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Abstract

Background: The COVID-19 pandemic has dramatically altered the practice of pediatric orthopedic trauma surgery in both outpatient and inpatient settings. While significant declines in patient volume have been noted, the impact on surgeon decision-making is unclear. **Purpose:** We sought to investigate changes in pediatric orthopedic trauma care delivery as a result of COVID-19 and determine their implications for future orthopedic practice. **Methods:** An electronic survey was distributed to all members (N = 1515) of the Pediatric Orthopedic Society of North America (POSNA) in March to April 2021; only members who provided care for pediatric orthopedic trauma patients were asked to complete it. The survey included questions on hospital trauma call, inpatient care, outpatient clinic practice, and 3 unique fracture case scenarios. **Results:** A total of 147 pediatric orthopedic surgeons completed the survey, for a 9.7% response rate, with 134 (91%) taking trauma call at a hospital as part of their practice. Respondents reported significant differences across institutions regarding COVID-19 testing, hospital rounding, and employee COVID-19 screening. Changes in outpatient fracture management were observed, including a decreased number of follow-up visits for nondisplaced clavicle fractures, distal radius buckle fractures, and toddler's fractures. Of respondents who changed their fracture follow-up schedules due to COVID-19, over 75% indicated that they would continue these outpatient treatment schedules after the pandemic. **Conclusions:** This survey found changes in pediatric orthopedic trauma care as a result of the COVID-19 pandemic. The use of telemedicine and abbreviated follow-up practices for common fracture types are likely to persist following the resolution of the COVID-19 pandemic.

Keywords

COVID-19, pandemic, pediatric trauma, POSNA, survey

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Introduction

After COVID-19 was first reported in December 2019 as a cluster outbreak in Wuhan, China [31], it quickly spread worldwide and in March 2020 was characterized a pandemic by the World Health Organization [29]. As of October 6, 2021, there have been over 235 million cases of COVID-19 worldwide, with almost 43 million in the United States alone [28]. Despite the introduction of multiple vaccines in 2020 and 2021 aimed at slowing the spread of COVID-19 [21-23], clinical patient care continues to be affected, with potentially long-lasting implications.

Significant declines in pediatric orthopedic patient volume have been observed. For example, the overall pediatric fracture volume at a large East Coast tertiary care institution

decreased by 2.5-fold in the early stages of the COVID-19 pandemic [1]. Additionally, in order to prevent potential COVID-19 transmission, there have been large shifts in how orthopedic care is delivered, including the increased

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use of telemedicine, an emphasis on nonsurgical treatment strategies, and an increased use of personal protective equipment (PPE) [2,5,14,18].

The purpose of this study was to investigate how pediatric orthopedic trauma care and institutional practices have been affected by the COVID-19 pandemic.

Methods

We developed a survey that was approved by the Pediatric Orthopedic Society of North America (POSNA) evidence-based-practice committee. It was deemed exempt and did not require Institutional Review Board approval by the primary institution where it was conducted. The survey was electronically distributed to all POSNA members (1515 at the time of the survey), although only members who were surgeons caring for pediatric orthopedic trauma patients were asked to complete it. Study data were collected and managed using REDCap electronic data capture tools [7,8]. Participation was voluntary and no compensation was provided.

Participants were asked to complete a maximum of 29 questions. The first section requested demographic information; states were reported according to United States Census Bureau region classifications [19]. This section also inquired whether or not the surgeon takes pediatric orthopedic trauma call in a hospital setting. If so, then 9 additional questions were asked related to COVID-19 treatment pathways, testing, and vaccines. The second section asked about orthopedic trauma care in the outpatient practice environment. The third section presented pediatric fracture scenarios regarding distal radius buckle fractures, nondisplaced clavicle fractures, and toddler fractures (nondisplaced spiral tibial shaft fracture). Respondents were asked if their traditional follow-up plan for each fracture type had changed as a result of the COVID-19 pandemic. All responses were deidentified and analyzed collectively.

