

Epidemiology of Forearm Fractures in the Population of Children and Adolescents -Current Data from the Typical Polish City

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Abstract

Background: Injuries of the musculoskeletal system in children and adolescents are an important clinical and economical problem. Forearm fractures involving one or two bones comprise more than one third of all fractures in this population group. In our work, we have decided to evaluate the epidemiological incidence of the forearm fractures with the special regard to the precise anatomical location in the representative population of children and youth from a typical Polish town.

Methods: The study included the entire population aged 0-18 years old from the city of Olsztyn in the years 2009-2012. The analysis of the incidence of fractures was based on the complete medical records. The test used the division of forearm fractures into 7 groups (depending on the anatomical location).

Results: The study recorded 1.668 new episodes of isolated fractures of the forearm in patients up to the age of 18 years; the incidence was 7.8/1000/year. A higher incidence of fractures was found in boys than in girls (66% vs. 34%). The most common location was the fracture of the distal radius (43% of all fractures of the forearm), the rarest location – the isolated fracture of the shaft of the ulna (3%). The spring is the period of the greatest incidence of fractures (38%), during the remaining seasons fractures in children include: 30% - summer, 18% - autumn, 14% - winter. The average age of a child with the fracture is 9.85.

Conclusions: Most authors in their work focus exclusively on the fractures of the distal epiphysis of the forearm. We have evaluated all the fractures of the forearm. In the light of the published data, there are no clearly documented reasons or etiopathogenetic links to the bone fragility in the first two decades of life. Further studies are needed to determine the exact causes and possibilities of their elimination or reduction as well as the minimization of consequences.

Keywords: Fractures in children; Forearm; Epidemiology

Introduction

Musculoskeletal injuries in children and adolescents are important clinical and economical problem. In both developmental period and in adolescents, the mechanisms of injuries and their treatment have a high dissimilarity compared to adults. Forearm fractures involving one or two bones comprise more than one third of all fractures in children [1-3]. Many researchers showed that their incidence is increasing, although there is no clearly documented reason or link explaining this trend [1,4,5]. Because most authors focus exclusively on the fractures of the distal epiphysis of the forearm, we have decided to evaluate epidemiological incidence of fractures of the forearm with the special emphasis on the precise anatomical location in the representative population of children and youth from a typical Polish town.

Study participants and methods

The study included the entire population aged 0-18 years old from the city of Olsztyn, in the period from 1st January 2009 to 31st December 2012 (4 years). The analysis of the incidence of fractures was based on the complete medical records (electronic medical records), derived from the Regional Specialized Children's Hospital in Olsztyn. The hospital, where the study was conducted, is the only paediatric hospital in the city and the whole region, while the unit supplies all episodes of injuries, including fractures. In our area, the entire population of children and adolescents (0-18) is treated only in our hospital. The medical records provided the following data: the age of a child at the moment of an injury, gender, fracture location, seasonality of fracture (season) and the mechanism of an injury.

The analysis used the following division of fractures depending on the location: fracture of the base of the Proximal Ulna (PU), fracture of the Proximal Epiphysis of the Radius (PR), fracture of the shaft of the

ulna (CU), diaphyseal fracture of the Radius (CR), vertebral fracture of both bones of the forearm (CRU), fracture of the distal epiphysis of the ulna and radius (DRU) and fracture of the Distal Radius (DR). Metaphyseal fractures of the proximal and distal forearm fractures were treated as shaft fractures. We have resigned from the specific classification of fractures in children such as 'Monteggia fracture', 'greenstick fracture', 'torus fracture', etc., assuming that in these cases the fracture occurs in a specific anatomical location which have been already used and grouped (7 groups). The mechanisms of injuries were divided into 4 main groups: a fall from a height of less than 1m, a fall from a height of more than 1m, traffic accidents and physical activity. Among all analyzed injuries, we have taken into consideration only the fractures that were clinically documented and radiologically confirmed and in rare cases, based on computed tomography. The location and distribution of fractures was assessed in relation to the age and gender.

For the purpose of statistical calculations, we have used the official data of demographic diversity of the population obtained from the Central Statistical Office (the years 2009-2012). The statistical analysis used the original program Statistica 10.0 (StatSoft Inc., 2011). The data

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was tested using the Shapiro-Wilk test, the U Mann-Whitney test and the ANOVA rank Kruskal-Wallis test. The analysis of the relationship between the gender and the fracture site was performed using the chi-square test. The significance level was accepted at $\alpha=0.05$. The results were considered statistically significant when the calculated test probability (p) satisfied the inequality $p<0.05$. We received permission of the Regional Committee on Bioethics for the purpose of this study as well as written consent of the patients and their parents.

