The impacts of COVID-19 on elective general pediatric surgery

- A retrospective study of single institution in Japan -

by

Keigo Yada

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Supervisors: Dr. Nobuo Nishi and Dr. Kevin Urayama

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Abstract

Background: The impact of the COVID-19 era on pediatric patients who underwent elective surgery have not been fully investigated, especially in Japan. The aims of this study are to clarify the impact of COVID-19 pandemic on elective general pediatric surgery at our institution comparing the circumstances before, during, and after the pandemic, so that these findings can be used to develop strategies for improving protocols for coping with pandemic situations in the future.

Methods: Patients who underwent elective general pediatric surgery in the Department of Pediatric Surgery at St. Luke's International Hospital between 2017 to 2023 were assigned to three groups: 1) pre-COVID group (n=460), 2) COVID group (n=508), and 3) post-COVID group (n=81). Rescheduling of elective surgery, the reason for rescheduling and associated information were retrospectively extracted and investigated.

Results: The baseline characteristics were comparable between the groups except for a larger proportion of female patients in pre-COVID group compared with COVID group ($p<0.01$). The proportion of rescheduling were 5.4% (25/460), 14.6 % (74/508), and 35.8 % (29/81) in the pre-COVID, COVID, and post-COVID groups, respectively ($p<0.01$ between all groups). Most patient experienced only one rescheduling, however, some patients experienced multiple rescheduling (e.g. 2 to 5 times). Among the total rescheduling events (41, 94, 39 times in pre-COVID, COVOD, post-COVID group, respectively), infectious disease and patient/parental inconvenience were the common reasons of rescheduling. Notably, the COVID group had some specific reasons for rescheduling which were related to the unique circumstance of the COVID-19 era (e.g. close contact with COVID-19 positive patient, pediatric ward closed due to COVID-19 cluster and concerning COVID-19 contact).

Conclusions: COVID-19 brought a significant impact on scheduling elective pediatric

surgery, even after calming down. Education of patients and efforts of medical staff are both important to provide appropriate elective pediatric surgery.

Keywords: viral infection, general anesthesia, pediatric general surgery

List of abbreviations

COVID-19	Corona-virus infectious disease, emerged in 2019
BT	Body temperature
SD	Standard deviation
CI	Confidence interval

1. INTRODUCTION

1.1. Background Information

There are several reasons it may be challenging to perform elective pediatric surgery as scheduled compared with elective surgery in adults. Pediatric surgery covers the general surgical conditions of patients from neonates to age 15 years (or until graduating junior high school). These patients usually are susceptible to viral infections or allergic diseases for which general anesthesia might be considered to be high-risk[1]. Furthermore, pediatric surgery needs to be accompanied by caregivers (parents, grandparents, etc.) since pediatric patients alone are not considered legally competent to allow surgery under general anesthesia. Therefore, in certain familial situations, unavailability of caregivers might be the reason for cancellation of pediatric elective surgery[2].

During the COVID-19 pandemic, the medical situation changed dramatically worldwide [3-5]. Non-emergent elective general pediatric surgeries needed to be cancelled for various reasons. Some of these reasons included, 1) lack of hospital resource because of the COVID-19 pandemic, 2) patient's infection/illness contact-relevant symptoms of COVID-19, 3) caregiver's infection/illness contact-relevant symptoms of COVID 19, and others.

Even if the elective pediatric surgery was successfully performed, patients and their families may have experienced inconveniences during the COVID-19 pandemic due to the inability of guardians to accompany the patient, as well as limited contacts of medical staff. These facts might have negative influences on the overall experience and well-being of the affected child receiving elective surgery. To deal with the pandemic in the future, it is important to understand the differences in the elective pediatric surgery circumstances between the periods before, during, and after the COVID-19 pandemic.

1.2. Objectives

The aims of this study were to clarify the impact of COVID-19 pandemic on elective general pediatric surgery in the Department of Pediatric Surgery at St. Luke's International Hospital, comparing the experiences before, during, and after the pandemic, so that these findings can be used to develop strategies for improving protocols for coping with pandemic situations in the future.

