

Research Articles

Outcomes of Pediatric Supracondylar Fracture Surgery During the COVID-19 Pandemic

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Objective

This paper aims to determine whether the COVID-19 pandemic affected critical time points in pediatric patient care of Supracondylar Humerus Fracture treatments within one level two pediatric trauma center.

Methods

Pediatric patients 16 years or younger who presented for supracondylar humerus fractures between 2016 and 2022 were included in this study, with March 11th, 2020, marking the beginning of the COVID-19 pandemic. Interventions included open reduction internal fixation, percutaneous pinning, and closed reduction. Primary outcome measures encompassed critical time points, including time from admission to discharge, time from admission to surgery start, time in surgery, and time from surgery end to discharge. Secondary outcome measures included complications, overall readmission, and reoperation rates of pediatric patients, which were observed to determine any impact of the pandemic on fracture treatment.

Results

Among the 168 patients included in this study, although median critical time points increased in length, there were no statistically significant differences in median critical time points between the pre-COVID and COVID-era groups. Furthermore, no significant differences in age or BMI were observed between the two groups. Intraoperative complication and readmission rates were universally minimal as well.

Conclusion

The reallocation of hospital resources and policy changes that occurred in response to the COVID pandemic did not negatively impact the treatment of pediatric patients for supracondylar humerus fractures at our institution. While this study demonstrates how one institution responded to the COVID pandemic, a more extensive multi-institutional approach is needed to understand COVID's impact on supracondylar humerus fixation within the nation.

Level of Evidence

Level III - Retrospective Case-Control Study

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INTRODUCTION

On March 11th, 2020, the World Health Organization (WHO) declared the novel Coronavirus disease (COVID-19) as the second worldwide pandemic of the twenty-first Century.^{1,2} The influx of COVID-19 patients needing respiratory and critical medical care significantly strained healthcare systems globally. Many hospitals were forced to reallocate resources and personnel to cope with the surplus of patients inflicted with the virus. The exponential nature in which COVID-19 spread during the height of the pandemic left many hospitals unable to increase their surge capacity in a very short period.^{3,4}

During the pandemic's peak, various medical and surgical departments reallocated their resources to treat the surplus of patients needing critical medical attention effectively.^{5,6} Prior studies demonstrated that some patients experienced a delay in medical care for acute strokes, myocardial infarctions, and breast cancers.⁷⁻⁹ Furthermore, current literature demonstrated that during the first few months of the pandemic, pediatric fracture and trauma surgeries declined significantly compared to previous years.¹⁰⁻¹³ This was especially seen for both upper limb and distal radius fractures.^{12,14} The reallocation of resources in hospitals and the decrease in pediatric trauma admissions raised the question of whether or not delays in the care of those patients were an issue during the peak of the pandemic.

The current literature is divided; some studies reported delays in the care of pediatric fracture patients, while others have concluded that there are no significant delays.^{10-13,15,16} A survey conducted by Johnson *et al.* noted delays in clinic or operative times as well as a reduced number of follow-up visits for nondisplaced clavicle fractures, distal radius buckle fractures, and toddler's fractures from March to April 2021, which consequently negatively impacted patient outcomes.¹⁵ Due to the lack of congruency in the literature, our study aims to elucidate the impact of the COVID-19 pandemic on pediatric supracondylar humerus fixation (SHF) within our institution. By analyzing the trajectory of medical care provided during the pandemic, we can identify strengths and limitations in our response to enhance the preparedness and resilience of healthcare providers. This knowledge provides the information needed to properly develop contingency plans to allocate resources and medical attention when navigating similar crises.¹⁷ Ultimately, the authors seek to understand how the COVID-19 pandemic affected pediatric orthopedic care and how healthcare facilities can be better equipped and more resilient for any similar predicaments in the future.

