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Original article

Epidemiology of Pediatric Hand Surgery Emergencies. Retrospective Study of 245 Patients Seen over 10 Months in Two Referral Centers

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ABSTRACT

Background: The primary objective of this retrospective study was to analyse the epidemiology and assess the characteristics of all paediatric hand injuries requiring emergent surgery.

Hypothesis: Paediatric hand emergencies that require surgical treatment have a specific epidemiological distribution.

Methods: We conducted a multicentre retrospective descriptive epidemiological study of surgical paediatric hand emergencies seen over 10 consecutive months.

Results: We included 245 patients between the 1st of January and the 31st of October 2016. Irrespective of age, most injuries (69%) occurred at home; 11% (n=26) occurred at school and 4% in a sports centre. Overall, most injuries involved the dorsal aspect and affected the fingers more often than the hand. The most common lesion was crush injury of a distal phalanx (36% of cases). Door guards were in use in only 9% of homes (n=8), and mean age of the patients in this group was 5 years. Paronychia/acute infections accounted for 27% of cases. Wounds of the hands of fingers made up 23% of cases, with the palmar aspect being involved in 70% of cases. The wound was often due to the use of a sharp-edged object. Fractures/dislocations accounted for 12% of cases and bites or scratches for 2%.

Discussion: This study showed that the most common hand injuries requiring emergent surgery in a paediatric population are crush injuries of the fingertip such as door-crush injuries, which most often occur at home. Reinforcing prevention strategies should be the main priority in order to decrease the incidence of hand lesions in children. Raising awareness among parents and improving the education of the public could significantly decrease the incidence of these injuries.

Level of evidence: IV; retrospective cohort

Key Words: Fingertip injury; pediatric surgery; pediatric emergency; epidemiology study; injury prevention; distal phalanx crush injury

1.Introduction

Traumatic injuries of the hand in children are among the leading reasons for visits to paediatric traumatology emergency departments. In the USA, they account for 1.7% of emergency room visits [1]. A nationwide retrospective study done in the USA from 1990 to

2009 showed that the incidence rate of paediatric hand injuries was 11.6/1000 children/year [2]. A good understanding of the epidemiology of hand injuries in children is crucial to the development of effective prevention strategies. Young children are the most exposed to domestic accidents. The incidence of fingertip crush injuries caused by doors was 3.5% in one study[3]. In adolescents, the most common traumatic injuries are fractures, which usually occur during sports activities. Fractures of the hand account for 14.7% of all paediatric fractures and are in second position after wrist fractures (35.8%)[4]. Despite the high frequency of hand injuries in children, few studies have specifically addressed the incidence and causes of paediatric hand injuries requiring emergent surgery. Most of the studies in the literature focussed on fingertip crush injuries (FCIs) and fractures of the hand and fingers, and they evaluated lesions diagnosed in the emergency room, irrespective of whether they required surgery. We therefore sought to evaluate all paediatric hand lesions that required emergent surgery, including not only lesions of the bones and FCIs but also wounds, infections, and bites.

The primary objective of this retrospective study was to analyse the epidemiology and assess the characteristics of all paediatric hand injuries requiring emergent surgery. Our working hypothesis was that paediatric hand emergencies that require surgical treatment have a specific epidemiological distribution.

2. Patients and Methods

2.1. Patients

We conducted a multicentre, retrospective, descriptive, epidemiological study of patients seen over the ten-month period from 1st January to 31st October 2016. We included all children aged less than 15 years and 3 months who were seen at either of the two

participating centres for a hand and/or finger lesion that occurred within the last 24 hours and required surgical treatment. There was no lower age limit because one of the two centres was equipped to provide care to neonates and infants.

Exclusion criteria were age older than 15 years and 3 months (the age limit used to define the paediatric population in one of the two centres); burns, which were managed in a burn centre; and a need for emergency surgery due to a secondary complication of a previous scheduled surgical procedure on the hand. Injuries to the wrist were also excluded.