2. METHODS

2.1. Study population

Patients who underwent elective general pediatric surgery under general anesthesia in the Department of Pediatric Surgery at St. Luke's International Hospital between 2017 to 2023 were considered for this study. After the official declaration of COVID-19 emergency from the Japanese government on April 7, 2020, close contact between people was limited in the hospital setting. Three years later, on May 8, 2023, COVID-19 was down-graded to a class 5 infectious disease. Therefore, the patients who underwent elective surgery between April 2017 to March 2020 were assigned to the pre-COVID-19 group. The patients who underwent general surgery between April 2020 to March 2023 were assigned to the COVID-19 group (COVID group). The patients who underwent general surgery between May 2023 to November 2023 were assigned to the post-COVID-19 group. The patients who underwent surgery in April 2023 were intentionally excluded for the following two reasons: 1) to adjust the duration and seasons between pre-COVID and COVID (e.g. 2 years for each), 2) April 2023 was the social transition-period just before post-COVID (e.g. COVID was still class I infectious disease). As an attending pediatric surgeon, the first author of this study extracted the data and performed the following data analysis upon the approval of the ethical review committee of St. Luke's International Hospital (Research number: 23-R018).

2.2. Inclusion and Exclusion criteria

General pediatric surgery covers the general surgical conditions of patients from neonates to age 15 years (or until graduating junior high school). The exclusion criteria

comprised of patients older than 16 years old, emergent surgery cases, and patients who underwent surgery under local anesthesia only.

2.3. Impact of scheduling elective pediatric surgery

For all patients, rescheduling of elective surgery and their reasons were extracted from the patients' electronic medical records. Also, age, gender, operative procedure, the duration between the primary scheduled surgery dates and actual surgery dates were extracted, and rescheduling events which crossed the defined COVID-19 period were excluded.

2.3.1. Criteria for cancelation and rescheduling surgery

Scheduling and rescheduling elective surgery is performed at the outpatient clinic of the Ambulatory Care Center for Children at St. Luke's International Hospital. Upon the patient/parental request, the surgery date is decided at earliest availability within 1 to 2 month, on average.

Although the cancelation of surgery occurs for various reasons, elective surgery are commonly cancelled for at least these following situations: 1) no guardian can accompany during surgery, 2) symptoms related to transmittable infectious disease (e.g. body temperature of 37.5℃ or higher, cough, runny nose, sore throat, vomiting or diarrhea) within 2 weeks before surgery, 3) receiving live vaccination within 3 weeks before surgery, or 4) any other conditions which are considered to be high risk to have general anesthesia and surgery by surgeon and/or anesthesiologist.

2.3.2. Special consideration during COVID-19 pandemic

In addition to the cancelation criteria described above, there were special considerations

for rescheduling surgery during the COVID-19 era (e.g. COVID group in this study).

"Close Contact with COVID-19 positive patient" was defined by the Japanese government. The person who had contact with a COVID-19 positive patient (including 48 hours before being symptomatic or having positive COVID-19 result) needed to be physically isolated. Although this isolation period varied by municipality, our hospital required at least 10 days to have surgery or accompany children.

2.3.3. Categorization of variables

Category of surgery were divided into major surgery or minor surgery, according to the definition of the Japan Society of Pediatric Surgeons [6]. Reasons for rescheduling surgery were retrospectively investigated using patient's electronic medical records and finally categorized into the following 8 groups: 1) infectious disease, 2) patient/parental inconvenience, 3) transient decrease of necessity of surgery, 4) occurrence/exacerbation of other disease, 5) recent vaccination, 6) close contact with COVID-19 patient, 7) pediatric ward closed due to COVID-19 cluster, and 8) concerning COVID-19 contact.

2.4. Statistical Analysis

Continuous variables were expressed as the mean ± SD. Statistical analyses were performed using the JMP statistical program (SAS Institute, Cary, NC, USA). Comparisons of the continuous variables between three groups were performed with Kruskal-Wallis test with the appropriate post-hoc test. As for the comparisons of the nominal variables between three groups were performed with chi-square test with Bonferroni's correction for

interpretation. For logistic regression, univariable and multivariable analyses was performed. Statistical significance was defined as $p<0.05$.

3. RESULTS

3.1. Patient Characteristics

During the study period, 460, 508, and 81 patients underwent elective surgery under general anesthesia during the pre-COVID, COVID, and post-COVID periods, respectively. The baseline characteristics of patients in each group were outlined in Table 1. Patients in each group was comparable with the other groups with regards to gender and category of surgery. The pre-COVID group had significantly more female patients compared with the COVID group ($p<0.01$) (Table.1).

3.2. The proportions of rescheduling for elective surgery

Among the patients who were scheduled to receive elective surgery, 25, 74, and 29 patients experienced at least one rescheduling until having surgery during the pre-COVID, COVID, and post-COVID periods, respectively (Fig.1). The proportions of rescheduling were 5.4% (25/460), 14.6 % (74/508), and 35.8 % (29/81) in pre-COVID, COVID, and post-COVID groups, respectively (Fig.1). The post-COVID group had significantly higher proportion compared with the other groups, and COVID-group had significantly higher proportion compared with the pre-COVID group ($p<0.01$).