Responses were collected for a 4-week period from March 12 to April 9, 2021. Comparison of categorical variables was performed using χ^2 or Fisher exact tests. All statistical analysis was performed using IBM SPSS Statistics for Macintosh, Version 24.0 (IBM Corp., Armonk, New York).

Results

A total of 147 respondents completed this survey, representing 9.7% of total POSNA membership. The majority of respondents practiced in the United States (91.8%), in an academic practice environment (71.4%), and were between 40 and 49 years of age (34.0%) (Table 1).

Approximately 91.2% of participants reported taking pediatric orthopedic trauma call in a hospital setting as part of their practice. Additionally, 104 (77.6%) respondents

Table 1. Demographic data of survey respondents (N = 147).

	N (%)
Country of practice	
USA	135 (91.8)
Canada	8 (5.4)
Other	4 (2.7)
Region of practice	
Midwest	23 (15.6)
Northeast	29 (19.7)
South	51 (34.7)
West	31 (21.1)
Other/unknown/outside of USA	13 (8.8)
Practice setting	
Academic	105 (71.4)
Community/private	35 (23.8)
Other/unknown	7 (4.8)
Age (years)	
20-29	0
30-39	41 (27.9)
40-49	50 (34.0)
50-59	31 (21.1)
60-69	23 (15.6)
70+	2 (1.4)
Proportion taking pediatric orthopedic trauma call in hospital setting	134 (91.2)

indicated that their hospitals required daily employee screening for COVID-19 (Table 2). Of these, 10 (9.6%) reported that their hospital required only temperature checks, 30 (28.8%) reported that their hospital required only screening questions, and 63 (60.6%) reported that their facility required both screens. Additionally, 38 (28.4%) respondents indicated that trauma coverage had been affected by a colleague who had tested positive for COVID-19.

Respondents who practice in academic settings were more likely than those who practice in community/private settings to report that the refusal of COVID-19 testing by a patient/parent had resulted in patients being treated as if they were COVID-positive (35.4% vs 10.7%, respectively; $P = .012$). There was no difference between academic and community/private practice in regard to employee screening policies ($P = .101$), visitor limits in place for patients' family members ($P = 1.000$), or COVID-19 testing protocols for patients in the emergency department ($P = .191$). As of December 31, 2020, a higher proportion of academic orthopedic physicians reported having received the COVID-19 vaccination compared to community/private practice physicians (74.7% vs 53.6%, respectively; $P = .031$).

Eighty-one (55.1%) respondents reported a delay in fractures being seen in an outpatient clinic due to COVID-19; 38 (25.9%) of these delays were reported to negatively affect patient outcomes (Table 3). Thirty-one (21.1%)

Table 2. Questions relating to hospital based orthopedic trauma call (N = 134).

Survey question	Response	N(%)
Are pediatric orthopedic trauma patients that need surgery tested for COVID in the emergency department?	Yes	119 (88.8)
	No	15 (11.2)
What is done for COVID+ trauma patients needing urgent surgery? (Select all that apply)	Full PPE utilized	128 (95.5)
	Limited staff in operating room	77 (57.5)
	Delayed case	10 (7.5)
	Canceled case	1 (0.7)
	Other	9 (6.7)
	What is done if a patient (parent) refuses COVID testing?	Not optional
Does the hospital have daily employee screening?	Patient treated as COVID+	38 (28.4)
	Not Sure	36 (26.9)
	Other	2 (1.5)
	Yes	104 (77.6)
Does the trauma hospital limit visitors for pediatric patients?	No	30 (22.4)
	Yes	131 (97.8)
What is done for daily rounding on COVID + trauma patients?	No	2 (1.5)
	Unknown	1 (0.7)
	Telehealth	7 (5.2)
	Round in room with PPE	92 (68.7)
	Not sure	27 (20.1)
Has trauma call coverage at your institution been affected by a COVID positive colleague?	Other/Unknown	8 (6.0)
	Yes	38 (28.4)
	No	96 (71.6)
As of December 31st, 2020, did you receive the COVID-19 vaccine?	Yes	93 (69.4)
	No	41 (30.6)
	Decline comment	0
Were pediatric orthopedic surgeons given priority in receiving the COVID-19 vaccine?	Yes, all surgeons	86 (64.2)
	Yes, if taking trauma call	9 (6.7)
	No	35 (26.1)
	Not sure	4 (3.0)

PPE personal protective equipment.

physicians reported that the quality of care given to patients during the COVID-19 pandemic has been affected; the most common changes were in the timing of surgery or clinic appointment times.

