Review Article

Focus of Pediatric Surgical Reports During the SARS-CoV-2 Pandemic: A Narrative Review

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Background: Coronavirus disease-2019 (COVID-19) pandemic impacted surgical activity at health-care facilities and led to significant changes in the characteristics of publications in medical journals. This is a narrative review that outlines the focus of pediatric surgical reports during the ongoing COVID-19 pandemic.

Methods: Publications on pediatric surgery during the pandemic were carefully reviewed, and data emerging from reports on COVID-19 were selected to address: (1) the impact of COVID-19 on pediatric surgical procedures; (2) children undergoing surgical intervention; and (3) expansion of telemedicine.

Results: Regarding surgical activity in tertiary hospitals, there was a reduction in the number of elective surgeries, with reports of an increase in complicated appendicitis and in testicular torsions with symptoms for more than 6 h. The pandemic impacted specific surgical fields, with reports on trauma, appendectomies, urology, cardiac surgery, and kidney transplant. In children positive for COVID-19 that underwent surgery, postoperative complications were more indicative of the primary surgical pathology and there were no postoperative deaths. In a report of universal screening, <1% of children had positive reverse transcription-polymerase chain reaction (RT-PCR). In a report addressing telemedicine during the pandemic, it was well evaluated by both pediatric surgeons and patients’ families, but most surgical departments did not provide the service.

Conclusions: The pandemic brought significant changes in surgical care. As expected, there was a reduction in elective surgeries, RT-PCR-positive children did not present worse postoperative outcomes than negative ones but there is still a paucity of data regarding COVID-19 children, and telemedicine may play an important role in health care, especially in times of social distancing.

Keywords: Child, COVID-19, pediatrics, surgery, telemedicine

INTRODUCTION

On March 11, 2020, the World Health Organization officially declared the infection by severe acute respiratory-coronavirus-2 (SARS-CoV-2) a pandemic.¹ Since the beginning of the outbreak, the spread of the coronavirus disease-2019 (COVID-19) has affected medical care worldwide. As the pandemic has unfolded, not only surgical activity at health-care facilities was deeply impacted but also an unprecedented quantity of new publications on the subject has arisen, and medical journals have been prioritizing these articles. Indeed, the pandemic led to a significant change in the characteristics of studies in medical journals.²³

The objective of this narrative review is to outline the focus of pediatric surgical reports during the pandemic, and addresses: (1) the impact of COVID-19 on pediatric surgical procedures; (2) children undergoing surgical intervention; and (3) expansion of telemedicine.

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**Impact of COVID-19 on Pediatric Surgical Procedures**

**Surgical activity in tertiary hospitals**

Álvarez García *et al.*[^4^] analyzed the impact of the pandemic on pediatric surgery activity at a Spanish pediatric surgery department, comparing cases from March to May 2020 with the same period in 2019. Only ten scheduled procedures were performed in 2020, whereas 610 were performed in 2019 (183 inpatients and 427 outpatients); a 98.32% decrease in activity during the pandemic. Regarding admissions from the emergency department, there were 97 admissions in 2019 and 48 in 2020. Although fewer appendicitis cases were recorded in 2020, an increase in the percentage of complicated cases (31% vs. 64%) and testicular torsions with symptoms for more than 6 h (0% vs. 75%) was observed. These were the most frequent conditions for urgent surgery, with an increase in severity from 29% to 66% (*P* = 0.0004, confidence interval [CI]: 95%). In 2019, 2748 outpatient visits were recorded and only 25 in 2020. External consultations were maintained mainly through telemedicine (445 phone consultations), with a 484% decrease in this activity.[^4^]

Utría *et al.*[^5^] studied patients undergoing surgery at an American regional pediatric hospital during the same period. During the outbreak, 1780 procedures were performed, representing a 55% decrease in volume compared to 2019 (4005 procedures). Outpatient procedures, which comprised 60% (*n* = 2402) of surgeries in 2019, corresponded to 36% (*n* = 644) of surgeries in 2020. The number of urgent/emergent procedures did not change significantly between 2 years (248 in 2019 vs. 175 in 2020, *P* = 0.305). Within the surgical departments, otolaryngology presented the biggest change in volume with a 76% activity reduction, followed by urology (74%) and craniofacial surgery (64%).[^5^]

Bada-Bosch *et al.* (2021)[^6^] described pediatric surgical procedures carried out in the same period in a Spanish hospital. During the pandemic, sixty-one patients underwent surgery, with a total of 76 procedures and a mean of 1.05 daily patients. In 2019, 406 patients underwent surgery, with a mean of seven daily patients (*P* < 0.001). In 2020, most surgeries (59.01%) were urgent, whereas in 2019, 76.1% were scheduled (*P* < 0.01).[^6^]

