Cross-sectional Study

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Impacts of COVID-19 pandemic on pediatric fractures: a 4-year evaluation of epidemiology and delayed treatment from prepandemic to pandemic period at a tertiary referral hospital

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Background: Definitive fracture surgery should be performed as soon as the patient's condition allows. However, there may be some delays in the treatment during a pandemic.

Objective: This study aimed to investigate and compare the epidemiology and delays in pediatric fracture management during the pandemic and prepandemic periods in terms of how many cases were delayed, how long were the delays, and the causes for the delays of fracture treatment.

Methods: This comparative-retrospective study was conducted in a tertiary referral hospital in Yogyakarta, Indonesia. The authors included all patients who presented to the hospital from 1 December 2019 to 30 November 2021 (pandemic group period) and from 1 December 2017 to 30 November 2019 (prepandemic group period). The collected data included: patients' age and sex, fractured bone, fracture type, concurrent fracture, hospital stay duration, treatment, need for multidisciplinary treatment, interval from arrival to treatment, and reasons for delayed surgical treatment. The data were obtained from the patients' medical records.

Results: Results showed a decrease in the pediatric fracture cases during the 2 years pandemic period compared to the prepandemic period (75 vs. 135 cases). There was no significant difference in the evaluated parameters of demographic, fractured bone and type, hospital stay duration, treatment, other department involvement, and delayed surgical treatment for the fracture. The most common reason for the definitive surgical management delay was the need for medical condition improvements ($n = 63$, 79.7%) and it was significantly associated with the need for multidisciplinary treatment approach (22.83 in isolated orthopedic cases vs. 87.5% in multidisciplinary cases; $P = 0.000$).

Conclusion: There was a decrease in the pediatric fracture cases during the 2-year pandemic period compared to the prepandemic period. The delay in definitive surgical management was mainly due to the need for the medical condition improvements and it was associated with the need for a multidisciplinary treatment approach.

Keywords: COVID-19, fracture, Indonesia, pediatric, time-to-treatment

Introduction

The novel coronavirus disease 2019 (COVID-19) was identified as the cause of a serious respiratory disease in Wuhan, China, in December 2019[1]. The WHO declared COVID-19 a Public Health Emergency of International Concern on 30 January 2020, and it was formally declared a pandemic on 11 March 2020[2]. Because of the virus's high transmissibility, it spread quickly

HIGHLIGHTS

- There was no delay in the emergency cases in both the prepandemic and pandemic groups.
- There were 34 (45.33%) nonemergent patients who got delayed surgical treatment during the pandemic period.
- Higher proportion of delayed treatment in nonemergent cases during the pandemic due to improvement of medical condition and limited operating room and personnel.
- The average time interval from arrival to surgery or definitive treatment was slightly longer in the pandemic group (3.7 ± 4.5 days) compared to prepandemic group (3.2 ±4.13 days).
- The difference in hospital length of stay for patients during the coronavirus disease 2019 pandemic was not significantly different compared to the prepandemic.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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throughout the world, including to Indonesia. The first confirmed case in Yogyakarta special region (Daerah Istimewa Yogyakarta) was declared on 13 March 2020[3]. The steep growth in COVID-19 infection rates prompted the worldwide implementation of social distancing protocols, strict hand-washing procedures, and the temporary banning of all nonessential commercial activities[4]. To prevent the rapid spread of infection, enforced adherence to these social distancing practices was essential. During a pandemic, patient management should be selected after careful assessment of the surgery's benefit, the patient's risk, and the surgeon's safety[5].

During COVID-19, our hospital which was a tertiary referral hospital, employed the following methods to improve surgeon and patient safety: minimize the number of surgeries; prioritize the conditions that can be addressed with minimally invasive surgery and only require a brief hospital stay; senior surgeons were withdrawn from direct medical management and were only available for telemedicine consultations; and confirm the patient's COVID-19 status before the surgery. Meanwhile, these strategies may cause delays in the treatment of some patients.

When pediatric patients with fractures were stabilized early in their hospital stay, they had fewer problems than those who were treated later[6]. As a result, definitive fracture surgery for fractures stabilization should be performed within 24–48 h of injury, or as soon as the patient's condition allows[6]. However, due to the aforementioned factors, there may be some delays in the treatment of pediatric fractures during a pandemic.

The goal of this study was to investigate the epidemiology of pediatric fracture treated operatively and delays in surgical pediatric fracture management during the pandemic period in terms of: how many cases were delayed; how long were the delays; and the causes for the delays of fracture treatment. The data were then compared to the same period in the previous year.