In response to a query about the incorporation of telemedicine into their practice, 87 (59.2%) respondents reported using telemedicine for outpatient trauma visits. Overall, 89 (60.6%) respondents reported either a “more favorable” or “significantly more favorable” view of telemedicine as a result of the COVID-19 pandemic, and 68 (78.2%) respondents said they would continue offering telemedicine after the pandemic (Table 4).

In total, 146 (99.3%) respondents fully completed the questions addressing fracture follow-up. The proportion of respondents who indicated that they would not routinely schedule follow-up visits prior to the COVID-19 pandemic for a patient with a distal radius buckle, nondisplaced clavicle, and toddler’s fractures were 35.4%, 15.0%, and 8.8%, respectively. During the pandemic, the proportion of

respondents who did not require follow-up for each fracture type increased to 45.2% ($P = .074$) for distal radius buckle, 25.3% ($P = .029$) for nondisplaced clavicle, and 15.8% ($P = .075$) for toddler’s fractures (Fig. 1). Prior to the COVID-19 pandemic, respondents practicing in an academic practice were less likely to require additional follow-up compared to respondents in community or private practice for nondisplaced clavicle fractures (81.0% vs 97.1%, respectively; $P = .026$). There was no difference in follow-up for distal radius buckle fracture (61.0% vs 74.3%, respectively; $P = .221$) or toddler’s fracture (89.5% vs 100%, respectively; $P = .065$).

Fifty-nine (40.4%) respondents indicated that the timing or quantity of follow-up visits changed for at least 1 of the 3 clinical scenarios. There was no difference in the proportion of respondents who changed their follow-up schedule based on academic versus community/private setting (36.5% vs 48.6%, respectively; $P = .234$). Of respondents indicating that their fracture management expectations had

Table 3. Questions relating to outpatient clinic based orthopedic trauma practice.

Survey question	Response	N (%)
Are patients screened prior to their in-person clinical visit?	Yes	134 (91.2)
	No	11 (7.5)
	Not Sure	2 (1.4)
If screened, how are patients screened? (Select all that apply)	Telephone call prior to visit	71 (48.3)
	Temperature check at arrival	104 (70.7)
	Screening questions at arrival	127 (86.4)
How many caregivers are allowed in the exam room with the patient?	1	101 (68.7)
	2	31 (21.1)
	As many as present	15 (10.2)
If an acute fracture needing surgery is seen in clinic, does the hospital require COVID-19 testing before urgent fracture surgery scheduled from clinic?	Yes	125 (85.0)
	No	21 (14.3)
	Unknown	1 (0.7)
How is pre-op COVID-19 testing done? (Select all that apply)	At the hospital day of surgery	63 (42.9)
	Prior to surgery at an outpatient clinic	77 (52.4)
	Prior to surgery at drive-through location	74 (50.3)
	Other	2 (1.4)
If COVID testing is positive for an outpatient fracture patient needing surgery, what is done?	Proceed with case using full PPE	116 (78.9)
	Case rescheduled until negative test	4 (2.7)
	Case rescheduled until after quarantine	16 (10.9)
	Not Sure	5 (3.4)
	Other	6 (4.1)
Have you had an urgent fracture case delayed from clinic to the operating room because of COVID-19?	Yes	49 (33.3)
	No	98 (66.7)
Have you noted delays in fractures being seen in clinic due to COVID-19?	Yes	81 (55.1)
	No	66 (44.9)
If yes, have you noted these delays negatively impacting patient outcomes?	Yes	38 (25.9)
	No	29 (19.7)
	Not Sure	14 (9.5)
Do you think the quality of care you have provided to trauma patients has changed during the pandemic?	Yes	31 (21.1)
	No	114 (77.6)
	Not Sure	2 (1.4)
If yes, please elect ways in which the quality of care has been affected: (Select all that apply)	Timing of surgery or clinic visit	29 (19.7)
	Timing or frequency of follow up	24 (16.3)
	Surgical indications	11 (7.5)
	Type of surgical fixation or immobilization	4 (2.7)
	Medical documentation	5 (3.4)
	Other	2 (1.4)