METHODS

We obtained approval from the Institutional Review Board to review the electronic medical records (protocol number 22-042, An Analysis of Pediatric Fracture and Time to Surgery in the COVID Era). The institution's patient database was queried using Current Procedural Terminology (CPT) codes. The CPT codes 24530, 24538, 24545, and

27511 were utilized to identify pediatric patients who had undergone a form of supracondylar humerus fixation at one level 2 pediatric trauma center from November 1st, 2016 to December 31st, 2022. A total of 177 patients were identified with supracondylar humerus fractures and underwent treatment, including open reduction internal fixation, percutaneous pinning, and closed reduction. Patients who were over the age of 16 or had extended hospital admissions due to extenuating circumstances such as child abuse concerns or unrelated trauma injuries were excluded. In total, nine patients did not meet the inclusion criteria for this study. Patients were then separated into their representative cohorts of admitted pre-COVID-19 ($n = 108$) and after the onset of the COVID-19 ($n = 60$) pandemic. Despite the reduction in sample size within the COVID-19 cohort, which may impact statistical power or precision within this group, it resulted from the data collection process. The beginning of the pandemic was classified as March 11th, 2020, per the guidance of the World Health Organization (WHO).¹⁸ Any patients who presented before this time point were classified as pre-COVID, while those who presented afterward were classified as a part of the COVID cohort.

A retrospective chart review was performed for patients who met the inclusion criteria ($n = 168$). Primary outcome variables included Time to Surgery (TtS), Time in Surgery (TiS), Time from Admission to Discharge (TfAtD), and Time from Surgery to Discharge (TfStD). Secondary outcome variables included discharge disposition, overall readmission, and reoperation rates where relevant. Demographic data such as age, race, and gender and explanatory variables, including body mass index (BMI), treatment type, and COVID test results were collected.

Statistical analysis was performed utilizing the Independent T-test, the Mann-Whitney U-test, and the Chi-Squared Test. This study used a P-value < 0.05 as the threshold to indicate statistical significance.

RESULTS

Primary outcome variable analysis detected no significant differences reported between the Pre-COVID and COVID groups amongst critical admission time points. The median time to surgery was 9.1 hours for pre-COVID and 11 hours for during COVID. Similarly, non-significant increases were observed in the median time from admission to discharge (TfAtD) and time in surgery (TiS). The median pre-COVID TfAtD was 27 hours, and during COVID, TfAtD at 29 hours. Median Pre-COVID TiS was 1.70 hours, and during COVID, TiS was 1.73. Contrarily, the median time from surgery to discharge decreased from 19 h pre-COVID to 18.2 h during COVID-19. Although changes in median time were observed, none of them were considered statistically significant at a level of significance of 0.05 (TtS, p -value = 0.18; TfAtD, 0.57; TiS, 0.39; TfStD, 0.84) [Table 1].

Gender analysis of the patient population indicated that in the Pre-COVID group, 53% (57) were male and 47% (51) were female, mirroring the distribution in the COVID group, where 55% (33) were male and 45% (27) were female.

Table 1. Mann Whitney U-Test results display no statistically significant difference in critical time points between the pre-COVID and COVID era groups.

		Critical Patient Admission Time Points			
		Admit to Discharge (Hours)	Admit to Surgery (Hours)	Surgery to Discharge (Hours)	Total Operation Time (Hours)
PreCOVID	N	108			
	25th Percentile	20.	4.7	8.4	1.4
	Median	27	9.1	19	1.7
	Interquartile Range (IQR)	19	8.1	19	0.62
	Mean	30.	9.8	18	1.8
	75th Percentile	39	13	27	2.0
COVID	N	60			
	25th Percentile	21	7.0	8.3	1.5
	Median	28	11	18	1.7
	Interquartile Range (IQR)	21	7.2	19	0.37
	Mean	32	11	20.	1.9
	75th Percentile	41	14	27	2.1
P-Value		0.57	0.18	0.84	0.39

Table 2. Independent T-test results depicting no significant change in observed body mass index (BMI) or age of pediatric supracondylar fracture patients admitted between the pre-COVID and COVID era groups.

		Age and BMI			
		N	Mean	Standard Dev.	P-Value
Age	Pre-COVID	108	5.3	2.2	0.37
	COVID	60	5.0	2.4	
BMI	Pre-COVID	88	18	3.6	0.15
	COVID	46	17	4.1	

Demographic analysis showed that the average age and BMI were 5.3 and 18 in the pre-COVID group, respectively. The average age and BMI in the COVID group were 5.0 and 17, respectively. Although we observed an average drop in age and BMI between the two groups, this difference was insignificant (age, P-value = 0.37; BMI, P-value = 0.15) [Table 2].

