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Contribution of Ultrasound and Radiography in The Diagnosis of Infantile Fractures in A First Referral Hospital in Mali

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1. Abstract

1.1. Objective

To describe the radiographic and ultrasonographic aspects of fractures in children aged 0 to 15 years at the Commune V Reference Health Center in the District of Bamako.

1.2. Patients and Methods

This was a prospective, descriptive and analytical study over twelve (12) months from December 1, 2021 to November 30, 2022. All children aged 0-15 years with a fracture detected by radiography or ultrasound were included

1.3. Results

We obtained 120 cases of fracture out of 415 examinations carried out, i.e. 29%. Males were the most represented with 62%, a ratio of 1.66. Etiologies were dominated by domestic accidents (55.8%), public road accidents (19.2%) and obstetric accidents (17.5%). Closed fractures accounted for 98%. The fracture line was transverse in 46.8% of cases; green limb (21.6%), butter clump (12.6%). Fractures of the clavicle were the most common (24.1%), followed by those of the tibia and humerus. Ultrasound revealed four (04) cases of angulation and three (03) cases of soft-tissue swelling.

1.4. Conclusion

We found that clavicle fractures were predominant among children at the Commune V Health Centre. Domestic accidents are the main reason for consultation. Standard radiography remains the 1st choice for diagnosis and post-treatment follow-up. Ultrasound is an alternative for simple fractures, to minimize children's exposure to X-rays.

2. Introduction

According to the World Health Organization (WHO), injuries, whether unintentional or violence-related, claim the lives of 4.4 million people worldwide every year and account for almost 8% of all deaths [1], making them a major public health problem [2,3]. In France, fractures account for around 13-15% of traumatic injuries in children [3]. An Austrian study estimates that 10-25% of all paediatric injuries result in fractures [4]. Childhood fractures occur during accidents in the home, on the road, in obstetrics or in sports. A fracture is a break in the continuity of a bone. It can range from a simple bone crack to a comminuted fracture [5]. Domestic accidents (DAs) are unintentional injuries that occur in or around the home. They occur mainly in children under the age of five, and to a much greater extent in the yard and garden. Falls are the predominant mechanism, followed by burns and accidental poisoning [6]. Injuries caused by AD include contusions, wounds and fractures, and can result in disabling after-effects and death [6-8]. Traffic accidents, mainly due to the proliferation of two-wheeled vehicles [9]. Obstetric trauma is considered a complication of difficult childbirth. They generally affect 5 to 7 children per 1,000 live births [10]. In addition to bone fractures, these traumas cause a significant number of soft tissue lesions [11]. In the literature,

pediatric fractures very often involve the upper limb [12]. Childhood fractures are characterized by their often incomplete nature (the greenwood fracture, the limited impaction fracture or torus, the possibility of complete remodeling of the bone after healing, the possibility of metaphyseal-epiphyseal fracture. These fractures have given rise to classifications, the most common of which is the SALTER and HARRIS classification [13]. In most cases, standard front and side X-rays confirm the diagnosis of fractures and classify them into different types. Ultrasound is used to detect intra-articular effusion and to study the soft tissues, muscles, tendons and ligaments. It is used particularly for the knee, shoulder and ankle [13]. It can also be used to diagnose certain fractures. In Mali, orthopedic treatment is the most widely used and gives satisfactory results. [9]. Because of the numerous complications, sequelae and disabilities, these fractures can be a cause of absenteeism or dropping out of school. Given the high frequency of this condition and the complications it can cause, few studies have been carried out on pediatric fractures in Mali. We therefore decided to carry out a study on this subject in the medical imaging unit of the Commune V Referral Health Center in Bamako. In Mali, reference health centers (CSREF) occupy the second level of the health pyramid. There are currently 65 in the country, including 06 in the capital Bamako (according to the strategic plan for Mali's national health and social information system 2020-2024). According to estimates from the Regional Directorate of Statistics, IT, Planning and Population (DRSIAP) of Bamako, commune V had 984,309 inhabitants in 2021. In this work, we study 120 cases of fractures in children managed in the radiology and medical imaging unit of CSREF V over a 12-month period from December 1, 2021 to November 30, 2022. The objectives of this study are first to describe and analyze the clinical and paraclinical profiles of fractures in children aged 0 to 15 admitted to its imaging unit.

3. Materials and Methods

This was a prospective, descriptive-analytical study conducted on medical observations of children aged 0 to 15 presenting with one or more bone fractures in the imaging unit of the Commune V Reference Health Center in the Bamako district over a twelve-month period from December1, 2021 to November 30, 2022. We used a "Stéphanie" semi-mobile X-ray table (BIM). A complete AGFA digitizing line with two processing consoles.

