Pediatric Supracondylar Humeral Fractures: Epidemiology and Mechanisms of Injury During the Covid-19 Pandemic

Dan Cohen, MD; Jeffrey Kay MD; Mohammed Shehab, MD, FRCSC; Darren de SA. MD, FRCSC; Devin C. Peterson, MD, FRCSC; Waleed Kishta, MD, FRCSC

Division of Orthopaedic Surgery, Department of Surgery, McMaster University, Hamilton, Ontario, Canada.

Corresponding Author Waleed Kishta, MD, FRCSC. Division of Orthopaedic Surgery, Department of Surgery, McMaster University Medical Centre, 1200 Main Street West, 4E15 Hamilton, ON, Canada L8N 3Z5 (email: waleed.kishta@medportal.ca).

Conflict of Interest The authors report no conflicts of interest.

Funding The authors received no financial support for the research, authorship, or publication of this article.

ABSTRACT

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

Methods: This is a retrospective chart review of all patients presenting with types II-IV supracondylar humerus fractures during the Covid-19 pandemic compared to a non-pandemic cohort.

Results: A total of 40 patients were included in the pandemic group with a mean age of 5.7 years, and 35 patients in the non-pandemic group with a mean age of 5.9 years. In the pandemic group, 5 (13.0%) fractures were graded as 2A, 15 (38.0%) were graded as 2B, 18 (45.0%) as grade 3, and 2 (5.0%) as flexion type. In the non-pandemic group, 8 (23.0%) fractures were graded as 2A, 10 (29.0%) were graded as 2B, 16 (46.0%) as grade 3, and 1 (3.0%) as flexion type. Furthermore, 11 fractures (28.0%) in the pandemic group were classified as having medial collapse while 5 (14.0%) fractures in the non-pandemic group presented with medial collapse. The most common mechanism of injury in the pandemic group was falling off furniture with 9 injuries (23.0%), and in the non-pandemic group was fall off monkey bars in 8 (23.0%) patients.

Conclusion: This study demonstrated a higher rate of serious fracture patterns with the presence of medial comminution in the pandemic group. The mechanism of injury differs from the non-pandemic group with most fractures occurring in an indoor as opposed to outdoor setting.

Keywords: Humerus; Pediatrics; Covid-19; Pandemics

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 11.0%.[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 11, 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 is essential to better plan for any possible future pandemics causing widespread activity restrictions.

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 lead to fractures, which will further allow us to create adequate preventative measures for these injuries. 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 year to 16 years of age who presented to the McMaster University Medical Centre from March 15, 2020 to June 30, 2020 for the pandemic cohort, and March 15, 2019 to June 30, 2019 in the non-pandemic cohort. According to Gartland's classification, all patients sustained a type II-IV supracondylar humerus fracture managed either operatively or non-operatively. Children presenting with non-displaced Gartland type 1 fractures were excluded.

Study Methodology

Using the 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, each patient's radiographs were analyzed and classified according to Gartland's classification. All patient information was de-identified and a study number was 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. Subsequently, figures were used demonstrating both fracture type and mechanism of injury. Calculations were conducted using StatsDirect statistical software (Version 3.2.7, StatsDirect software, Cheshire, UK).

Results

A total of 40 patients were included in the pandemic group with a mean age of 5.7 years (SD=2.1 years). Fourteen (35.0%) of the patients included were female, and 19 (48.0%) were left elbow injuries. Twenty-five of the patients (63.0%) were transferred from another institution for management (Table 1). 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 (90.0%) was normal, while four (10.0%) presented with a pulseless, but viable extremity. In terms of the pre-operative neurological status of the extremity, 36 (90.0%) had no neurological deficits preoperatively, while two patients had an isolated anterior interosseus nerve (AIN) palsy, one had an isolated ulnar nerve palsy, and one had a combined AIN and radial nerve palsy pre-operatively. The patient with an ulnar nerve palsy sustained a flexion type fracture while the two patients with AIN palsy, and the patient with a combined palsy sustained extension type fractures.

