–20% of all physeal injury in children. Swenson et al.[19] also stated that at school age, injuries often occur due to sports. This may explain why distal tibia is most frequently mentioned.[20]

The incidence of fractures of the distal femur, is the most common occurrence in children and has the same incidence in both genders.[2] The most common Salter-Harris classification mentioned is Salter-Harris type II fracture. This is understandable because type II is the most prevalent.[21] The diagnosis of intra-articular involvement can be more clearly determined using MRI modalities than x-ray.[22] The two most common types of MOI are trauma and fall. Trauma in children is not uncommon, and it usually poses serious consequences.[23] In the management of fractures of the distal tibia fibula epiphysis, conservative treatment is the most common treatment option with satisfactory results.[17]

The most common immobilization method is immobilization by cast. There is currently no standard for epiphyseal injury treatment. A previous study was conducted by Ward, from 18,693 cases treated with fractures that consisted of fractures of the elbow (25.3%), tibia (12%), femur (9.8%), forearm (5.5%), and distal radius (5.5%)). There is only 5 percent of cases treated with surgery.[24] Although in some cases such as intra-articular cases, fractures that injured the vascular and avulsion fractures require surgery.[24,25] However, proper immobilization is compulsory.[26] Due to high variability of the studies, the results and complications mentioned were also variable. However, generally, most of the studies mentioned good results.

Conclusion

Growth plate injury is a debilitating condition for children if not treated properly. Even though there is no common standardized treatment for epiphyseal injury, proper reduction and immobilization are mandatory. The most mentioned treatment method is conservative treatment using cast as a means of immobilization, presented with good outcome. However there is small number of complications including limb-length discrepancy, deformity, growth disturbance, and premature physeal closure caused by various factors such as mechanism of injury, Salter-Harris type of fracture, patient's age and methods of treatment.

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Contribution

Panji Sananta: Conceptualization, formal analysis.
Albert Lesmana: Writing original draft, methodology, project administration.
Muhammad Alwy Sugiarto: writing-review & editing, methodology.

Declaration of conflicting interests

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Ethics approval

This study does not requires institutional ethical approval.

Patient consent for publication

Not applicable.

Informed consent

The manuscript does not contain any individual person's data in any form.

Significance for public health

Growth plate injury is a debilitating condition for children, The epiphyseal injury usually resolves without complication. However, this entity may pose serious complications such as premature physeal closure, bone bridge formation, deformity, and limb-length discrepancy. Therefore, Growth injury should be more attention because it will interfere the child's future and further will be morbidity on children

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

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