ABSTRACT

Background: The purpose of this study was to evaluate the impact of the COVID-19 pandemic activity restrictions on pediatric supracondylar humerus fracture epidemiology in terms of both mechanism of injury and fracture patterns.

Methods: This was a retrospective chart review of all patients presenting with types II-IV supracondylar humerus fractures between March 15th and June 30th 2020 at the McMaster University Medical Centre. Data were collected from our secure electronic medical records for information on patient demographic data, mechanism of injury, operative reports and imaging. 5 treating surgeons independently analyzed each patient's radiographs and classified them according to Gartland's classification.

Results: A total of 40 patients were included in this study with a mean age of 5.7 years (SD=2.1 years). Fourteen (35%) of the patients included were female, and 19 (48%) were left elbow injuries. Of the 40 fractures included, 5 (13%) were graded as 2A, 15 (38%) were graded as 2B, 18 (45%) as grade 3, and 2 (5%) as flexion type. The most common mechanism of injury of patients included in this study was falling off furniture (including chairs, couches and beds) within the house, with 9 injuries (23%).

Conclusion: This study demonstrates the epidemiology of supracondylar humerus fractures during the COVID-19 pandemic. This study demonstrated a high rate of serious fracture patterns with the presence of medial comminution. The mechanism of injury differs from the published literature with most fractures occurring in an indoor as opposed to outdoor setting.

Keywords: Supracondylar; Humerus; Fracture; Pediatrics

INTRODUCTION

Supracondylar humerus fractures constitute one of the most common fracture patterns seen in children and often require operative fixation [1]. These fracture patterns also confer high rates of neurovascular injury with reported neuropraxia rates as high as 11% [2]. Furthermore, the most common mechanism of injury are falls sustained while using outdoor playground equipment [1,3].

The World Health Organization (WHO) declared the SARS-CoV-2 virus a global pandemic on March 11th 2020. This subsequently led to many nationwide restrictions including stay-at-home orders and park closures for several months. This further resulted in the closure of all elective procedures at most hospitals with patients only being seen in person if absolutely necessary such as if they experienced a traumatic fracture [4]. Understanding the effect of activity restrictions and widespread lockdown on trauma cases presenting to the hospital is essential in order to better plan for any possible future pandemics causing widespread activity restrictions.

In order to plan for effective safety measures to reduce the incidence of fractures in the pediatric population, it is crucial to study mechanisms of injury that leads to fractures which will further allow us to create adequate preventative measures for these injuries. Therefore, the aim of this study is to evaluate the impact of the COVID-19 pandemic activity restrictions on pediatric supracondylar humerus fracture epidemiology in terms of both mechanism of injury and fracture patterns.

METHODS

Study Design

This retrospective study included all patients between 1-16 years of age who presented to the McMaster University Medical Centre from March 15th 2020 to June 30th 2020 and sustained a type II-IV supracondylar humerus fracture according to Gartland's classification managed either operatively or non - operatively. Children presenting with non– displaced Gartland type 1 fractures were excluded.

Study Methodology

Using our secured electronic handover database, patients were identified, and their charts were reviewed for information on demographic data, mechanism of injury, operative reports and imaging. Subsequently, five treating surgeons independently analyzed each patient's radiographs and classified them according to Gartland's classification. All patient information was de – identified and a study number assigned to each participant as the only form of identification. Ethics approval was received and the project identification number is 11160-C.

Statistical Analysis

Descriptive statistics were used to classify and describe the patients and types of fractures included in the study with means and standard deviations (SD) used for continuous variables and counts and percentages for categorical variables. Inter-reviewer agreement was calculated using the Fleiss extension for Kappa (κ) with multiple raters, with associated 95% confidence intervals (CI) [5]. Agreement was categorized *a priori* as follows: κ of 0.81–0.99 was considered as almost perfect agreement; κ of 0.61–0.80 was substantial agreement; κ of 0.41–0.60 was moderate agreement; 0.21–0.40 fair agreement and a κ value of 0.20 or less was considered slight agreement [6]. Calculations and figures were conducted using StatsDirect statistical software (Version 3.2.7, StatsDirect software, Cheshire, UK).