An EDAN Acclarix multipurpose ultrasound scanner with a 12Mhz probe was used in some cases for the examinations. All examinations were interpreted by a specialist in Radiology and Medical Imaging. Sampling was exhaustive, covering all children aged 0 to 15 years who had undergone bone radiography or ultrasonography during the study period. The variables studied were age, sex, residence and occupation of parents, circumstances of occurrence, reason for consultation, physical signs, complementary examinations, limb segment, type, level and appearance of fracture. All children aged between 0 and 15 with one or more fractures detected on X-ray or ultrasound during the study period were included in our study. Children outside this age range, radiographs or ultrasounds not interpreted by a specialist, or refusal to participate in the study were not included. They were entered and analyzed using "SPSS" version 26 software. Tests were compared using the Chi2 statistical test with P significant < 0.05.

4. Results

From December 1, 2021 to November 30, 2022, we collected one hundred and twenty (120) children with one or more fractures out of four hundred and fifteen (415) children admitted for radiographic examination, i.e. a prevalence of 29%. Males were the most represented with 74 cases, i.e. 62% of cases and a sex ratio of 1.66 (Figure 1). The middle 1/3 of the clavicle was fractured in 65.5% of cases. According to the SALTER and HARIS classification, Stage II was the most common, with 6 cases (66.7%). Transverse fracture was the most common type of fracture, accounting for 46.8%. Stable fractures were found in 80% of cases, followed by overlapping fractures (16.7%), angulated fractures (2.5%) and rotated fractures (0.8%).In our study, 8.3% of patients underwent ultrasound examination, and angulated fractures accounted for 40% of lesions detected.

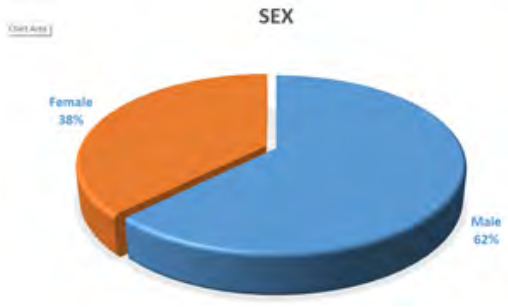

Figure 1: Distribution of patients by sex.

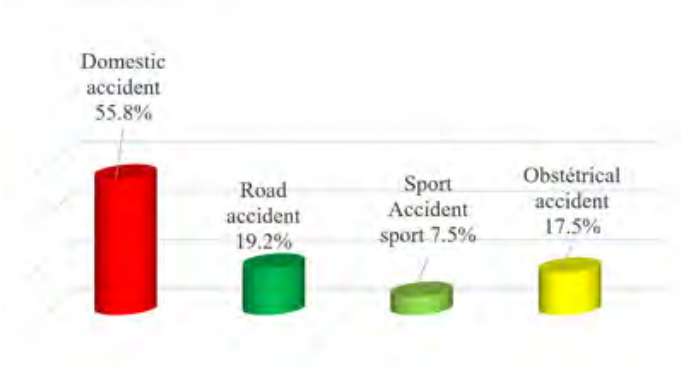

Figure 2: Distribution of patients by diagnostic circumstances.

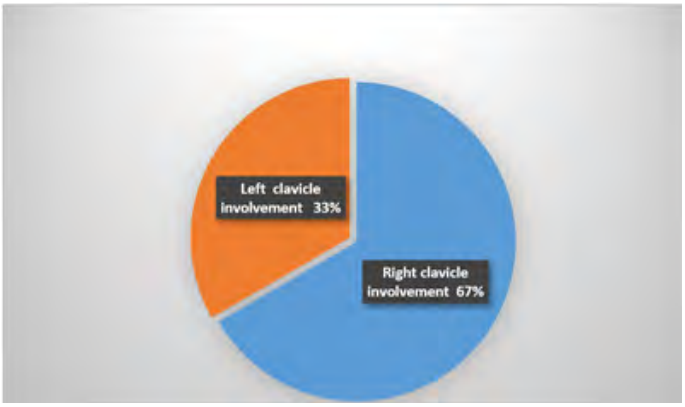

Figure 3: Distribution of patients according to obstetrical causes.

Table I: Distribution of patients by age group.

