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Fractures of limbs specific to children: the experience of a Senegalese tertiary hospital

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Abstract

Introduction: Fractures specific to the pediatric age group represent a particular injury due to their pattern, diagnosis, management, and outcomes. In sub-Saharan Africa, studies on this particular injury are scarce. This study reports sociodemographic, diagnostic, and therapeutic aspects and outcomes of these fractures.

Methods: We conducted a descriptive cross sectional study at the pediatric surgery department of Aristide Le Dantec University Teaching Hospital in Dakar, Senegal, from January 2012 to December 2015.

Results: A fracture specific to children was diagnosed in 180, of whom 47.7% were school-aged, with 59.4% of males. The mean time from injury to the attendance of our department was 48.2 h. Domestic accidents occurred in 51.1%. A total of 243 fractures occurred, mainly on the upper limbs (75.3%), as the most affected bones were the radius (47.3%), ulna (22.6%), and tibia (13.6%). Greenstick fractures represented 46.9%, buckle fractures, 42.8%, plastic deformations 9%, and subperiosteal fractures 0.7%. In all patients, management was orthopedic, with associated analgesic treatment. No sequel nor other complication was registered.

Conclusion: Fractures proper to the child are a particular entity in children's trauma, frequently happening in boys, with greenstick and buckle fractures being the most common. Their treatment is exclusively orthopedic, with excellent outcomes.

Keywords: Children's Fracture, Fractures specific to children, Greenstick fracture, Buckle fracture, Plastic deformation, Subperiosteal fracture

Introduction

Trauma is the most common cause of consultation at pediatric emergency units, as shown in Senegal and worldwide [1, 2]. Consequently, several injuries occur, of which fractures are common [1–4]. Differently from the adult patients, pediatric ones have an immature, growing skeleton, which properties have two implications: (a) a specific pattern of skeletal injuries and (b) remodeling properties, which allow progressive natural correction of

acceptable deformation and make the treatment of children's fractures mainly orthopedic [5].

Children's fractures are subdivided into physeal and non-physeal [6]. While the first injuries the growth plate, the latter does not. Among non-physeal fractures, there are complete fractures, similar to those found in adults, and fractures specific to children, which are exclusively found in the pediatric population. These include greenstick fracture, buckle fracture, plastic deformation, and subperiosteal fracture. These injuries require special attention due to the particularity of their anatomy, exclusively orthopedic treatment and outcomes, which are excellent compared to other children's fractures [7].

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In our environment, studies on these particular pediatric injuries are inexistent. Thus, we aimed to conduct this study at our pediatric surgery department in Dakar, Senegal, to report the sociodemographic characteristics of affected children, pattern of different fractures, management, and outcomes.

Methods

We conducted a descriptive cross sectional study at the pediatric surgical department of Aristide Le Dantec University Teaching Hospital, located in Dakar, Senegal.

Data were collected from medical records of patients. This was done by recording them on a predesigned sheet, then encoding them in an Excel (Office 2010) spreadsheet.

We included patients who attended our emergency unit from 1 January 2012 to 31 December 2015, in whom the diagnosis of a fracture specific to children was made. Patients with missing details in the medical records were not included in our study.

We studied several variables, including sociodemographic (age, sex, duration before seeking care, circumstances of the accident), diagnostic (affected bone, kind of fracture), therapeutic (kind of management), and outcomes (presence of complication or not).

The fracture diagnosis and the precision of the type of fracture specific to children were collected from patients' medical records. The standard protocol in our department is that interpretation is first made by the Residents' team, under the guidance of the Senior Resident on-call, and after that, during the morning meeting, confirmed by three Consultant Pediatric Surgeons and a Professor

in Pediatric Surgery, and finally written on the patients' medical records.

This study was approved by Ethics Committee of Aristide Le Dantec UTH. Due to its retrospective aspect, the consent to participate was waived.

Data were analyzed with SPSS (Statistical Package for the Social Sciences) version 15 (IBM).

Results

During our study period, fractures were diagnosed in 1369 children at our emergency unit, among which limbs' fractures specific to children were encountered in 180 patients, which determines a frequency of 13.1%.