2.2 Assessment methods

Potentially eligible patients were identified based on the diagnostic codes assigned in the electronic databases of the two centres. Before the study, the legal representatives of these patients were sent an email providing information about the epidemiological study and its objectives, and asking for their consent to participation. If no answer was received, a phone call was made. Patients whose legal representatives declined participation or could not be contacted by email or telephone were excluded.

An analysis of the type of the lesions identified five different categories: FCIs, such as those caused by a closing door; paronychia and other finger and hand infections, irrespective of the source of the initial infection; wounds; fractures and dislocations of the fingers and carpal bones, including open and closed fractures and dislocations but excluding fractures as part of FCIs; and bites or scratches. We also differentiated four age groups to allow a detailed analysis of the distribution of each lesion type: 0 to 2 years; 3 to 5 years, 6 to 10 years, and 11 years to 15 years and 3 months.

The following data were abstracted from the notes made at emergency room admission and during subsequent visits: data on the patient (general characteristics, medical history, and vaccinations); data on the injury (site of the accident, circumstances of the injury, and

whether a witness was present); data on the lesion (side, type, and mechanism; for FCIs, parents were asked when in the emergency room or during the post-operative visit whether a door guard had been in place. For paronychia and other infections, the circumstances of development and any prior treatments were recorded. Bites were classified as made by a human or animal, and if the latter, the species and/or breed of the animal was specified. In the event of missing data, the legal representatives of the patients were contacted by email or telephone to obtain the necessary information.

The surgical reports and correspondence about the hospital admission were searched for data on the following: type and location of the lesion (on the hand and/or fingers and at the dorsal and/or volar aspect). Whether imaging studies were performed was recorded and any available imaging studies were reviewed to look for a fracture and determine its location or to identify a foreign body.

2.3. Statistical analysis

Qualitative variables were described as frequencies and percentages and numerical variables as the median with the interquartile range. The normal distribution of the numerical parameters was checked graphically and tested using the Shapiro-Wilk test. For comparisons of lesion types, the chi-square test was applied for qualitative parameters and the Cochran Armitage test for ordinal parameters. All tests were two-tailed and values of p smaller than 0.05 were considered significant. The statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC, USA).

3. Results

In all, 307 patients were eligible. Among them, 62 were excluded secondarily, for the following reasons: the legal representatives of 47 patients could not be contacted by email or

telephone; surgical data were missing for 12 patients; and 3 patients were older than 15 years and 3 months. This left 245 patients for the analysis.

Mean age was 6.4 years and 110 (45%) patients were female. A significant history of disease was noted for 12 (4.9%) patients (asthma in 6 and 1 case each of laryngeal spasm, Hodgkin disease, ventricular septal defect, severe haemophilia A, and diabetes with autistic spectrum disorder). Over the 10-month study period, no patient returned to the emergency room for another hand and/or finger injury. Table 1 details the distribution across the four age groups.

Of the 245 injuries, 169 (69%) occurred at home, 26 (11%) at school, and 4% in a sports centre (Figure 1). FCIs accounted for over a third of the patients, followed by paronychia /infection, wounds, fractures/dislocations and, finally, bites and/or scratches (Figure 2). The lesion involved the dorsal aspect in 73% of cases, the volar aspect in 23% of cases, and both aspects in 4% of cases. The hand was involved in only 18 (7%) patients. A foreign body was present in 10 (5%) patients. A radiograph was obtained for 130 (53%) patients and showed a fracture in 52% of cases. No ultrasound scans were performed. Table 2 reports the main results according to the type of lesion.

The patients in the fracture/dislocation group were significantly older than those in the FCI group ($p < 0.0003$). No significant difference was found across groups for sex ($p = 0.54$) or involvement of the dominant side ($p = 0.47$).

Of the 89 patients with FCI, 79 had had their finger caught in a door and 8 (9%) lived in homes where door guards were in place. A radiograph was obtained in 85 (95.5%) cases and showed a fracture of the distal phalanx in 36 (40%) patients.