Methods

This study was performed in compliance with the Declaration of Helsinki, in line with the Strengthening the Reporting of Cohort, Cross-sectional and Case–control studies in Surgery (STROCSS) criteria[7] and has received ethical clearance for the use of secondary data from medical records. This comparative-retrospective study was conducted in a tertiary referral hospital, Yogyakarta, Indonesia. All data were obtained from the patients' medical records and did not directly involve human subjects. We had registered our research in a research registry with the Unique Identifying Number of researchregistry8936. The protocol for this study is available upon request.

We included all pediatric patients (0–18 years old) who presented to the emergency department or orthopedic clinics who were then diagnosed with new onset (< 1 week) fractures based on the patient history with clinical and radiological examinations. The fractured bones included in this study were clavicle, scapula, humerus, radius, ulna, hand, spine, pelvic, femur, tibia, fibula, and feet. For the COVID-19 group (during the pandemic period), we included all patients who presented to the hospital from 1 December 2019 to 30 November 2021. For the comparison (prepandemic period) group, the period was 1 December 2017–30 November 2019.

We excluded the patients with pathological fractures due to bone tumors (primary and metastatic), genetic bone abnormalities, unhealed previous fractures (poor union or nonunion), periprosthetic fractures, and patients with data missing from their medical records. We did not exclude patients with COVID-19 positive status.

The collected data included the demographic characteristics of the patients (age and sex), fractured bone, type of fracture, concurrent fracture, hospital stay duration, treatment, other department involvement on the management, interval from arrival to treatment, and reasons for delayed surgical treatment for the fracture.

The fractured bone was documented as the clavicle, scapula, humerus, radius, and/or ulna, hand, spine, pelvic, femur, tibia and/or fibula, foot, and patella. The patients were stated to have concurrent fractures when they had more than one fracture based on the mentioned bone group. We defined the patient as one who underwent surgical treatment when the procedure was performed in the operating room under anesthesia and the procedure includes at least one of the following actions: skin incision, wound closure, or implant placement. We considered the treatment of fractures was delayed when it was conducted in greater than 24 h for emergency surgical case or conservative case, then greater than 48 h for nonemergency cases[6].

Statistical analysis was conducted by using SPSS 23.0 software (IBM Corp.). First, we performed descriptive statistic for all variables and the Kolmogorov–Smirnov test to evaluate the normality of the distribution for numerical variables. For data with a normal distribution, *t*-tests were used to assess the difference of mean. Otherwise, the Mann–Whitney tests were used. χ^2-test was performed for categorical variables. When the expected count was less than 5, we used Fisher's exact tests. We considered a significant result when $P < 0.05$.

Results

The total number of the patients included in this study was 210, with 159 male patients (75.7%) and 51 female patients (24.3%). During the prepandemic period, we identified 135 (64.3%) patients, while during the pandemic period, there were 75 total patients (35.7%). The patients' age range was between 0 and 17 years and the average was 11.54 years. Figure 1 depicts the distribution of patients' age. The incidence of fracture was increased in children between 5 and 8 years old and further increased in the adolescence age group (>12 years). There were no differences in the proportion of sex and average age between the pandemic and prepandemic period groups (Table 1).

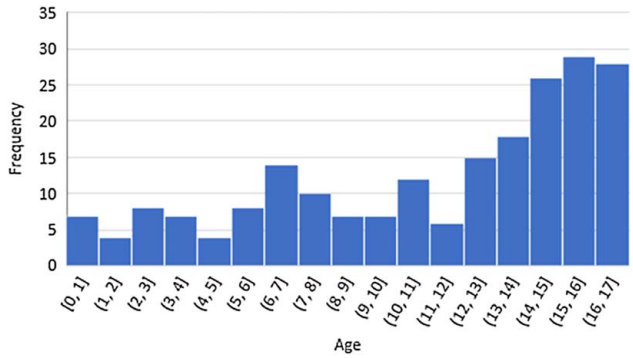

Figure 1. Distribution of patients' age.

Table 1

Comparison of epidemiology and fracture management between two study periods.