Sociodemographic parameters

Among our patients, school-aged children were more represented, with 86 patients (47.7%), followed by pre-school-aged patients, with 52 cases (28.9%), 40 infants (22.2%), and two newborns (1.1%). Boys were predominant with 107 cases (59.4%), as 73 girls were registered, leading to a sex ratio of 1.5. The mean time from the injury to the attendance of our department was 48.2 hours, with extremes ranging from an hour to 11 days.

Concerning circumstances of the injury, there were 92 domestic accidents (51.1%), 60 ludic accidents (33.3%), 24 road traffic accidents (RTAs) (13.3%), three sport accidents (1.7%), and a single obstetrical trauma (0.6%). Mechanism of the four accidents is represented in Fig. 1, of which the falls happened in 126 patients, i.e., 70% of cases.

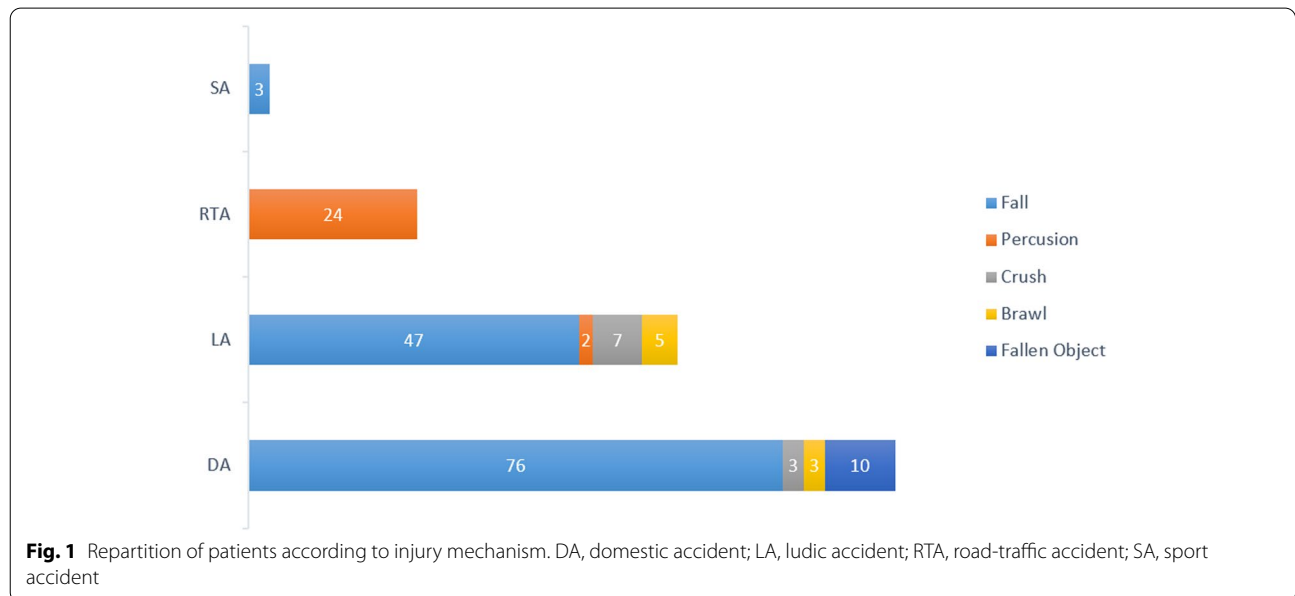


Table 1 Frequency of fractures by limbs' bones

Affected bones	Number	Percentage
Clavicle	5	2.1
Humerus	5	2.1
Radius	115	47.3
Ulna	55	22.6
Metacarpal bones and phalanges	3	1.2
Femur	5	2.1
Tibia	33	13.6
Fibula	19	7.8
Metatarsal bones and phalanges	3	1.2
Total	243	100



Fig. 2 Greenstick fracture. Lateral x-ray showing unilateral anterior cortical rupture of distal ulna and radius (white arrows), with intact opposite cortical

Injury patterns

A total of 243 fractures were encountered among the 180 patients. The upper limbs were affected 183 times (75.3%), while lower limbs were counted 60 times (24.7%). The radius was affected 115 times (47.3%), the Ulna 55 times (22.6%), and the Tibia 33 times (13.6%). Table 1 presents the affected bones.