Paronychia or another infection was present in 66 (27%) patients, including paronychia in 41 (62.1%) patients and another type of infection in 25 (37.9%) patients (13 infections of neglected wounds, 7 infections around foreign bodies, and 5 phlegmons). Local antiseptic treatment had been initiated by the usual doctor in 65% of cases, at a visit to a different emergency department in 17% of cases, and by the parents of their own accord in 18% of cases. Furthermore, 18% of these patients had a past history of paronychia.

Of the 57 wounds, 40 (70%) were on the volar aspect and 24 (34%) involved the forefinger. Surgical exploration of the wound showed no damage to the local structures in 47 (82.5%) cases; of the 10 other patients, 3 (5.3%) had isolated section of a digital pedicle, 2 (3.5%) had section of a digital pedicle and of one (n=1) or two (n=1) flexor tendons; and 5 (8.8%) had injuries to the extensor apparatus (3 in zone 5, 1 in zone 2, and 1 in zone 3). Of the 57 patients with wounds, 27 (47.4%) underwent radiography, which never showed any fractures but visualized radio-opaque foreign bodies in 4 patients.

Of the 28 patients with fractures/dislocations, only 1 had a dislocation (dorsal dislocation of the proximal interphalangeal joint of the second ray with a wound on the volar aspect), i.e., 3.5% of the population. The other 27 patients had fractures. In 8 (36%) patients, the fracture had occurred while practicing sports; in 6 (21%) patients, during a fall; in 5 (18%) patients, after punching a wall; and in 5 patients, due to a door. The fracture involved a metacarpal in 7 (26%) patients and a proximal phalanx in 12 (44%) cases.

All 5 patients in the bite/scratches subgroup had been injured by a dog. Among them, 4 had been bitten and 1 scratched. The animal was known in 4 of the 5 cases. Only 1 of the dogs was properly immunized against rabies; another dog had not received the full complement of injections and for the 3 remaining dogs no information on rabies immunization was available.

Figure 3 reports the distribution of the lesions by age group. In the three youngest groups (up to 10 years), FCI was the most common injury (n=82, 43%) followed by paronychia /infection (n=57, 30%) then by wounds (n=38, 20%). Among the wounds in these younger children, 1 involved a digital pedicle (0-2 years group), 2 involved a digital pedicle and the flexor apparatus (1 in the 3-5 years group and 1 in the 6-10 years group) and 1 involved the extensor apparatus in zone 3 (3-5 years group). In the older children (11-15 years and 3 months), 19 (35%) lesions were wounds, 17 (31%) were fractures/dislocations, 8 (15%) were paronychia/infections, and 8 (15%) were FCIs. Six explored wounds showed lesions, which involved the extensor apparatus in 4 patients (3 in zone 5 and 1 in zone 2) and 2 consisted in the isolated section of the digital pedicle.

4. Discussion

This study reports on the epidemiology of paediatric hand emergencies requiring surgical management. Except for the wounds, the lesions most often involved the dorsal aspect of the fingers rather than the hand, in keeping with earlier studies [5,6]. Our cohort was larger than previous ones, perhaps because we included paronychia /infections, which were not taken into account by others [1,5,7-9]. In some centres, procedures may have been performed in the emergency room and not in the operating room (e.g., certain FCIs and hand wounds that did not seem to involve underlying structures). In the two centres that participated in our study, when a lesion required a procedure (e.g., suture, fracture reduction,), this procedure was always performed in the operating room. Mean age of patients in our study was 6.4 years, in keeping with the range of 7 to 7.5 years reported in the literature [5,8]. We defined paediatric patients as younger than 15 years and 3 months, which

may explain that the mean age was somewhat higher in other studies that included patients up to 18 years of age.

The high incidence of domestic accidents, irrespective of patient age, contrasting with the low incidence in schools and playgrounds, may be due not only to greater attention on the part of teachers and parents than in other places but also to the availability of infrastructures specifically designed for children and geared towards injury prevention. The presence of an adult does not seem to prevent injuries, since an adult was present in over 50% of cases of FCIs, wounds, and bites/scratches. This proportion is higher than in the study by Liu et al.[7]. Presence of an adult has received little attention in the literature. Nevertheless, this point highlights the importance of strengthening prevention policies and improving the information given to parents and to other adults involved with children.