3.3. Characteristics of the rescheduled cases

Among the patients who experienced at least one rescheduling, the durations from the firstly attempted surgery date to actual surgery date were not significantly different in each groups (Table.2). Most patient experienced only one rescheduling event, however, the remaining patients experienced multiple rescheduling (e.g. 2, 3, 4, or 5 times), in each group (Table.2). Total numbers of rescheduling events were 41, 94, and 39 times in the pre-COVID, COVID, and post-COVID group, respectively (Table.2).

3.4. Predictors of rescheduling elective pediatric surgery

Logistic regression analysis was performed for identifying independent predictors of rescheduling elective pediatric surgery. After univariable/multivariable analysis, we found that younger age and the COVID-19 groups (e.g. pre-COVID, COVID, or post-COVID) were significant independent predictors of rescheduling elective surgery (Table.3).

3.5. Characteristics of reason for each rescheduling

To clarify the reasons for difference of rescheduling proportions among the study groups, the reason for rescheduling were categorized (Table. 4). As for the common reasons for all groups, infectious disease, patient/parental inconvenience, transient decrease of necessity of surgery, occurrence/exacerbation of other diseases were noted (Table.4). Only one case in the pre-COVID group had rescheduling due to recent vaccination. Notably, the COVID group had some specific reasons for rescheduling which were related to the COVID-19 era (e.g. close contact with COVID-19 positive patient, pediatric ward closed due to COVID-19

cluster and Concerning COVID-19 contact) (Table.4).

Table 1. Comparison of baseline characteristics between each group

Factors	Pre-COVID (n=460)	COVID (n=508)	Post-COVID (n=81)	*p*-values
Age	**4.1 ± 3.6**	**4.6 ± 3.9**	**3.4 ± 3.1**	**N.S.**
Gender (Male/Female)	**244 / 216**	**341 / 167**	**49 / 32**	**< 0.01***
Category of surgery (Major / Minor)	**19 / 441**	**30/478**	**5 / 76**	**N.S.**

*Pre-COVID group had significantly more female compared with the COVID group

Table 2. Characteristics of rescheduled patients

Factors	**Pre-COVID (n=25)**	**COVID (n=74)**	**Post-COVID (n=29)**	***p*-values**
The duration from the firstly attempted surgery date to actual surgery date (day)	**75.0 ± 76.6**	**77.2 ± 117**	**56.2 ± 40.4**	**N.S.**
Numbers of Rescheduling for each case				
1	15	60	21	-
2	8	11	6	-
3	0	1	2	-
4	0	1	0	-
5	2	1	0	-
Total numbers of rescheduling event	41	94	39	-

Table 3. Predictors of rescheduling elective pediatric surgery

	Unadjusted		Adjusted*		
Variables	**OR**	**95% CI**	**OR**	**95 % CI**	***p*-values****
Age per year	**0.89**	**0.84 – 0.95**	**0.89**	**0.83 - 0.94**	**< 0.01**
Male (vs. female)	**1.29**	**0.88 – 1.91**	**1.11**	**0.74 – 1.68**	**N.S.**
Category of surgery **Major (vs. minor)**	**0.72**	**0.25 – 1.69**	**0.61**	**0.20 – 1.50**	**N.S.**
COVID (vs. pre-COVID)	**2.97**	**1.88 – 4.84**	**3.10**	**1.94 – 5.10**	**< 0.01**
Post-COVID (vs. Pre-COVID)	**9.70**	**5.30 – 17.9**	**9.36**	**5.08 – 17.4**	**< 0.01**