PPE personal protective equipment.

changed for any of the fracture types, 9 (15.3%) reported fewer scheduled visits for distal radius buckle fractures, 19 (32.2%) for nondisplaced clavicle fractures, and 16 (27.1%) for toddler's fractures. The majority of respondents (78.0%) indicated that they would continue treating patients with the same follow-up schedule employed during the COVID-19 pandemic if social distancing policies were no longer needed.

Discussion

The COVID-19 pandemic has had a significant effect on orthopedic physicians and the delivery of pediatric

orthopedic trauma care in North America [1,2,5,11,14,18]. Our survey findings demonstrate the variability of hospital protocols, vast changes in the use of and attitudes about telehealth, and new approaches to the outpatient management of specific fracture types. These changes are likely to continue to influence pediatric orthopedic trauma care in the future.

While this survey provides insight into how pediatric orthopedic trauma care has been delivered across North America during the pandemic, there are clear limitations. The survey was distributed to 1515 POSNA members, but only 147 responses were received, representing a 9.7% response rate. While a downward trend in POSNA survey response

Table 4. Telemedicine usage in the outpatient clinic.

	N (%)
Total proportion of visits via Telemedicine	
0%	60 (40.8)
1-25%	81 (55.1)
25-50%	6 (4.1)
>50%	0
First trauma visit via Telemedicine	
0%	121 (82.3)
1-25%	25 (17.0)
25-50%	0
>50%	1 (0.7)
Perception of Telemedicine as a result of the COVID-19 pandemic is:	
Significantly less favorable	0
Less favorable	15 (10.2)
No change	43 (29.3)
More favorable	73 (49.7)
Significantly more favorable	16 (10.9)
If the population was fully vaccinated and no social distancing policies were needed, would you continue to offer telehealth visits for orthopedic trauma care?	
Yes	68 (78.2)
No	5 (5.7)
Not sure	14 (16.1)

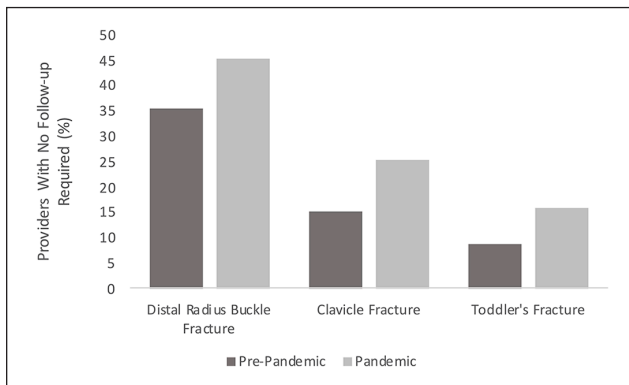


Fig. 1. Proportion of physicians indicating that they would require no follow up appointments following initial injury prior to allowing full return to activities for distal radius buckle fractures, nondisplaced clavicle fractures, and Toddler's fractures in the pre-pandemic versus pandemic timeframe.

rates has been noted over recent years [26], it is also important to note that our survey was specific only for a subset of POSNA members: orthopedic surgeons caring for pediatric orthopedic trauma as part of their regular practice. Additionally, the survey respondents represented surgeons from across North America, improving the generalizability of the results. Although the survey was limited in its scope, we included questions on hospital and outpatient-based practices.