Results

The study included the population of 53.329 children and youth from Olsztyn (the years 2009-2012); 1.668 new episodes of the isolated fractures of the forearm were recorded in patients up to the age of 18 years (38% of all fractures among all 4.697 fractures); the incidence was 7.8/1000/year (Figure 1). A higher incidence of fractures was found in boys than in girls (boys 66%, girls 34%). The most common location was the fracture of the distal radius (43% of all fractures of the forearm), the rarest – the isolated fracture of the shaft of the ulna (3%). The proportions of fractures depending on seasonality showed that the spring was the period of the greatest incidence (38%), the remaining periods of fractures in children were as follows: 30% - summer, 18% - autumn, 14% - winter. The average age of a child with the fracture is 9.85 (SD: 3.79). The distribution of fractures is shown in Table 1.

The most common mechanism of fracture was a fall from a height <1 m (39%), the rarest - traffic accidents (3%). In contrast, the analysis of traumas associated with physical activity and sport (68%) revealed the largest number of forearm fractures while playing football (27%). Table 2 presents the most common mechanisms of fractures in the study group.

Discussion

The study evaluated the locations of the forearm fractures in the population of children and youth from a typical large Polish city. Olsztyn is a city inhabited by 296.274 people (the city and district). It is the capital of the Warmia and Mazury province. At the end of 2012, the Warmia and Mazury population was 1.452.596 people. The inhabitants of the province were 3.7% of the Polish population (the 12th position in the country). Almost 60% of the population of Warmia and Mazury lived in cities (61% in the country). The great advantage of this study was the ability to access all fractures in children from the city

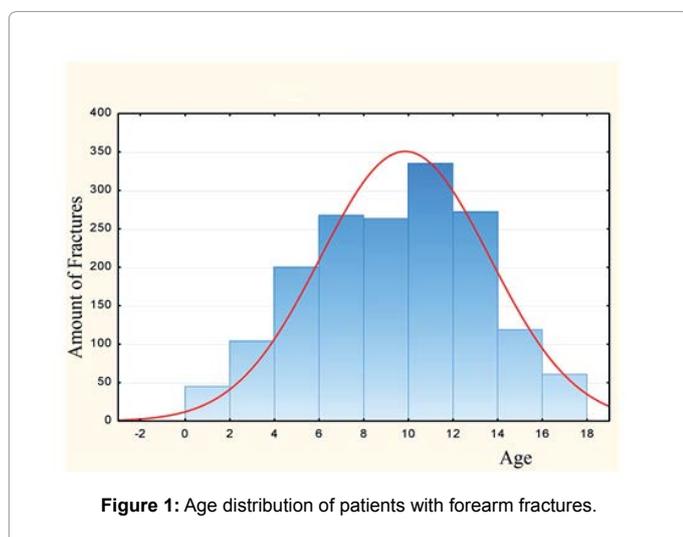


Figure 1: Age distribution of patients with forearm fractures.

(the only one children's hospital in the city). Instead of estimating, we have collected the actual data, clinically diagnosed and radiologically confirmed fractures. Thus, the type of minor injuries like bruises, sprains or dislocations were excluded.

The epidemiological data about the population of a typical large Polish city confirm the location of the most common fractures in children and adolescents (bones of the forearm: 38% of all fractures), as well as the advantage of fractures in male children and adolescents (boys: 66% of all fractures). Other researchers have similar values (14). The incidence of the forearm fractures goes up over the age of 2 years, which is associated with the increasing physical activity and the peak of the forearm fractures coincides with the period of maturation (Figure 1). The results show an increasing trend of the forearm fractures in the study age group [3,5,6-11].

The largest number of fractures occurred in the spring (38%). The most common mechanism of fracture was a fall from a height <1 m. This may be related to the deficiency of vitamin D. It is known that the synthesis of the active metabolites of vitamin D decreases from the autumn until the spring, which together with the reduced physical activity during the winter can contribute to the increased bone fragility. The low levels of vitamin D cause a decrease in the bone mineral content (this was also shown by our analysis). On the other hand, more evidence prove that the incidence of fractures in children is associated with the reduced Bone Mineral Density (BMD) coexisting with the factors such as physical inactivity, poor nutrition, vitamin D deficiency and reduced exposure to the sunlight [11-17]. Some researchers have suggested that the problems with the osteoarticular system in adulthood are associated with the abnormal accumulation of bone mass during the growth and