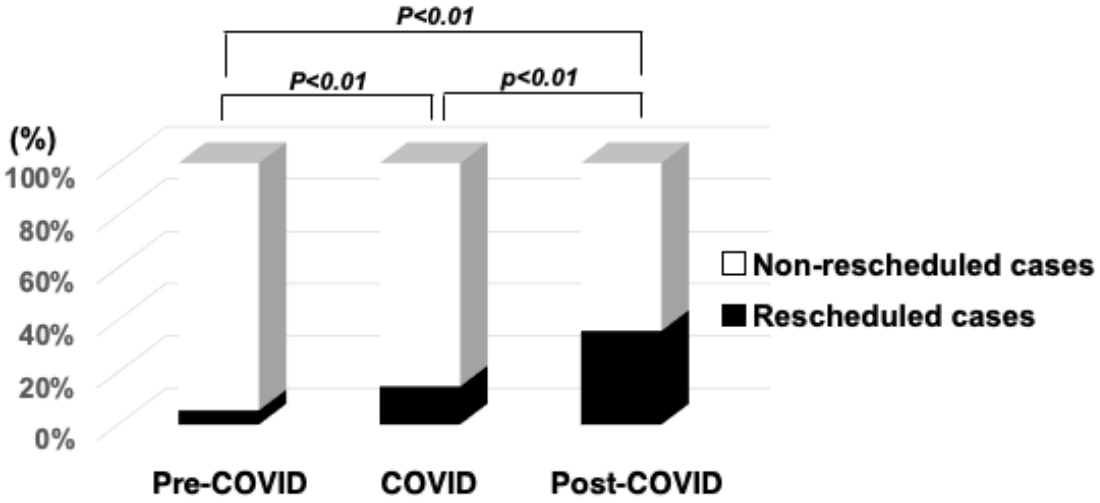
*Adjusted OR and 95% CI were calculated using multivariable logistic regression including all variables listed in the table.

** p-values were similar for both the unadjusted and adjusted analyses.

Table 4. Characteristics of reason for each rescheduling

Reason for rescheduling	Pre-COVID N (%)	COVID N (%)	Post-COVID N (%)	Total N (%)
Infectious disease	**28 (68.3)**	**62 (66.0)**	**36 (92.3)**	**129 (72.9)**
Patient/Parental inconvenience	**9 (22.0)**	**9 (9.6)**	**1 (2.6)**	**19 (10.7)**
Transient decrease of necessity of surgery	**2 (4.9)**	**3 (3.2)**	**1 (2.6)**	**6 (3.4)**
Occurrence/exacerbation of other diseases	**1 (2.4)**	**4 (4.3)**	**1 (2.6)**	**6 (3.4)**
Recent vaccination	**1 (2.4)**	**0 (0.0)**	**0 (0.0)**	**1 (0.6)**
Close contact with COVID-19 positive patient	**N.A**	**7 (7.5)**	**N.A**	**7 (4.0)**
Pediatric ward closed due to COVID-19 cluster	**N.A**	**5 (5.3)**	**N.A**	**5 (2.8)**
Concerning COVID-19 contact	**N.A**	**4(4.3)**	**N.A**	**4 (2.3)**
Total	**41**	**94**	**39**	**174**

N.A: not applicable



	Pre-COVID	COVID	Post-COVID
Rescheduled cases (%)	25 (5.4)	74 (14.6)	29 (35.8)
Total cases	460	508	81

Figure 1: The proportions of rescheduling for each group.

4. DISCUSSION

In this study, we investigated the impact of the COVID-19 era on rescheduling events among elective general pediatric surgery patients and observed the following; 1) The rescheduling of elective pediatric surgery significantly increased during and after the COVID-19 pandemic, compared with the pre-COVID-19 era; 2) The durations from the firstly attempted surgery date to actual surgery date were comparable between the groups, and multiple rescheduling were not rare in the all groups; 3) Major reasons for rescheduling were common across in the groups (e.g. infectious disease and patient/parental inconvenience), however, the COVID-19 group had specific reasons which were related to the COVID-19 pandemic (e.g. close contact with COVID-19 positive patient, pediatric ward closed due to COVID-19 cluster and concerning COVID-19 contact); 4) Timing of the surgery (e.g. Pre-COVID/COVID/Post-COVID) and the younger age were significant predictors for rescheduling surgery; and 5) Even after COVID-19, rescheduling of surgery were common especially because of infectious disease as the reason.

It has been reported that cancelation rates of general pediatric surgery was 7.64% before COVID-19 pandemic [7]. In our study, the proportion of rescheduling of elective surgery during pre-COVID period was comparable, measuring 5.4% (Fig.1). In 2010, Bathla et al. reported that the reasons of cancelation for pediatric elective surgery had been "preventable" cause (e.g. shortage of operating time, non-availability of blood, incomplete work up, administrative reason or patient not fasting with total rate of 38.6%), rather than upper respiratory tract infection (30.7%). On the other hand, the pre-COVID phase of our study showed that the most common reason was infectious disease (68.3%), and preventable cause was only 2.4% (e.g. recent vaccination) (Table.4). Therefore, we consider that preoperative protocol of our department was sufficient enough to prevent rescheduling at least before the COVID-19 pandemic. In our study, pre-COVID patients included

significantly more female compared with COVID group ($p<0.01$) (Table.1), however, logistic regression analysis revealed that gender was not the significant predictor for rescheduling surgery (Table.3). In general, general pediatric surgery covers the common surgeries which have higher incidence in males (e.g. testicular hydrocele, inguinal hernia, undescended testicle, circumcision and so on), thus the surgical patients include more males than females (Table.1). However, the reason why pre-COVID patients included significantly more female compared with COVID group is unknown (Table.1).