**Impact on specific surgical fields**

**Trauma**

Sanford *et al.* (2021)[^7^] reported an American level 1 pediatric trauma center experience in children <19 years and compared cases between 2015 and 2019 to cases from 2020. They found that trauma encounters were significantly lower in 2020 (*n* = 392) than the bootstrap means from pre-COVID (*n* = 460, 95% CI 424–496; *P* < 0.001). However, burn injury admissions (79 vs. 64, 95% CI 60–69, *P* < 0.001) and penetrating trauma encounters (43 vs. 34, 95% CI 28–40, *P* = 0.002) increased in 2020, whereas blunt trauma decreased (270 vs. 359, 95% CI 324–394, *P* < 0.001). For burn admissions, there was a significant increase in flame burns (*P* < 0.001).[^7^]

As expected, there were fewer victims of motor vehicle crashes (*P* < 0.001), trauma involving pedestrians (*P* < 0.001), vehicle/motocross/bicycle/skateboard injuries (*P* = 0.02), falls (*P* < 0.001), and sports-related injuries (*P* < 0.001) in 2020. Interpersonal violence (assault, nonaccidental trauma, and self-harm) was also lower during the pandemic (*P* = 0.04).[^7^]

In 2020, trauma occurred more among caucasian (*P* = 0.01) and privately insured (*P* < 0.001) children. The authors suggest this could be explained by the skepticism within immigrant communities toward medical establishments and the loss of insurance coverage instead of actual differences in the occurrence of traumatic injury. There was no difference in suspected abuse, injury severity, mortality, age, or gender.[^7^]

**Appendectomies**

Bada-Bosch *et al.* (2021)[^6^] described the impact of the pandemic on acute appendicitis, comparing them with the same period in 2019. Appendectomy was the most common surgery performed during the state of the emergency period (*n* = 13, 19.6%). In the same period in 2019, there were 33 appendectomies. They found that the open approach was more frequently performed during the pandemic (6/13 vs. 2/33, *P* = 0.004). Speculation about the possibility of minimally invasive surgery in SARS-CoV-2 patients increasing the risk of contagion may have accounted for this. There was no difference in the age, sex, incidence of complicated appendicitis, PICU admission, complications, and mean hospital stay.[^6^]

**Urology**

Tur *et al.* (2020)[^8^] reviewed the scientific evidence based on the publications available and the recommendations of the main scientific societies regarding pediatric urology during the pandemic. Based on their review, they published some recommendations:

1. Treat only high-priority and emergency cases surgically
2. In case of surgical treatment, perform polymerase chain reaction (PCR) test whenever possible
3. Aerosol-generating procedures should only be performed with full personal protective equipment,
with the minimal team possible, and by experienced surgeons
4. Reduce the possibility of particle aerosolization by diminishing the use of monopolar, ultrasonic dissectors, and advanced bipolar devices
5. For minimally invasive procedures, consider the use of CO2 filtering devices and aspirate as much gas as possible before removing trocars
6. Consider regional and local anesthesia whenever possible to avoid the need for mechanical ventilation.[9]

**Cardiac surgery**
Korun et al.[9] analyzed the effect of the COVID-19 pandemic on congenital heart surgery in a Turkish center, comparing cases from March to May 2020 to patients from the pre-COVID-19 period (March 2019 to March 2020). No significant difference was found regarding age and gender, but the proportion of foreign citizens decreased significantly during the COVID-19 period (47/632 pre-COVID-19 vs. 1/70 during the pandemic, \(P = 0.04\)), the most common country of origin in both periods being Syria.[9]

After March 2020, the length of hospital stay before surgery was shorter (median 1 day vs. 3 days, \(P < 0.01\)), but the median postoperative hospital stay did not change. The authors suggest the operation of the patients right after hospitalization due to the priority of emergency procedures could explain this shortening. During this period, the duration of the operating room use was longer (300 min vs. 240 min, \(P = 0.005\)), which they associated with the measures taken during the pandemic. No significant change was observed in mortality and categories of surgeries performed.

The most common procedure during COVID-19 was bidirectional cavopulmonary anastomosis (6; 13%).[9]

**Transplantation**
Charnaya et al.[10] investigated changes in pediatric kidney transplants between February and June 2020 in patients <17 years using the Scientific Registry of Transplant Recipients, an American national registry. They found that the pandemic had a significant impact on waitlist mortality (189% increase until midMarch, \(P = 0.005\)) and waitlist registration (152% increase in change to inactive status until midMarch, \(P < 0.001\)). There were 157 pediatric kidney transplantations, 22.8% fewer than expected (\(P = 0.001\)). Deceased donors were 19.2% fewer than expected (\(n = 108, P = 0.03\)), but living donors were not significantly different (\(P = 0.058\)) when compared to the average counts during the same period from 2017 to 2019.[10]