Further analysis of treatment type for supracondylar fractures displayed a statistically significant change in surgical treatment, particularly within the number of percutaneous pinnings performed, increasing from 33% of patients within the pre-COVID group to 68% in the COVID group undergoing the procedure. However, no statistically significant difference in the laterality of fracture was observed between the pre-COVID and COVID groups. Within both groups, the CPT code 24538, corresponding with the percutaneous skeletal fixation of the supracondylar or transcondylar fracture - with or without intercondylar extension, was primarily utilized with 87% in the pre-COVID and 90.0% of procedures in the COVID era using the code [Table 3].

Complication and mortality rates were notably low amongst pediatric supracondylar humerus fracture patients. No intraoperative complications were observed in the pre-COVID group, and only one was observed during COVID-19, with the patient experiencing hypoventilation with bronchoconstriction and bronchospasm. Post-operative complications were categorized into infection, pneumonia, or deep vein thrombosis. Three readmissions were observed in both groups, with one reoperation being done in the pre-COVID group due to observed changes in pins and two in the COVID group due to pin migration requiring repeat reduction and fixation. Only two out of the 60 patients tested positive for COVID-19 infection in the COVID era group. No mortalities were observed within the collected patient population [Table 4].

DISCUSSION

The onset of the COVID-19 pandemic presented many unique challenges to medical systems globally. Hospitals adopted various new protocols and reallocated both human

Table 3. Chi-Square Test results depicted significant changes observed in the type of procedure done, and no significant change in laterality or CPT code was utilized between the two groups.

	Pre-COVID			COVID			
	N	n	Percent	N	n	Percent	P-Value
Treatment Type							
Open Reduction Internal Fixation	108	8	7.4%	60	5	8.3%	<0.001
Percutaneous Pinning		36	33%		41	68%	
Closed Reduction		2	1.9%		1	1.7%	
Multiple		62	57%		13	22%	
Laterality of Fracture							
Left	108	64	59%	81	37	46%	0.76
Right		44	41%		44	54%	
CPT Code							
CPT: 24545	108	14	13%	60	5	8.3%	0.28
CPT: 24538		94	87%		54	90%	
CPT: 24530		0	0.0%		1	1.7%	

Table 4. Count data depict minimal complication, readmission, and reoperation rates observed within our institution for supracondylar humerus fixation before and after the onset of the COVID-19 pandemic. Specific statistical analysis was not possible due to the small data sample size.

Complication / Readmission / Reoperation Numbers		
Intraoperative Complications	Pre-COVID	0
	COVID	1
Readmission	Pre-COVID	3
	COVID	3
Reoperation	Pre-COVID	1
	COVID	2

and physical resources in response to the rapidly spreading virus. According to the World Health Organization (WHO), at the peak of the pandemic, the United States was experiencing a weekly increase of up to two million cases, with the Centers for Disease Control reporting 14% of patients who visited emergency departments around this time being diagnosed with COVID-19.¹⁹ As previously described, the reallocation of resources, as well as COVID-19 hospitalization surge, resulted in an unprecedented strain on healthcare systems. The number of orthopaedic surgeries performed fell by approximately 23% during the first year of the pandemic, with elective surgeries being the most affected and trauma surgeries the least affected.²⁰ Due to a drastic alteration in children's activity patterns due to the pandemic, the overall incidence of supracondylar humerus fractures decreased by up to 50% in some studies within the first year of the pandemic.²¹ Despite an overall decrease in pediatric fractures likely correlating to government policies closing schools and public parks, supracondylar humerus fractures remained a significant fracture pattern observed in the pediatric population during the pandemic as domestic or at-home supracondylar humerus fractures increased over 30% in one study.²¹ Because supracondylar humerus

fractures are associated with a risk of injury to crucial neurovascular structures, prompt diagnosis and treatment remain extremely relevant. Appropriate triage and comprehensive physical exam are of utmost importance as these fractures continue to be the most common pediatric fracture of the upper extremity.²²