Our survey respondents reported a variety of institutional protocols in place for limiting COVID-19 transmission risk in inpatient and outpatient settings. Nearly all patients presenting through the emergency department requiring surgery are tested for COVID-19, with differing approaches taken if the test results are positive. Additionally, in the event of a parent refusing COVID-19 testing for their child, academic institutions were more likely than community or private practices to proceed with the case and treat the patient as COVID-positive. The potential implications of these protocol differences warrant further study. Another difference based on practice setting was seen in surgeon vaccination, with academic-affiliated respondents vaccinated in higher proportions than those in a community/private practice as of December 31, 2020. Potential explanations include differences in vaccine availability or COVID-19 case burden based on practice location.

The use of telemedicine has increased substantially across multiple care-delivery settings during the COVID-19 pandemic [15]. Of physicians in our survey who offered outpatient telemedicine services during the pandemic, over 60% reported having an improved perception of it and almost 80% planned to continue to offer telehealth visits for orthopedic trauma care following resolution of the pandemic. With changes in U.S. insurance reimbursement policies for telehealth [3] and relaxed state licensure requirements for care delivered across state lines during the pandemic [20], telehealth may continue to represent a useful tool for providing nonurgent clinical care.

Different approaches to pediatric orthopedic treatment have been used as a result of the COVID-19 pandemic. In a survey by Rangasamy et al of 127 Indian orthopedic specialists treating clubfoot during the COVID-19 pandemic, 20.5% of physicians remotely managed newborn cases of clubfoot during the pandemic by asking parents to manipulate/stretch the foot without formal Ponsetti casting [17]. Additionally, Bram et al conducted a study of pediatric orthopedic fractures during the early stages of the pandemic and observed an increase in the prescription of Velcro splints for distal radius fractures [1]. This highlights the potential for decreasing the number of office visits for routine fractures by altering clinical treatments.

While our survey did not include questions related to specific treatment modalities, it did inquire about the total number of follow-up visits and timing of visits for 3 common nonoperative fracture types commonly seen in a pediatric orthopedic trauma practice. Prior to the COVID-19 pandemic, significant variability in follow-up scheduling was observed across these 3 fracture types. Of note, physicians practicing in an academic setting were more likely not to request an additional visit for patients presenting with a nondisplaced clavicle fracture. As a result of the COVID-19 pandemic, there was an increase in the proportion of respondents indicating that they would not require any follow-up

visits for each of the 3 fracture types. This likely represents a desire to limit patient exposure to clinical and hospital settings for patients with a low concern for fracture-related complications [10,13,24,27]. Interestingly, the overwhelming majority of physicians indicated that they planned to continue this new follow-up schedule following the resolution of the COVID-19 pandemic. This may lead to a reduction in unnecessary clinical visits and overall cost savings for patients and health systems [10,27].

Significant delays to care have been observed throughout medicine as a result of the COVID-19 pandemic [6,12,30]. In this survey, 55% of orthopedic physicians reported delays in presentation to care and 33% reported delays in surgical scheduling from clinic to operating room because of COVID-19. While children have greater remodeling potential and fracture tolerance than adults, suboptimal outcomes may result from delayed care [9,25], including malunion and nonunion of pediatric fractures, which can have long-lasting implications for patients [4,16]. Our survey results suggest that physicians should continue to monitor for delays in care as the overall burden of COVID-19 lessens. Furthermore, approximately a fifth of respondents reported a change in care quality, including changes in the timing of surgery and the frequency of follow-up, which may have significant implications to the safety of care provided.

In conclusion, the COVID-19 pandemic has changed pediatric orthopedic trauma care in both hospitals and clinics, with potential long-term implications for management of certain types of fractures in outpatient settings. Although care was affected by COVID-19-related health concerns and a desire to minimize patient exposure to the virus, our survey respondents indicated a desire to continue to use telemedicine and streamlined care plans for fractures in children.

Declaration of Conflicting Interests

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Human/Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

Informed Consent

Informed consent was obtained for participants included in this survey.

Required Author Forms

Disclosure forms provided by the authors are available with the online version of this article as supplemental material.

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