They suggest several factors might have contributed to these findings: (1) pediatric transplant patients require intensive postoperative care, and health-care systems were already overburdened by the pandemic; (2) the decrease of live donors might be explained by the reduction in elective and nonemergent procedures; and (3) shortages of COVID-19 testing or delayed results might have diminished the willingness to accept possibly contaminated organs from deceased donors.[10]

**Children Undergoing Surgical Intervention**
The COVID-19 pandemic has raised questions concerning the timing and appropriateness of surgical interventions in infected patients due to its possible effects on postoperative course. In this context, Mehl et al.[11] described their experience with short-term outcomes in children who underwent surgery at an American pediatric hospital. There were 66 patients ≤18 years of age that underwent surgery with a preoperative positive SARS-CoV-2 reverse transcription (RT)-PCR. The median age, weight, and body mass index were 9.5 years, 41.6 kg, and 21.5 kg/m². Ninety-one percent of patients (\(n = 60\)) initially presented to the emergency room, and only 9% (\(n = 6\)) presented for elective procedures. Most patients (\(n = 43, 65\%\)) had no comorbidities, and there were six postoperative intensive care unit admissions, half primarily driven by respiratory symptoms. Postoperative complications were more indicative of the primary surgical pathology than of having positive RT-PCR, and there were no postoperative deaths.[11]

Lin et al.[12] sought to determine the incidence of RT-PCR-positive tests in pediatric patients presenting for surgery at three tertiary children’s hospitals across the United States (Children’s Hospital of Philadelphia in Philadelphia, Pennsylvania; Texas Children’s Hospital in Houston; and Seattle Children’s Hospital in Seattle, Washington) from March to April 2020. The hospitals used universal screening with RT-PCR. They included 1295 surgical patients <19 years, with a mean age of 7.4 years. Overall incidence of positive test was 0.93% (12/1295), and \(n = 6\) (50%) had preoperative symptoms: fever (\(n = 3\)), rhinorrhea (\(n = 2\)), and cough and diarrhea (\(n = 1\) each).[12]

As a narrative review, this article is limited by the information provided by the studies. The distinction between RT-PCR-positive patients that are asymptomatic and, therefore, infected with SARS-CoV-2 but not diagnosed with COVID-19 was not so well established at the beginning of the pandemic and many studies (as those included in this review) did not separate these two groups of patients. In this context, how to diagnose COVID-19 children that could present in the high-risk
category for possible perioperative complications is a question that remains unanswered.

Expansion of Telemedicine

Given the pandemic restrictions, telemedicine has presented as a versatile tool for providing health care. Lakshin et al.[13] studied the spread and effectiveness of this practice in Germany using anonymous surveys to pediatric surgery departments, pediatric surgeons, and patients’ families. The most common diagnoses for teleconsultations were congenital malformations, urology, urinary/defecation disorders, hemangiomias, and posttrauma follow-ups.[13]

Of the 89 pediatric surgery departments listed by the German Society of Pediatric Surgery, 73% (65/89) responded, 71% (46/65) did not have telemedicine services, and 11 had launched the service precisely due to the pandemic.[13]

Only 10% (81/812) of the pediatric surgeons of the German Society responded to the online survey. Most of them (54/81, 59%) reported that their facility did not provide telemedicine; the majority indicated that they would not consult new patients or indicate surgery over the telephone but would indicate surgery in a video consultation. The average rating of telemedicine on a scale from one (satisfied) to six (unsatisfied) was 2.22.[13]

Regarding patients’ families, 71.6% (86/120) responded to the questionnaire. All but one engaged with telemedicine by telephone. In their assessment, 35% (29/83) of the parents reported the lack of visual contact to be a disadvantage. In an open-ended question addressing the advantages and disadvantages of the modality, 50% (6/12) of the answers concerned saving time and resources, and 69% (20/29) of the parents mentioned the lack of physical examination and face-to-face contact to represent significant limitations. The average rating of telemedicine on a scale from one (very satisfied) to five (very dissatisfied) was 1.91.[13]

Summary

The pandemic resulted in major changes in surgical care. This is a narrative review during the ongoing COVID-19 pandemic to streamline pediatric surgical reports on the subject and addresses:

1. The impact of COVID-19 on pediatric surgical procedures: as expected, there was a reduction in elective surgeries
2. Surgical intervention in the context of RT-PCR-positive children: there is still a paucity of data to support which cases would fall into the high-risk category for complications and when to resume elective surgeries post-COVID-19
3. Telemedicine saves time and resources and represents an important tool in health care when social distancing is crucial. On the downside, it requires specific resources, such as access to technology.

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Conflicts of interest
There are no conflicts of interest.

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