Concerning the precise kind of fractures specific to children, greenstick fractures (Fig. 2) occurred 114 times (46.9%), buckle fractures (Fig. 3) happened in 104 times (42.8%), plastic deformations (Fig. 4) occurred 22



Fig. 3 Buckle fracture. Distal forearm anteroposterior x-ray, showing bowing of both medial and lateral radial cortices (white arrows), with a visible fracture line on the metaphysis (black arrow)



Fig. 4 Plastic deformation. Forearm anteroposterior x-ray shows lateral bowing of the distal ulnar and radial diaphyses (white arrows), without identifying any fracture line

times (9.1%), and subperiosteal fractures (Fig. 5), three times (1.2%).

Management and outcomes

All patients received painkillers, including acetaminophen alone in 67 cases (37.2%) and acetaminophen with a nonsteroidal inflammatory drug (NSAID) in 113 cases (62.8%). Two NSAIDs were used: ibuprofen in 55 patients (30.6%) and niflumic acid in 58 children (32.2%).

Treatment of all the 180 patients was non-operative as orthopedic immobilization with cast was used in 150 patients, split cast in 20 cases, Mayo Clinic bandage and strapping for five patients each.

All fractures healed without any complications or sequels.

Discussion

Trauma is one of the most common reasons for consultation in pediatric emergency units. Several authors reported that fractures were the most common injuries [1, 3, 4]. In our study, fractures specific to children occurred predominantly in school-aged patients, representing almost half of the population study. This trend is the same in children's fractures in general, where authors report an increased incidence in school-aged children and adolescents [8–12]. This is mainly due to exploratory activities and increased sports activities in this category, which lead to more trauma [11].

Our results showed a male predominance. This is also reported by local studies [1, 3] and worldwide [10, 12]. Some authors strictly link that predominance to social factors, pointing out the higher activity and risk-taking in boys [3, 13], while others add the effect of the hormonal weakening of the growth plate [10], which lead to physeal fractures, which are not taken in account in our study.

We highlighted that domestic accidents occurred in half of the cases. There is significant variability in prevailing circumstances of accidents in the pediatric population, mainly due to cultural differences. However, domestic accidents were reported to be the most common cause of children's trauma in Senegal [1] and worldwide [12, 14, 15]. However, some authors have reported sport's accidents as the first cause of children's fractures [7, 16]. This is linked to increased sports activity in school-aged children. In our study, falls remain the most common mechanism of fractures, which is similar to data reported in children's trauma [1, 17] and children's fractures specifically [6, 7, 9, 18, 19]. This may be linked to increased sports activity and poor motor coordination.

Our results showed that the upper limb was most affected, with three quarters of patients. This is similar to data reported in all children's fractures [6, 9, 12, 18]. This is probably because most fractures are secondary to falls; the child attempts to avoid the fall by outstretching the upper limb. However, some authors have reported differences in fracture location due to falls according to the patient's age. Infants were more vulnerable to head and neck fractures, children, upper limb and vertebral fractures, and adolescents, lower limbs and vertebral fractures [12]. This difference is linked to the reception mode according to the age [12].

The most affected bones were the radius with almost half of the cases, followed by the ulna, tibia, and fibula, all located in limb segments with two bones. This is not the same trend as in all children's fractures, where radius still comes first within the same proportion but is followed by humerus, tibia, and clavicle [2]. This may be since incomplete fractures are rare in the humerus and clavicle, which were underrepresented in our study.

Our review considered fractures specific to children. The most typical fractures were greenstick fractures, found in approximately half of the population study. Authors have reported that greenstick fractures represent approximately 50% of all pediatric fractures; it is the most common of fractures specific to children [20]. Certain elasticity of the pediatric bone allows higher compliance to trauma, resulting in bending of the bone before unilateral and, after that, bilateral cortical rupture [5, 21]. These fractures occur when the compression force ceases after the first cortical rupture [20]. These



Fig. 5 Subperiosteal fracture. Distal left leg anteroposterior x-ray shows an oblique fracture line (white arrows) on the distal third of the diaphysis that does not affect any of the two intact cortices, realizing a toddler's type I fracture

are characterized by unilateral cortical rupture when the opposite remains intact or is bent.