A total of 35 patients were included in the non-pandemic group with a mean age of 5.9 years (SD=1.9). Sixteen (46.0%) of the patients included were female and 16 (46.0%) were left elbow injuries. Twenty-one (60.0%) of the patients were transferred from another institution for management (Table 1). All fractures were closed and 33 (94.0%) patients presented with an intact, peripheral vascular exam while two (6.0%) patients presented with a pulseless, but viable extremity. In terms of the preoperative neurological status of the extremity, 32 (91.0%) patients had no neurologic deficit preoperatively while two (6.0%) of the patients had an isolated AIN nerve palsy, and one (3.0%) patient had an isolated radial nerve palsy that resolved by 6 months postoperatively. The two patients with an AIN palsy both sustained extension-type fractures.

In the pandemic group, the most common mechanism of injury was falling off furniture (e.g., chairs, couches, and beds) within the house, with nine injuries (23.0%) resulting from these falls. A fall onto an outstretched hand from standing height (FOOSH) was the next most common mechanism of injury (eight patients, 20.0%). A total of six (15.0%) patients injured their arm falling off their bicycle, followed by four (10.0%) with a trampoline injury, and three (7.5%) with an all-terrain vehicle (ATV) accident. Two patients (5.0%) injured their arm on hoverboards and playground structures. Other mechanisms of injury included falling from a swing, tree, down a hill or stairs, and falling down from barn rafters (Figure 1). In the non-pandemic group, the most common mechanism of injury was a fall off monkey bars in eight (23.0%) patients, followed by a fall off other playground structures such as the swing, trampoline or slide in seven (20.0%) patients. Falling off furniture (e.g., chairs, couches, and beds) within the house was the next most common mechanism of injury in six (17.0%) patients. A total of five (14.0%) patients injured their arm from a FOOSH injury, while three (9.0%) patients injured their arm falling off a bicycle, and two (6.0%) patients injured their arm falling off their scooter. Other mechanisms of injury included falling down stairs, from a tree, in a jungle gym, or while playing basketball (Figure 2).

In the pandemic group, 39 of the cases were managed operatively (98.0%), while one case was managed non-operatively. Of the operative cases, 36 (92.0%) required only a closed reduction in the operating room (OR), while three (8.0%) 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 11.0% requiring open reduction among those with type 3 fractures, while the one other patient sustained a flexion-type fracture. In the non-pandemic group, all 35 cases were managed operatively (100.0%) with two (6.0%) of these requiring open reduction and none of them requiring vascular exploration. Of the two patients requiring open reduction, both patients sustained type 3 fractures for an incidence of 13.0% requiring open reduction among those with type 3 fractures.

Table 1 *Patient Demographics*

	Pandemic Group	Non-pandemic Group
Total Patients	40	35
Age	5.7 +/- 2.1	5.9 +/- 1.9
Gender	35.0% Female	46.0% Female
Fractured Extremity	48.0% Left	46.0% Left
Transfer from Another Institution	63.0%	60.0%