Our institution has multidisciplinary approach towards supracondylar humerus fixation, which aims to optimize patients for surgery as quickly as possible. Before and during the COVID-19 pandemic, fractures were considered an urgent issue and, therefore, were prioritized to be immediately treated within our institution. Hence why, despite the challenges presented by the pandemic, patients presenting to our institution experienced a median time to surgery of 9.08 h before COVID-19 and 11 h during COVID-19, a statistically insignificant increase between the two eras. Furthermore, a slight decrease in the median time from surgery to discharge was observed as our institution aimed to minimize each patient's time in the hospital during the pandemic (19 hours pre-COVID vs. 18 hours during COVID). This contrasts with the findings of Johnson et al., whose survey revealed significant care delays, with 55% of orthopedic physicians reporting delays in patient care and 33%

citing delays in surgical scheduling due to the pandemic.^{13, 15} We believe the protocols implemented by our institution in response to the COVID-19 pandemic allowed the treatment of pediatric humerus supracondylar fractures needing no substantial modification. Primarily, our institution continued to utilize a focused medical consulting service that provided perioperative medical comanagement throughout the pandemic. This service allowed for the efficient dispersal of patients who require urgent medical or surgical care after being triaged by our institution's emergency department, reflected in a consistent time from admission to surgery before and after the pandemic.

Furthermore, despite decreases in the number of operating room (OR) staff, the median time patients were in the OR stayed relatively consistent at 1.7 h pre-COVID and 1.73 h during COVID. We believe this is because our institution canceled all elective procedures, creating more OR availability for urgent procedures across all surgical specialties. Without the need to compete for operative time, the treatment of emergent injuries such as supracondylar humerus fractures was fast-tracked during the pandemic. The combination of established efficient perioperative workflow and increased available OR time allowed our institution to continue efficiently treating pediatric patients who presented with supracondylar humerus fractures.^{23,24}

Limitations of this study innately include its retrospective design. However, it was necessary to comparatively review pre-pandemic and pandemic data. Furthermore, due to the nature of the pandemic, our institution prioritized patient care over research and prospective data collection at the time. Second, we could not note readmission or reoperation rates of patients post-surgery if they were done at a different institution than ours. Luckily, this did not affect the collection and analysis of our primary outcome values for critical admission time points for pediatric patients. Lastly, COVID tests, especially at the beginning of the pandemic, reported results at varying degrees of sensitivities. This means that patients could have been diagnosed with false negatives or positives within our pandemic group due to factors such as rushed collection methods or inadequate specimen amounts. However, test outcomes did not affect the time to surgery for patients within our institution, as seen in the results. Our physicians understood the risk of operating during the pandemic and continued placing the patient's health above their own, allowing positive patient outcomes. Lastly, our data only accounts for critical time points observed within our institution. A larger multi-institutional study looking into the supracondylar humerus fixation at different times is needed to understand how the pandemic affected hospitals nationwide.

CONCLUSION

Although the COVID-19 pandemic presented various challenges to hospital systems globally, the overall care of pediatric supracondylar humerus fractures was not compromised within our institution. Within the realm of pediatric orthopaedic trauma, supracondylar fractures are one of the most common injuries seen, further emphasizing the importance of maintaining efficiency in treating these fractures. Implementing an efficient perioperative protocol, as well as an emphasis on the importance of urgent procedures within our institution, allowed for the continued efficient treatment of pediatric fractures during the pandemic. With the constant possibility of new viral outbreaks occurring, hospital systems must remain vigilant and have protocols ready to be implemented for the eventuality of the onset of another virus that could disrupt hospital systems similar to COVID-19. This paper outlines how our institution's approach to treating pediatric supracondylar humerus fractures allowed us to maintain successful patient outcomes despite disruptions from the pandemic.

DECLARATION OF CONFLICT OF INTEREST

The authors do NOT have any potential conflicts of interest for this manuscript.

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

This study was approved by our Institutional Review Board on 04/04/2022. Approval Number: 22-042.

DECLARATION OF INFORMED CONSENT

None of the information presented within this manuscript can be used to identify any patients.

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