	Prepandemic		Pandemic		
Variables	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	***P***
Sex (Male)	103	76.3	56	74.7	0.792
Age	11.4 ± 4.8 y.o.		11.6 ± 4.9 y.o.		0.677
Close fracture	128	71.1	71	70.3	0.885
Fractures treated surgically	151	83.9	83	82.2	0.712
Time from arrival to treatment	3.2 ± 4.13 days		3.7 ± 4.5		0.578
Case with treatment delay	45	33.3	34	45.33	0.085
Causes of delay	0.180				
Need for medical condition improvements	38	84.4	25	73.5	
Limited surgical theater or personnel	4	8.9	8	23.5	
Others/unspecified	3	6.7	1	2.9	
Duration of hospital stay	6.31 ± 5.77 days		6.58 ± 5.20 days		0.428

We found a total of 281 fractures during the study period, where 180 (64.1%) occurred during the prepandemic period and 101 (35.9%) occurred during the pandemic. Most of the patients (75.2%) had 1 fractured bone, 36 patients (17.1%) had 2 fractured bones, and 16 patients (7.6%) had 3 or more fractured bones. There was no difference in the proportion of concurrent fractured bones during the two study periods ($P=0.685$). The overall number of fractured bones is shown in Figure 2 and Table 2. The majority type of fracture was closed fractures (199 fracture, 70.8%). There was no difference in the proportion of open and closed fractures between the prepandemic and the pandemic group (Table 1).

The time interval from patient arrival at the hospital to surgery is shown in Figure 3 and Table 3. We found that 48 (22.8%) patients underwent the surgical or nonoperative definitive treatment in less than 24 h, with only 14 (6.67%) patients taking more than 10 days. The average time interval from arrival to surgery or definitive nonoperative treatment was 3.2 days with a SD of 4.13 days in the prepandemic group and 3.7 days (SD 4.5 days) in the pandemic group ($P=0.578$). There was no delay in the emergency cases in both the prepandemic and pandemic groups. For the nonemergency cases, there were 45 (33.3%) patients who were delayed to receive surgical treatment during the prepandemic period and 34 (45.33%) patients who got delayed surgical treatment during the pandemic period. However, the difference was not statistically significant ($P=0.085$).

The major cause of the delayed treatment was the need for medical condition improvements (63 patients, 79.7%). The other reasons were limited surgical theater or personnel available, in both the pandemic and prepandemic periods (12 patients, 15.2%). The comparison between percentage of the cause of delayed treatment is presented in Table 1. The most common medical condition that caused delay in the surgical treatment was anemia (35 patients) and increased intracranial pressure that needed mannitol administration (29 patients). The other medical conditions that needed to be treated were thrombocytopenia, abnormal coagulation factors, seizure, and pulmonary contusion. A number of patients (28 patients) had two or more medical conditions that needed to be improved to decrease the risk of surgical and anesthetic complications. During the COVID-19 pandemic, one patient was delayed receiving surgery due to

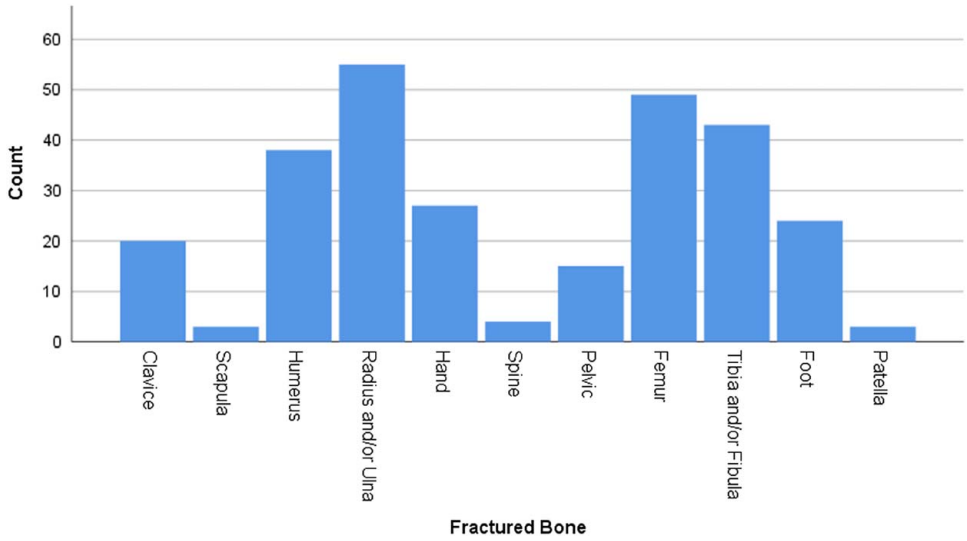

Figure 2. The number of fractured bones during the two study periods.

Table 2

Comparison of fractured bone between two study periods.

Fractured bone	Prepandemic Frequency	Prepandemic Percentage (%)	Pandemic Frequency	Pandemic Percentage (%)	*P*
Clavicle	15	8.3	5	5.0	0.240
Scapula	1	0.6	2	2.0	
Humerus	27	15.0	11	10.9	
Radius and/or ulna	37	20.6	18	17.8	
Hand	17	9.4	10	9.9	
Spine	3	1.7	1	1.0	
Pelvic	9	5.0	6	5.9	
Femur	23	12.8	26	25.7	
Tibia and/or fibula	30	16.7	13	12.9	
Foot	17	9.4	7	6.9	
Patella	1	0.6	2	2.0	

COVID-19 positive and therefore should be sent to the isolation ward first until negative.