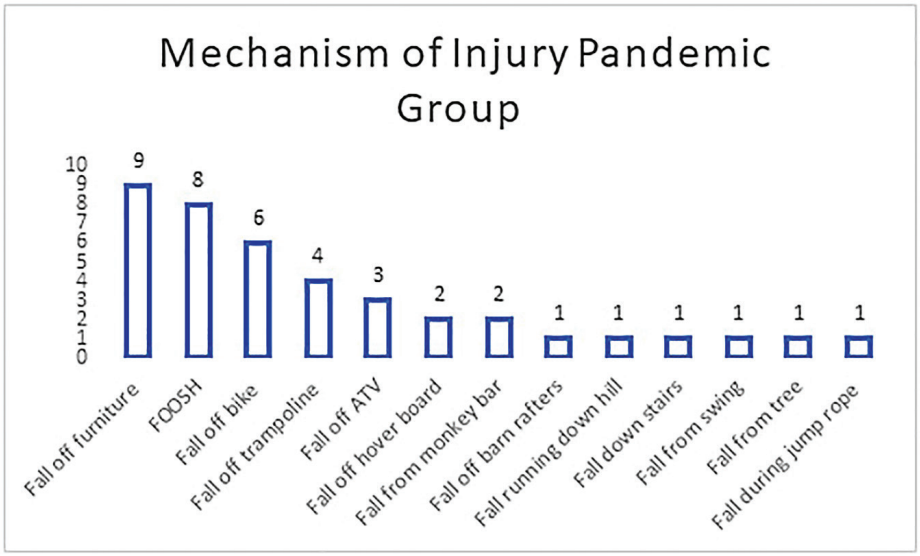

Figure 1. *Figure depicting the mechanisms of injury of supracondylar humerus fractures for the pandemic group.*

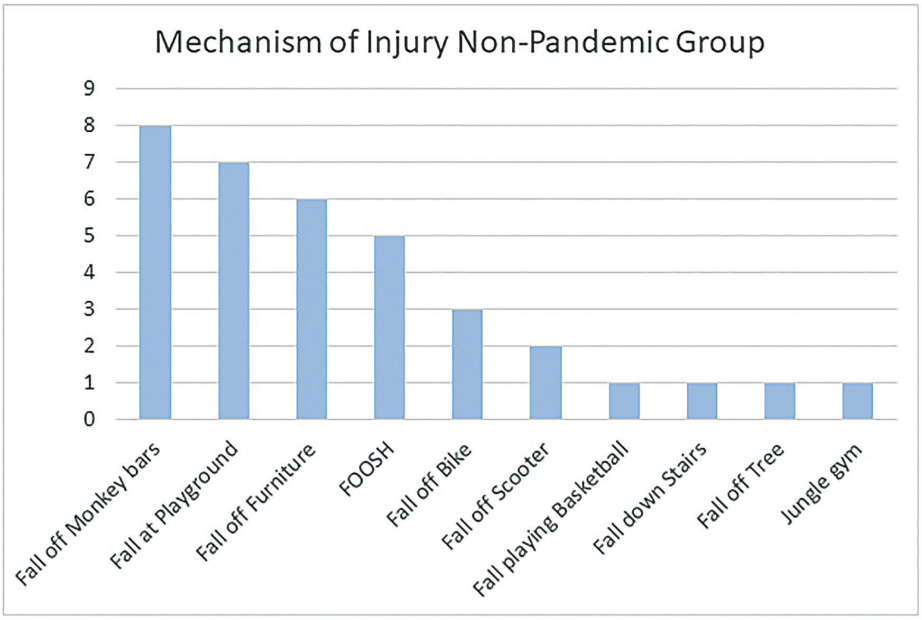

Figure 2. *Figure depicting the mechanisms of injury of supracondylar humerus fractures for the non-pandemic group.*

Of the 40 fractures in the pandemic group, five (13.0%) were graded as 2A, 15 (38.0%) were graded as 2B, 18 (45.0%) as grade 3, and two (5.0%) as flexion type (Figure 3). Furthermore, 11 fractures (28.0%) were further classified as having medial collapse with loss of Baumann's angle. Of the 35 fractures in the non-pandemic group, eight (23.0%) were graded as 2A, 10 (29.0%) were graded as 2B, 16 (46.0%) as grade 3, and one (3.0%) as flexion type (Figure 4). Furthermore, five fractures (14.0%) were further classified as having medial collapse with loss of Baumann's angle.

DISCUSSION

The most important findings of this study were that the mechanism of injury for supracondylar fractures in the pandemic group were different from the non-pandemic group, and more patients in the pandemic group presented with severe fracture patterns evidenced by the presence of medial comminution.