Anatomical Location of Forearm Fracture	N = 1107 Boys	N = 561 Girls	N = 1668 Total Amount of Fractures
the Base of the Proximal Ulna (PU)	99	28	127
% Total	5,94%	1,68%	7,61%
the Proximal Epiphysis of the Radius (PR)	59	33	92
% Total	3,54%	1,98%	5,52%
the Shaft of the Ulna (CU)	36	15	51
% Total	2,16%	0,90%	3,06%
Diaphyseal of the Radius (CR)	78	48	126
% Total	4,68%	2,88%	7,55%
Both Bones of the Forearm (CRU)	207	92	299
% Total	12,41%	5,52%	17,93%
the Distal Radius (DR)	471	250	721
% Total	28,24%	14,99%	43,23%
the Distal Epiphysis of the Ulna and Radius (DRU)	157	95	252
% Total	9,41%	5,70%	15,11%
Total	1107	561	1668
% Total	66,37%	33,63%	100,00%

Table 1: The distribution of forearm fractures.

Football	27 %
Cycling/Biking	19 %
Scooter/Motorcycle	10 %
Trampoline	13 %
Roller skating	9 %
Skateboard	8 %
Skiing/Snowboarding	4 %
Ice-skates	3 %
Volleyball	5 %
Basketball	1.5 %
Swimming pool	0.5 %

Table 2: The most common mechanisms of fractures in the study group.

the positive history of fractures in childhood [12,18-20].

Poland's long-term and short-term weather patterns are made transitional and variable by the collision of diverse air masses above the country's surface. Maritime air moves across Western Europe, Arctic air sweeps down from the North Atlantic Ocean, and subtropical air arrives from the South Atlantic Ocean. The spring arrives slowly in March or April, bringing mainly sunny days after a period of alternating wintertime and springtime conditions. Summer, which extends from June to August, is generally less humid than winter. Showers and thunderstorms alternate with dry sunny weather that is generated when southern winds prevail. Early autumn is generally sunny and warm before a period of rainy, colder weather in November begins the transition into winter. Winter, which may last from one to three months, brings frequent snowstorms but relatively low total precipitation.

The statistical analysis clearly indicates that damage to the forearm in boys occurred a little later. The average age of fractures in boys was 10.39 (SD: 3.78), while in girls 8.77 (SD: 3.57). It is noticeable that the fracture of the ulna epiphysis occurs at the latest - the average age in both sexes is the highest and reaches the value of 12.3, while the average age in the other locations is similar. The analysis of gender and fracture location revealed the existence of the statistically significant ($p=0.04825$) relationship between the gender and the place of fracture. We distinguish the fracture of the ulna epiphysis, where the share of boys in relation to other locations is the highest (boys=78%, girls=22%) (Table 3). It becomes the most characteristic of the male part of the study group (the proportion was nearly twice higher in the group of boys). On the other hand, the most similar proportions occur in relation to the shaft fractures of the radius (boys=62%, girls=38%). Like in the case of other researchers from Europe and the USA, our analysis reported the greatest incidence of the forearm fractures of distal epiphysis in boys [3,4,11,21-23]. The mechanism of the formation of fracture is also similar [5]. The results are also consistent and indicate the peak incidence of fractures of the distal forearm reaching a maximum at about 12 years in girls and 14 years in boys [24].

The epidemiology of fractures in children and adolescents for many years has been the subject of numerous studies and discussions. In the light of the published data, there are no clearly documented reasons or etiopathogenetic links to the bone fragility in the first two decades of life, as some fractures in children and adolescents result from many coexisting factors such as age, race, biogeographic conditions, sex (predominance of boys), some physiological and environmental factors, lifestyle or even familial and genetic factors. A clear cause of fractures in low-energy trauma has not yet been established [25-27]. The forearm fractures caused by the direct trauma are often related to the hormonal changes during puberty. Therefore, further research is necessary to determine the exact causes and possibility of their

SEX (B – Boys, G – Girls)	Incidence of Fractures Observed in the Anatomical Location							
	PU	PR	CU	CR	CRU	DR	DRU	Total Amount
B	99	59	36	78	207	471	157	1107
% the columns	78%	64%	71%	62%	69%	65%	62%	
G	28	33	15	48	92	250	95	561
% the columns	22%	36%	29%	38%	31%	35%	38%	
Total Amount	127	92	51	126	299	721	252	1668

Table 3: Incidence of fractures observed in the anatomical location.

elimination or reduction of their impact on the incidence of fractures in children and adolescents in the future as well as the minimization of the consequences. It should be strongly emphasized that the causes of fractures are multifactorial and the efforts aimed to improve motion safety, in particular cautious behaviours, are so far the most important.

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