The second most common fractures specific to children were buckle fractures, encountered in two fifths of cases. It is estimated that they occur in 1 of 25 children and represents 50% of wrist fractures, their primary location [22]. They happen at the junction between the diaphysis and the metaphysis, due to density difference between the diaphyseal and the metaphyseal bone tissues, which is porous and covered by a thick and resistant periosteum at the metaphysis. The more cortical diaphyseal bone compresses the porous metaphyseal bone, resulting in bowing at the junction of these two parts [5, 21].

Plastic deformations were the third commonest fractures specific to children, happening in approximately a tenth of patients. Frequency of these injuries is difficult to estimate since they are underdiagnosed [23]. It is assumed that these fractures are more common than generally admitted [24]. In children, particular elasticity of the immature bone results in this injury pattern when traumatic compression ceases before any cortical rupture [5]. This lesion is characterized by bending of the diaphysis without any fracture line identified.

Subperiosteal fractures were the less represented in this study; other authors also reported this [25]. They occur in hands and feet's small bones, in the proximal ulna, and the tibia. Those occurring in the latter are referred to as toddler's fractures, with type I occurring in the diaphysis and type II in the proximal metaphysis [25]. These fractures are often retrospectively diagnosed after the callous formation at the fracture's site 15 to 21 days posttraumatic [26]. They have the particularity to have a thin fracture line that does not interrupt the cortices and periosteum [26].

In our study, all patients benefited from orthopedic treatment, using a cast in the large majority of patients. This is the case for not or slightly displaced complete fractures of the child, where the treatment is essentially orthopedic [2, 27]. In our practice, we use abacus which details acceptable displacements depending on fracture's location on the bone, and patient's age, as suggested by the French Society of Pediatric Orthopedics [28]. This is due to the unique remodeling property of the pediatric bone, which allows not always attempt the anatomic reduction of fractures [5]. For all fractures specific to children, including greenstick fractures, when displacement was within acceptable limits, a cast is done without any reduction. But when displacement exceeded acceptable limits, reduction must be done, followed by cast immobilization [28]. Realization of non-orthopedic (operative) treatment depends on a combination of five factors: older children, fracture's location on a site with poor remodeling properties (such as distal humerus),

non-tolerable displacement, association with other injuries (polytrauma), and schooling [28].

In all of our patients, no complication was registered. This is mainly because we only considered incomplete fractures in limbs, not considering complete and physeal fractures, where complications are not rare [29].

Limitations

We conducted a cross sectional study at our institution, which aimed to report our experience with fractures specific to children. The retrospective aspect of our studies had some limits, such as fewer data available about the circumstances of the accident leading to fractures. This resulted in no case of non-accidental fracture identified among our patients, which was probably missed.

Conclusion

Fractures proper to the children mainly occur in males, on the upper limbs, with the radius and ulna being the most affected bones. The majority are greenstick and buckle fractures, all conservatively treated with excellent outcomes.

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Authors' contributions

FTAZ analyzed and interpreted findings and wrote the manuscript. MF participated to data acquisition and was a major contributor in writing the manuscript. PAM double-checked analyzed data and interpreted them. DG analyzed and interpreted data and critically revised the manuscript. AKB acquired data, analyzed, and interpreted them. NFS participated in the study design, acquired data, and contributed to writing the manuscript. SC participated to data acquisition and double-checked analyzed data. IBW acquired data and analyzed and interpreted them. YD acquired data and double-checked analyzed data. NAN participated in the conception of the study, interpreted data, and proceeded to critical revision of the manuscript. AS participated to the study design and to the critical revision of the manuscript. ON participated to the conception of the study and made critical revision of the manuscript. GN participated in the conception and design of the study, interpreted the data, and made a significant contribution by critically revising the manuscript. He is the guarantor of the present work. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Our review received approval from the Ethics Committee of Aristide Le Dantec University Teaching Hospital. Seeing its retrospective aspect, consent to participate was waived by the committee.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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