Similar to prior studies, the incidence of fracture type was similar in both groups with 45.0% of patients in the pandemic group sustaining a type 3 fracture, 38.0% a type 2B fracture, and 13.0% a type 2A fracture.1,8 In the non-pandemic group, 46.0% of patients sustained a type 3 fracture, 29.0% a type 2B fracture and 23.0% a type 2A fracture.[1,5] However, 28.0% of patients in the pandemic group showed evidence of medial comminution radiographically while only 14.0% of patients in the non-pandemic group showed evidence of medial comminution. It is important to be wary of patients with medial comminution because it is associated with high rates of loss of reduction and

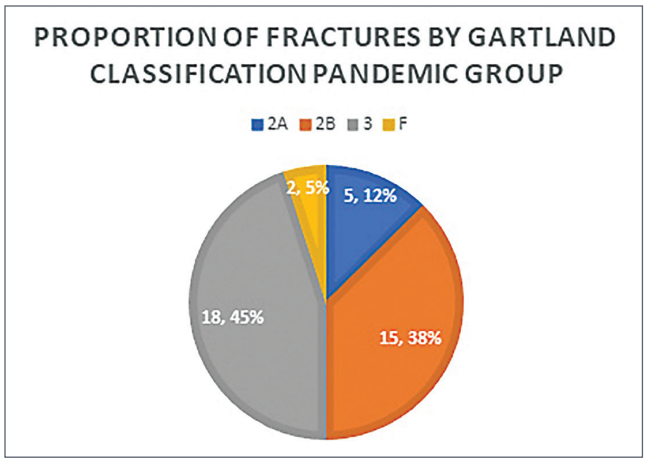

Figure 3. *Figure demonstrating the proportion of fracture type by the Gartland Classification for the pandemic group.*

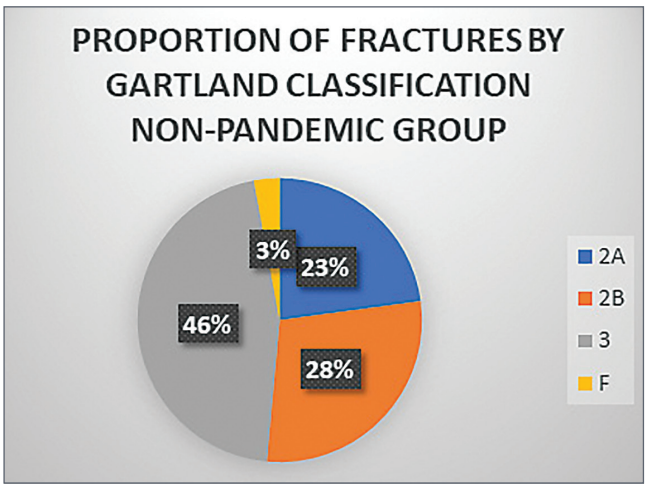

Figure 4. *Figure demonstrating the proportion of fracture type by the Gartland Classification for the non-pandemic group.*

generally requires additional medial pinning of the fracture to provide adequate stability.[6]

Three patients (8.0%) in the pandemic group and two (6.0%) patients in the non-pandemic group required open reduction of their fracture, with 11.0% and 13.0% of patients sustaining type 3 fractures requiring open reduction. This is in keeping with previously published literature reporting rates of 2.9% to 22.0% requiring open reduction for type 3 fractures.[7,8] Furthermore, in the pandemic group, four patients (10.0%) presented with a pulseless, viable extremity, with two of them (5.0%) requiring vascular exploration while two (6.0%) patients in the non-pandemic group presenting with a pulseless, viable extremity and none requiring vascular exploration. This rate of vascular injury is slightly lower than the documented rate of 12.0% to 15.0% in prior studies.[9]

There were similar rates of neurological deficit noted in both groups with four (10.0%) patients in the pandemic group and three (9.0%) patients in the non-pandemic group presenting with a preoperative deficit. This incidence is in keeping with previously published studies reporting rates of 6.0% to 20.0%.[2,3,7] Furthermore, the 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.[2,10]