Over a third of injuries in our study were FCIs. Mean age for these injuries was 5 years. Other studies found similar [10] or higher [11,12] mean ages, pointing out that FCIs do not occur only in the youngest children. Vadivelu et al.[13] found 65.5% of fractures of which 64% were crush injuries, but this difference is probably ascribable to the inclusion in the fracture group of patients with fractures due to FCIs, whereas we separated the two groups. As in other studies, FCIs were usually due to the finger being caught in a door (89%) and most often occurred at home [11,14–16]. The inadequate equipment of homes was demonstrated in our study and has already been pointed out by others [10]. The use of door guards should be more widespread and encouraged, notably by prevention campaigns. Other security devices seem necessary, such as guards for door hinges and for doors of furniture.

Furthermore, although paronychia s/infections are not acute lesions in the strict sense of the term, we decided to include them because they often require surgical management. Thus, paronychia /infections accounted for 27% of the lesions in our study. Medical

treatment had often been given previously, at the early stages of the paronychia, before the stage of collection requiring surgical intervention. [17].

Two studies [2,8] found a higher incidence of wounds. However, they counted all patients visiting the emergency room for a hand injury, irrespective of whether surgery was needed. In our study, the majority of wounds occurred at home and involved the volar aspect, requiring a technically challenging procedure to repair the neurovascular bundle and/or the flexor apparatus in these young patients. Although most wound explorations found no damage to underlying structures, irrespective of the age group, most of the technically difficult repair procedures were required in the groups aged 3 to 5 and 6 to 10 years (damage to a digital pedicle combined with an injury to the flexor tendon). This age distribution probably reflects the beginning of the use of high-risk objects. The technical challenges are increased by the small size of the pedicles and tendon structures. Our results are thus a caution against underestimating these wounds seen in the emergency room. Wound exploration in the operating room must be proposed routinely, notably in young children in whom the physical examination may not be fully reliable.

We believed it was relevant to separate crush fractures occurring in younger children from the other types of fracture, which are more common in older children (in our study, mean age was 9.6 years) and often occur during sports (36% of cases) [2,4,6,9,18–23]. The small proportion of patients with fractures in our study is also due to the fact that the treatment usually consists in closed reduction. Interestingly, as in previous studies, the locations where the accidents occurred were fairly evenly distributed in the group with fractures, as were the mechanisms, which showed greater variation [18,19] Finally others have also reported a predominance of fractures of the proximal phalanx [24].

We had only very few patients with bites or scratches. The literature is conflicting on this point [25,26]. Nevertheless, Speirs et al. found only 4 cases of bites requiring surgery,

and Aksam et al. found 6 cases among 310 patients[27,28]. Dog bites predominated. Bites are very common in children but are usually located at the face (75-80%) rather than at the hands. The face seems particularly exposed to bites because it is at the level of the dog's muzzle [25]. In our study, only one of the dogs had received the full complement of anti-rabies injections, which were properly documented. For the other animals, there was either no information on anti-rabies immunization or the dog was overdue for a booster dose. In some cases, the owner of the dog is unknown and the animal cannot therefore be placed under monitoring by a veterinarian (stray dogs). These situations make rabies prevention challenging and support the need for a visit to an anti-rabies centre after an animal bite, as well as for greater efforts toward prevention and education of the public about the anti-rabies vaccine.

Our study has a number of limitations. The retrospective design may limit the relevance of our findings. However, this risk was mitigated by a painstaking search for data about the emergency room care, the surgical procedure, and the follow-up visits. Recall bias may have occurred, since missing data were obtained by contacting the parents of the patient. Our decision to confine our analysis to lesions requiring surgery led to a low incidence of fractures and dislocations in our cohort but is consistent with our initial objective, which was to describe the epidemiology of surgical indications. Many studies included burn injuries. However, patients with burns were managed at a burn centre, so that including burn injuries would have complicated the collection of the study data.