It has been reported that "parental inconvenience" seems to be the major reason for cancelation of elective plastic surgery for children[2]. Similarly, our study showed that the second most common reason for rescheduling was "patient/parental inconvenience" (Table.4) which is not practically preventable by medical effort. Considering the tremendous loss of medical resource[8] and parental responsibility, we consider that some "cancellation fee or penalty" might be needed to apply especially for the cancelation just before surgery date. Also, the detailed reasons of "patient/parental inconvenience" are unclear in this study, however, they are theoretically important, and will be a future research topic to prevent rescheduling surgery.

During the COVID-19 era, elective pediatric surgeries had been restricted because of the decreased burden of medical staff and facilities, worldwide[3-5, 9-11]. In fact, our study showed that the proportion of rescheduling of COVID-19 phase was significantly higher compared with the pre-COVID phase (e.g. 14.6 % vs 5.4 %, $p<0.01$) (Fig.1), partly because the COVID group had some specific reasons for rescheduling which were related to the COVID-19 era (e.g. close contact with COVID-19 positive patient, pediatric ward closed due to COVID-19 cluster and concerning COVID-19 contact) (Table.4). "Close contact with COVID-19 positive patient" which was defined by Japanese government might have some effect in preventing COVID-19 infection in Japan, however, some adverse effects was also reported

including work place mistreatment[12]. We consider that our study had valuable to clarify that "close contact with COVID-19 patient" can lead to the need to reschedule elective pediatric surgery. During the COVID-19 pandemic, Slater et al. reported that pediatric surgical wait priority score (pSWAPS) was useful to prioritize elective surgery [13].

After the COVID-19 pandemic had settled down, the Japanese government decided to downgrade COVID-19 to a class 5 infectious disease on May 8, 2023. Likely due to the lack of immunity to common viral/bacterial immunity due to isolation measures to prevent COVID-19, there may have been an increased incidence and severity of invasive infection in the pediatric age group in some countries [14]. In fact, our study revealed that the proportion of rescheduling surgery during post-COVID period was significantly higher compared with pre-COVID and COVID periods ($p<0.01$)(Fig.1). The most common reason for rescheduling during post-COVID-19 was infectious disease (92.3%), suggesting that pediatric patients may have been more susceptible to infection recently. In general, younger children (e.g. infant) are more susceptible to common viral infections compared with the older children. Therefore, we consider that the younger age was one of the significant predictors of rescheduling surgery (Table.3).

The process of rescheduling surgery itself is not an easy task for medical staff, rather it takes at least 20 minutes for calling with parents, booking for preoperative appointments/ hospitalization/anesthesia clinic/operation room. In our study, most patients experienced only one rescheduling, however, the remaining patients experienced multiple rescheduling (e.g. 2, 3, 4, or 5 times) (Table 2). Therefore, it is important to reduce multiple rescheduling to prevent loss of medical resources.

According to the previous reports and our results, we consider that several factors are important to deliver elective surgery appropriately in the future.

1. Education for the patient: prevention of infection, no live vaccination 3 weeks before

surgery, proper fasting before surgery and keeping appointment.

2. Effort of medical staff: appropriate preoperative work up and ordering, prioritize elective surgery.
3. Protocol for upcoming Pandemic: prevention of shut down of pediatric ward/operation room and prioritize emergent/elective surgery in whole facility.

4.1. Limitations

This was a retrospective study conducted within a single institution with relatively small numbers of patients. Because of the retrospective nature, the influence of mis-classification bias and unknown confounding factors on the study results cannot be fully excluded. Especially, this study did not include simple cancelation of elective surgery (e.g. the patients who canceled elective surgery without completing surgery), therefore, the results of cancelation rates/reason might have some bias.

4.2. Conclusions

The COVID-19 pandemic significantly impacted the scheduling circumstance for elective pediatric surgery, with lasting effects even after the pandemic period. Education of the patients and efforts of medical staff are both important to provide appropriate elective pediatric surgery.

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