Age group	Number (n)	Percentage (%)
[0 - 6 months]	27	22,5
[6 months - 2 years]	14	11,7
[2 years - 5 years]	21	17,5
[5 years - 10 years]	**32**	**26,7**
[10 years - 15 years]	26	21,7
Total	**120**	**100**

The majority of children resided in Bamako's Commune V (68.3%), followed by Commune VI and V (15.8% and 7.5% respectively).

Table II: Breakdown of patients by reason for consultation.

Consultation reason	Number (n)	Percentage (%)
Pain	**60**	**50,0**
Tumefaction	**40**	**33,3**
Deformation	**15**	**12,6**
functional impotence	4	3,3
Stiffness	1	0,8
Total	**120**	**100**

According to the type of osteoarticular damage found on X-ray, the clavicle was the most frequently affected bone (24.1%).

Osteoarticular disorders	Number (n)	Percentage (%)
Clavicle	**29**	**24,1**
Tibia	**22**	**18,3**
Humerus	**19**	**15,8**
Radius	**17**	**14,2**
Femur	**12**	**10**
Radio-ulnary	8	6,7
Foot bones	4	3,3
Ulna	3	2,5
Tibia-fubila	2	1,7
Ankle	2	1,7
Hand bones	1	1,6
Total	**120**	**100**

The middle 1/3 of the clavicle was fractured in 65.5% of cases. According to the SALTER and HARIS classification, Stage II was the most common, with 6 cases (66.7%). Transverse fracture was the most common type of fracture, accounting for 46.8%.

Table IV: Distribution of fractures according to shape.

Fracture	Number (n)	Percentage (%)
Transversal	**52**	**46,8**
Green wood	**24**	**21,6**
Lump of butter	**14**	**12,6**
In hair	11	9,9
Oblique	9	8,1
Plastic	1	0,9
Total	**111**	**100**

Simple fractures were the most frequent at 93.3%.

Table V: Distribution of fractures according to severity.

Degree of severity	Number (n)	Percentage (%)
Simple fractures	**112**	**93,3**
Complex fractures	8	6,7
Total	**120**	**100**

Stable fractures were found in 80% of cases, followed by overlapping fractures (16.7%), angulated fractures (2.5%) and rotated fractures (0.8%).

Table VI: Summary of fractures according to stability.

Fracture pattern	Number (n)	Percentage (%)
Stable	**96**	**80**
Overlap	20	16,7
Angulation	3	2,5
Rotation	1	0,8
Total	**120**	**100**

In our study, 8.3% of patients underwent ultrasound examination, and angulated fractures accounted for 40% of lesions detected.

Table VII: Distribution of lesions found on ultrasound examination.

Ultrasound performed	Number (n)	Percentage (%)
Fracturing angulation	**04**	**40**
Cortical rupture	02	20
Peri-osseous collection	01	10
Soft-tissue swelling	03	30
Total	**10**	**100**

Iconography

*Observation 1: 2-year-old child referred for swelling of the right clavicle. Front X-ray of the right shoulder.

Image 1: Transverse fracture of the middle 1/3 of the right clavicle with overlap.

***Observation 2**: 5-year-old child referred for pain and swelling of the left arm. Front X-ray of left arm.

Image 2: Oblique, buttercup-shaped double fracture site above the left humeral pallet.

***Observation 3:** 3-year-old child referred for painful swelling of the right forearm. X-ray of right forearm in profile.

Image 3: Greenwood fracture of the forearm with angulation, callus and soft tissue swelling.

***Observation 4:** 10-year-old child referred for pain and functional impotence of the right leg. Front X-ray of right leg.

Image 4: Oblique right tibial diaphyseal-metaphyseal fracture and soft-tissue swelling.

***Observation 5:** 4-month-old child referred for swelling and functional impotence of the left thigh.
Radiograph of left thigh.

Image 5: Transverse fracture of the left femoral shaft with slight translation.

***Observation 6:** Ultrasound of the thigh in a child about 04 years old.

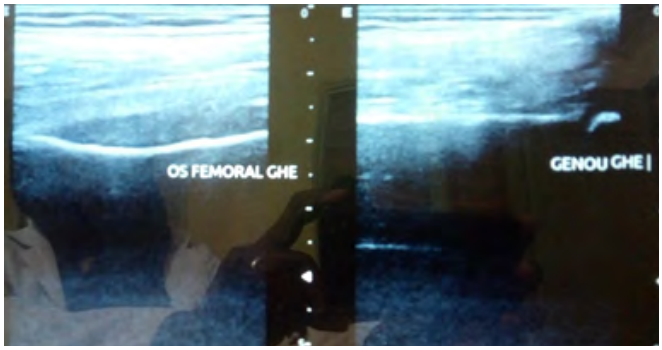

Image 6: Ultrasound of the left thigh. Angulation of the left femoral bone with soft-tissue swelling.