5. Conclusion

This study showed that paediatric hand and finger injuries requiring surgical management are most often FCIs and occur in the home. Prevention should be the key

priority in order to decrease the incidence of finger and hand injuries in children. Raising awareness among parents and educating the public could lead to a substantial decrease in the incidence of these lesions.

Conflicts of interest

None of the authors has any conflicts of interest to declare in relation with this study.

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None

Contributions of each author

FD collected the study data and wrote the manuscript.

MS revised the manuscript for important intellectual content.

AM supervised the conduct of the study.

EG collected the data.

CC supervised the conduct of the study and revised the manuscript for important intellectual content.

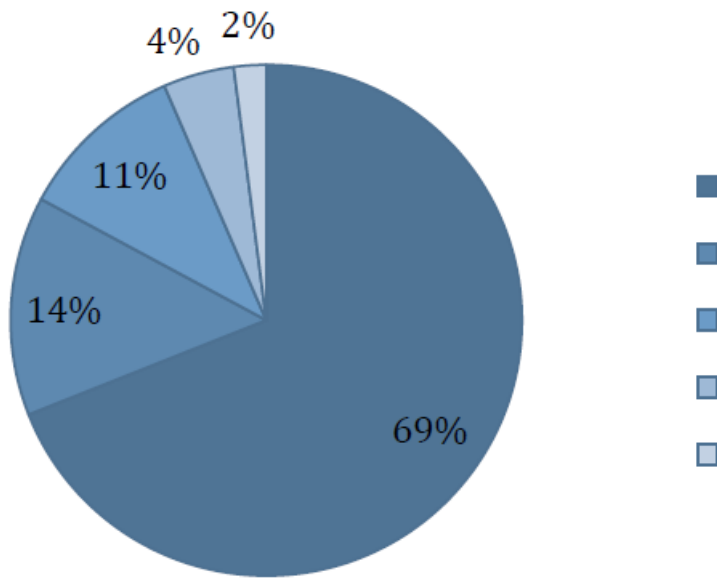
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Figure 1 : Places where the accidents occurred



Home

Street or equivalent

School

Sports centre

Playground

(placer les légendes au niveau des carés svp)