RESULTS

A total of 40 patients were included in this study with a mean age of 5.7 years (SD=2.1 years). Fourteen (35%) of the patients included were female, and 19 (48%) were left elbow injuries. Twenty-five of the patients (63%) were transferred from another institution for management. All fractures were closed, and two had ipsilateral both bone forearm fractures one of which was highly comminuted. On presentation, the vascular status of the involved extremity in 36 patients (90%) was normal, while four (10%) presented with a pulseless, but viable extremity. In terms of the pre-operative neurological status of the extremity, 36 (90%) had no neurological deficits pre-operatively, while 2 patients had an isolated AIN nerve palsy, 1

had an isolated ulnar nerve palsy, and 1 had a combined AIN and radial nerve palsy pre-operatively. The 1 patient with an ulnar nerve palsy sustained a flexion type fracture while the 2 patients with AIN palsy and the 1 patient with a combined palsy sustained extension type fractures.

The most common mechanism of injury of patients included in this study was falling off furniture (including chairs, couches and beds) within the house, with 9 injuries (23%). A fall onto an outstretched hand from standing height (FOOSH) was the next most common mechanism of injury (8 patients, 20%). A total of 6 (15%) patients injured their arm falling off their bicycle, followed by 4 (10%) with a trampoline injury, and 3 (7.5%) with an all – terrain vehicle (ATV) accident. Two patients each (5%) injured their arm on hoverboards and playground structures such as monkey bars. Other mechanisms of injury included falling from a swing, tree, down a hill or stairs, and falling down from barn rafters (Figure 1).

Thirty-nine of the cases were managed operatively (98%) while 1 case was managed non-operatively. Of the operative cases, 36 (92%) required only a closed reduction in the OR, while three (8%) required an open reduction, with two of these cases also involving a vascular exploration. Of the three patients requiring open reduction, two of them sustained type 3 fractures for an incidence of 11% requiring open reduction among those with type 3 fractures, while the one other patient sustained a flexion type fracture. Two Kirschner (K) -wires were used in 15 (38%) cases, three K-wires in 19 cases (49%) while four K-wires were used in five ases (13%), for a mean (SD) of 2.7 (0.68) K-wires used per case. The K-wires were placed only lateral in 26 cases (67%), and both medial and lateral in 13 cases (33%). The mean (SD) surgical time was 47.8 minutes (45.5 minutes) with a range of 15 minutes to 3 hours. The mean (SD) length of stay in the hospital was 1.4 days (1.9 days), with 35 (90%) patients staying 24 hours or less.

Overall, there was substantial inter-reviewer agreement amongst the five blinded raters with respect to the Gartland Classification grades given to the fractures with a combined Fleiss Kappa of 0.74 (95% CI = 0.68 to 0.81, $p<0.0001$), and a weighted kappa of 0.72. Of the 40 fractures included, 5 (13%) were graded as 2A, 15 (38%) were graded as 2B, 18 (45%) as grade 3, and 2 (5%) as flexion type (Figure 2).

Furthermore, 11 fractures (28%) were further classified as having medial collapse with loss of Baumann's angle.

DISCUSSION

While the overall incidence of supracondylar fractures did not change, the most important finding of this study was that the mechanism of injury was different, and many patients presented with severe fracture patterns and medial comminution.

The mean age of included patients was 5.7 years and the majority of patients affected were boys (65%) which is in keeping with previous studies that have found an approximate average age of 6 years with a male predominance in patients sustaining supracondylar fractures [3,7].