In the pandemic group, the most common mechanism of injury seen in this study was falling off indoor furniture in nine patients (23.0%). Conversely, in the non-pandemic group, the most common mechanism of injury was a fall off monkey bars in eight (23.0%) patients, followed by a fall off other playground structures (e.g., the swing, trampoline, or slide) in seven (20.0%) patients. As seen in the non-pandemic group in this study, 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 38.0% seen in prior studies.[1,3] Therefore, prevention strategies for these injuries are aimed toward 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 this local hospital's city. Moreover, during the majority of the pandemic 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. 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.[11] Furthermore, four patients (10.0%) in the pandemic group 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.[12]

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 people to accordingly tailor their injury prevention strategies in this pandemic. 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 mechanisms of injury and presentation of supracondylar humerus fractures during the Covid-19 pandemic compared to a non-pandemic patient group. This study demonstrated a higher rate of serious fracture patterns with the presence of medial comminution in the pandemic group. The mechanism of injury differs from the non-pandemic group 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.

REFERENCES

1. Pilla NI, Rinaldi J, Hatch M, et al. Epidemiological analysis of displaced supracondylar fractures. Cureus. 2020;12(4):e7734. doi: 10.7759/cureus.7734.
2. Babal JC, Mehlman CT, Klein G. Nerve injuries associated with pediatric supracondylar humeral fractures: a meta-analysis. J Pediatr Orthop. 2010;30(3):253-263. doi: 10.1097/BPO.0b013e3181d213a6.
3. Barr LV. Paediatric supracondylar humeral fractures: epidemiology, mechanisms and incidence during school holidays. J Child Orthop. 2014;8(2):167-170. doi: 10.1007/s11832-014-0577-0.
4. Baxter I, Hancock G, Clark M, et al. Paediatric orthopaedics in lockdown: A study on the effect of the SARS-Cov-2 pandemic on acute paediatric orthopaedics and trauma. Bone Jt Open. 2020;1(7):424-430. doi: 10.1302/2633-1462.17.BJO-2020-0086.R1.
5. Khademolhosseini M, Abd Rashid AH, Ibrahim S. Nerve injuries in supracondylar fractures of the humerus in children: is nerve exploration indicated? J Pediatr Orthop B. 2013;22(2):123-126. doi: 10.1097/BPB.0b013e32835b2e14.
6. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. J Pediatr Orthop B. 2001;10(1):63-67.
7. Kim KY, Conaway W, Schell R, et al. Prevalence of ulnar nerve palsy with flexion-type supracondylar fractures of the humerus. J Pediatr Orthop B. 2020;29(2):133-136. doi: 10.1097/BPB.0000000000000702.
8. DeFrancesco CJ, Shah AS, Brusalis CM, et al. Rate of open reduction for supracondylar humerus fractures varies across pediatric orthopaedic surgeons: a single-institution analysis. J Orthop Trauma. 2018;32(10):e400-e407. doi: 10.1097/BOT.0000000000001262.
9. Usman R, Jamil M, Hashmi JS. Management of arterial injury in children with supracondylar fracture of the humerus and a pulseless hand. Ann Vasc Dis. 2017;10(4):402-406. doi: 10.3400/avd.oa.17-00050.
10. Balakumar B, Madhuri V. A retrospective analysis of loss of reduction in operated supracondylar humerus fractures. Indian J Orthop. 2012;46(6):690-697. doi: 10.4103/0019-5413.104219.
11. Suginaka M, Abe T, Murata K, et al. Characteristics of indoor injuries in hotels compared to home among young children. Pediatr Int. 2020;62(2):146-150. doi: 10.1111/ped.14099.
12. Kasmire KE, Rogers SC, Sturm JJ. Trampoline park and home trampoline injuries. Pediatrics. 2016;138(3):e20161236. doi: 10.1542/peds.2016-1236.