5. Discussion

Pediatric fractures are common in children aged 0-15 years, especially males in rural and urban areas. In our study, we collected 120 children meeting our criteria out of 415 paediatric radiological examinations performed, i.e. 29%. Cissoko F [9] found at the Fousseyni Daou Regional Hospital in Kayes (Mali) that the 12-15 age group was the most represented, at 40%. Mohamed A.S in Dakar (Senegal) found that children under 5 were the most affected (63.4%) [18]. The Austrian study by Johannes Schalamon [4] shows that 9.8% of boys are in our age group. These differences may be explained by the number of cases and the study setting. Commune V of the Bamako District is the most represented with 68.3%, which could be explained by the fact that the survey took place in this health center. It is followed by Commune VI and IV for reasons of proximity. Our result is very close to that of Cissoko F in Kayes 60% and the Austrian study 61.3% [9,4]. Our results are lower than those of Chrestian P and D. DeBilly [14], who found a male predominance of 75%. In all studies, there is a male predominance, which is due to the fact that boys are more hyperactive and mobile. Girls, on the other hand, have a more developed instinct for self-preservation. In Dakar, a study carried out by Mohamed A.S et al at the Pediatric Surgery Department of Aristide-Le-Dantec University Hospital showed that domestic accidents were the main reason for admission (28.8%). In Kayes, Cissoko F found that sports-games accidents were the main cause of admission to his hospital, accounting for 40%. In Austria, Johannes also reported that the majority of fractures occurred in sports facilities (34.7%). These results are comparable to those reported in the literature, where the circumstances of childhood fractures are dominated by accidents in the home, in sports, on public roads and in obstetrics [15,9,4]. In the literature, all authors have found the omnipresence of signs such as pain and swelling in their studies [9,16,4,17]. Our result is very similar to those of Sola.J and Gordon JE [19] and Gregory-P [20], who found 97.43% and 96.29% of closed fractures respectively in their study. This is higher than that of Cissoko F and Coulibaly MS [9,21], who found 80% and 82.10% respectively. In all studies, closed fractures were more frequent than open ones. We found that clavicle fracture was the most frequent. Cissoko F, found that the femur was the most affected bone at 44%. In Austria, the most frequent fracture was of the distal portion of the radius, at 15.3%. In Dakar, Mohamed A.S et al found that fractures predominated in the limbs (46%), without specifying the segment concerned. A study by Nandiolo-Anélone KR et al, conducted at the Pediatric Surgery Department of the University Hospital of Treichville in Côte d'Ivoire, on the management of obstetric trauma, found that clavicle fractures accounted for 52.02% of obstetric injuries [9,4,17,10]. In our underdeveloped countries, obstetric trauma is considered to be a complication of difficult childbirth. In the literature, pediatric fractures very often involve the upper limb [12].

We found that the middle 1/3 of the clavicle is the most affected. Keita SM found 62.5%. This result is comparable to that of Malgaine and Maurin [16,22], who found an average of 68%. This result may be explained by the fact that the middle 1/3 of the clavicle is a fragile zone for this bone. Our result is very similar to that of Cissoko [9], in whom all patients underwent Face Profile radiography, with 10% undergoing ultrasound. All Keita S.M. patients at Gabriel Touré University Hospital in Bamako had a standard radiograph [16]. Standard radiography of the face and profile is the key para-clinical examination used in the diagnosis of fractures. CT and MRI scans are rarely indicated for limb fractures and are not included in our protocol. In metaphyseal-epiphyseal fractures, our figures are close to those of Cissoko F[10], who also found that stage II of the Harris and Salter classification in epiphyseal

fracture-decollement is the most represented. A study carried out by Chevrot A et al. on traumatic bone, joint and tendon injuries at the Cochin Hospital in Paris (France) showed that stage II of the Salter and Harris classification accounts for 75% of metaphyseal-epiphyseal fractures in children. Pull-out fractures occur preferentially during growth, when the metaphyseal cartilage is active and weakened [13].

5. Conclusion

Pediatric fractures are a frequent occurrence in our department in Bamako. Boys aged 5-10 are the most affected, and the main cause remains domestic accidents. Fractures of the clavicle, tibia and humerus are the most common. Obstetric trauma during dystocic delivery is responsible for many clavicle fractures in newborns. Standard radiography is the key confirmatory examination. Ultrasound remains an alternative to reduce children's exposure to X-rays.

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