Similar to prior studies, 45% of patients sustained a type 3 fracture, 38% a type 2B fracture and 13% a type 2A fracture [1,8]. Of the 40 fractures included in this series, four patients (10%) had a documented neurological deficit noted preoperatively. This incidence is in keeping with previously published studies reporting rates of 6-20% [2,3,7]. Furthermore, the two patients with isolated AIN palsy sustained extension type fractures while the one patient with ulnar nerve palsy sustained a flexion type injury. This observation is in keeping with previously published literature which demonstrates the higher rate of AIN palsy in extension type injuries and higher rates of ulnar nerve palsies in flexion type injuries [2,9].

Three patients (8%) required open reduction of their fracture, with 11% of patients sustaining type 3 fractures requiring open reduction. This is in keeping with previous published literature reporting rates of 2.9%-22% requiring open reduction for type 3 fractures [7,10]. Furthermore, 4 patients (10%) presented with a pulseless, viable extremity, with 2 of them (5%) requiring vascular exploration. This rate of vascular injury is slightly lower than the documented rate of 12-15% in prior studies [11]. Moreover, 28% of patients demonstrated evidence of medial comminution radiographically. It is very important to be wary of patients with medial comminution as it is associated with high rates of loss of reduction and generally requires additional medial pinning of the fracture to provide adequate stability [12].

The most common mechanism of injury seen in this study was falling off indoor furniture in ~~in~~ 9 patients (23%). Classically, one would expect the most common mechanism of injury in supracondylar humerus fractures to be related to falls off playground equipment such as monkey bars and trampolines with a prevalence of 38% seen in prior studies. [1,3]. Therefore, prevention strategies for these injuries are aimed towards targeting playground equipment by introducing softer landing surfaces beneath select play equipment, lower heights of the monkey bars, increased adult supervision and increasing parent education surrounding the risks of these injuries in outdoor playgrounds. However, the COVID 19 pandemic has resulted in decreased overall outdoor activity particularly related to the stay – at - home orders that have been put in place at our local hospital's city. Moreover, during the majority of this study period, outdoor parks and playgrounds were closed to the entire public altogether. Despite this, children were still managing to sustain supracondylar fractures albeit by completely different modes of injury with the most common mechanism being falling off indoor furniture including couches, chairs and beds. This highlights the need for further prevention strategies not only in outdoor settings but in indoor areas as well particularly in pandemic setting. These include the use of bed rails, carpets with thick padding and limiting the use of bunk beds among others [13]. Furthermore, 4 patients (10%) sustained fractures after falling off a trampoline. Given that parks were closed, these trampoline accidents were presumably related to patient – owned trampolines located in their backyards which highlights the need for further patient education and injury prevention strategies when purchasing and installing a trampoline in one's backyard. These include increased adult supervision, and only allowing a single jumper per trampoline, among others [14].

The findings of this study are significant as it provides us with valuable information on supracondylar humerus injury mechanisms particularly related to the COVID-19 pandemic and allows us to accordingly tailor our injury prevention strategies in this pandemic or any future pandemics. Furthermore, given that this observed difference in mechanism of injury is likely attributable to increased time spent at home as a result of pandemic restrictions, it is possible that we would find similar injury mechanisms during the

winter season where many children are spending most of their time indoors. Therefore, future research examining the seasonal mechanisms of injury in these fractures would be useful to further tailor prevention strategies accordingly. Additionally, future research evaluating the effectiveness of various prevention strategies would be helpful in providing evidence – based primary prevention recommendations for these injuries.

Limitations of this study include a retrospective design, small sample size and the short study period.

Conclusion

This study demonstrates the epidemiology of supracondylar humerus fractures during the COVID-19 pandemic. This study demonstrated a high rate of serious fracture patterns with the presence of medial comminution. The mechanism of injury differs from the published literature with most fractures occurring in an indoor as opposed to outdoor setting. This suggests that injury prevention strategies focused on the indoor setting are needed particularly in a pandemic setting.

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FIGURES

Figure 1. Figure Depicting the Mechanisms of Injury of Supracondylar Humerus Fractures

Figure 2. Figure Demonstrating the Proportion of Fracture Type by the Gartland Classification