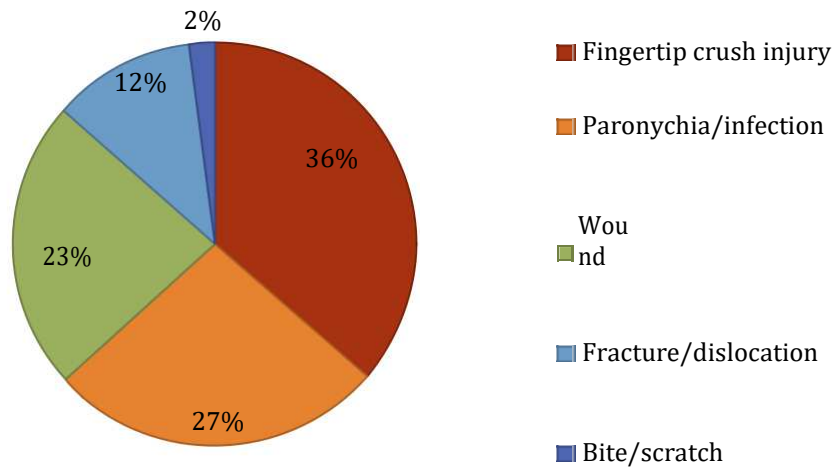


Figure 2: Types of lesions

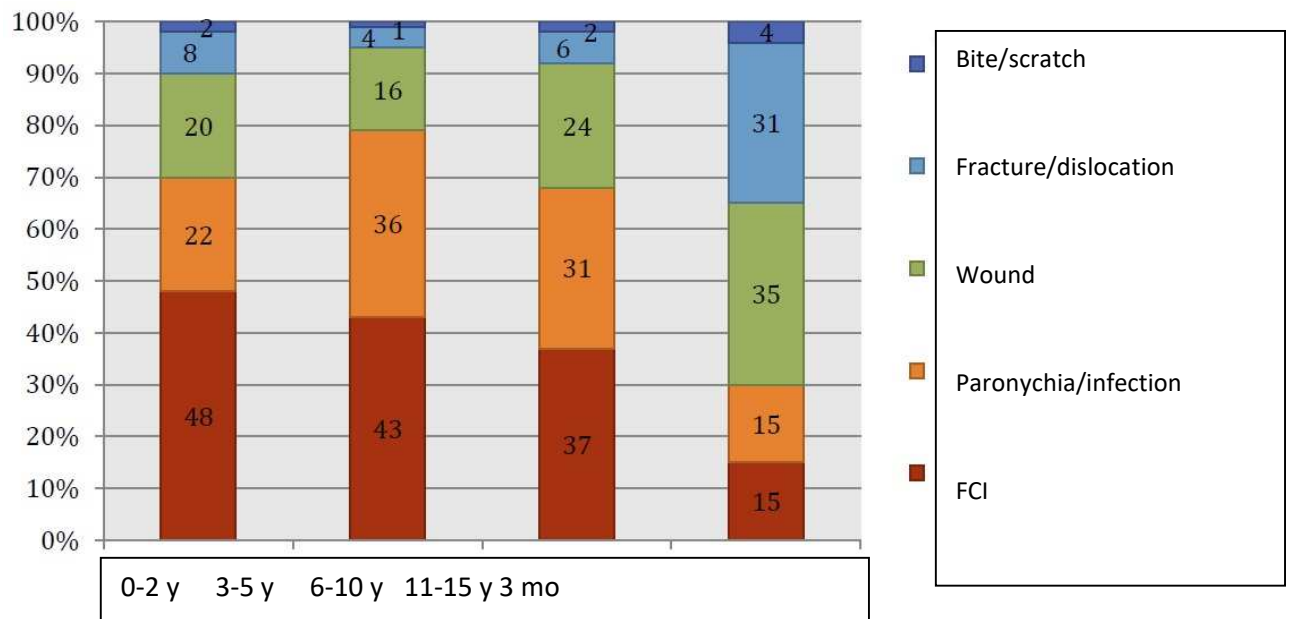


Figure 3 . Distribution of the lesions by age group

FCI : fingertip crush injury

	0-2 years	3-5 years	6-10 years	11-15 years
n (%)	54 (22%)	70 (29%)	67 (27%)	54 (22%)
Distribution: n (%)				
- Girls	31 (57%)	31 (44%)	25 (37%)	23 (43%)
- Boys	23 (43%)	39 (56%)	42 (63%)	31 (57%)
Mean age (years)	1.4 (±0.7)	3.8 (±0.8)	7.9 (±1.4)	12.7 (±1.4)

Table 1: Distribution of the population across the four age groups

	FCIs	Felon/ Infection	Wounds	Fracture/ Dislocation	Bite
n (%)	89 (36%)	66 (27%)	57 (23%)	28 (12%)	5 (2%)
Age in years (mean ±SD)	5 (±3.5).	5.6(±3.5)	7.6 (±4.6)	9.6 (±5)	7.6(±4.6)
Mechanism					
- Door	89%	4.5%	-	18%	-
- Infection	-	89%	-	-	-
- Sharp-edged object	-	-	83%	3.5%	-
- Fall	2%	4.5%	12%	21%	-
- Sports	2%	1%	2%	36%	-
- Bite	-	-	-	-	100%
- Punch	-	-	-	18%	-
- Hit by falling object	7%	-	-	3.5%	-
Location					
- At home	70%	91%	63%	29%	60%
- In the street or equivalent	14%	3%	21%	25%	40%
- School	12%	4.5%	9%	21%	-
- Sports centre	2%	-	3.5%	25%	-
- Playground	2%	1.5%	3.5%	-	-
Witness					
- At least one adult	63%	17%	65%	46%	80%
- A child	29%	4%	19%	36%	20%
- No witness	8%	79%	16%	38%	-

Table 2: Main results according to the type of lesion.

FCI: fingertip crush injury