About 77.1% of cases (162 cases) were isolated orthopedics cases, while the others (48 patients/22.9%) needed to be treated by a multidisciplinary team (Fig. 4). From 162 isolated orthopedic cases, delayed surgical fixation happened in 37 (22.83%) patients. In contrast, from 48 patients who needed other department involvement for treatment, there were 42 (87.5%) patients who experienced delayed surgical treatment for the fracture. Therefore, it can be concluded that the necessity of multidisciplinary treatment for the pediatric fracture patient is significantly associated with delayed surgical management of the pediatric fracture ($P = 0.000$).

The percentage of fractures that received surgical treatment was 83.3%. There was no difference in the proportion of treatment choice (surgical vs. conservative) between the two study periods (Table 1). The modality of surgical treatment is depicted in Figure 5. For the open fracture, we always performed debridement before stabilizing the fracture with internal or external fixation.

The duration of hospital stay was 0–30 days with an average of 6.41 days (SD 5.56 days). The difference was not statistically significant between the pandemic and prepandemic groups ($P = 0.428$). The average duration of hospital stay was 6.31 days (SD 5.77 days) in the prepandemic group and 6.58 (SD 5.20 days) in the pandemic group (Table 1).

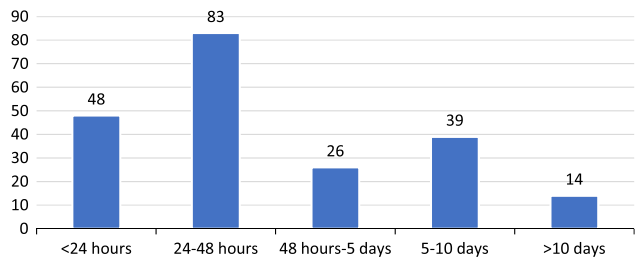

Figure 3. Time interval from arrival at the hospital to surgery.

Discussion

This study aimed to investigate and compare the epidemiology and delays in pediatric fracture management during the pandemic and prepandemic periods. According to our findings, the COVID-19 pandemic definitely affected the epidemiology of fractures in our region. The pandemic also affected the management of pediatric fracture, although the difference of delayed fracture surgical treatment was not significant statistically.

As seen worldwide, the total number of patients with fractures was reduced. Hidayat *et al.*[8] in 2021 reported the reduction of fracture cases in five hospitals in Yogyakarta, Indonesia, which was reduced by 47.68%. The amount of reduction was similar to a study in China with a reduction of 46.74%[9]. The reduction was also observed in particularly in the pediatric fractures. During the COVID-19 outbreak, several studies revealed a decrease in pediatric fracture rates. The sharpest decline occurred during the first lockdown, with a 56% drop in boys and a 47% drop in girls[10]. This study also demonstrated a decline in the incidence of fractures during the 2 years of the COVID-19 pandemic, where there was about 33% reduction in the fracture incidence.

High rates of COVID-19 infection in Indonesia, led to an increase in COVID-19-related hospitalizations. In our hospital, several wards were modified for COVID-19 patient care during the Delta variant wave in July and August 2021, as well as the Omicron wave in February and March 2022. We performed a number of examinations to determine the COVID-19 infection status, as depicted in Figure 6. For patients who should undergo emergency surgery but were suspected of having COVID-19 infection, we performed surgery as soon as possible with our COVID protocol: complete personal protective equipment as well as decontamination of the equipment and operating theater after the procedure[11].

During the COVID-19 period, the previous research reported the discrepancy between boys and girls in terms of the total number of fractures, which had greatly declined. It is possible that this is due in part to the floor effect. Although the overall number of cases dropped in both sexes, the incidence of cases in particular age groups of girls was already so low that they were not been able to show the reduction as much as boys. Furthermore, boys were likely to be more active than girls prior to COVID-19, therefore, the effect of lockdown was more prominent in boys[12]. In this study, the proportion of fracture incidence in boys and girls was not statistically different.

Table 3

Comparison of time interval from arrival to surgery between two study periods.

Time from arrival to surgery	Prepandemic Frequency	Prepandemic Percentage (%)	Pandemic Frequency	Pandemic Percentage (%)	*P*
< 24 h	28	20.7	20	26.7	0.116
24–48 h	62	45.9	21	28.0	
48 h–5 days	13	9.6	13	17.3	
5–10 days	24	17.8	15	20.0	
> 10 days	8	5.9	6	8.0	

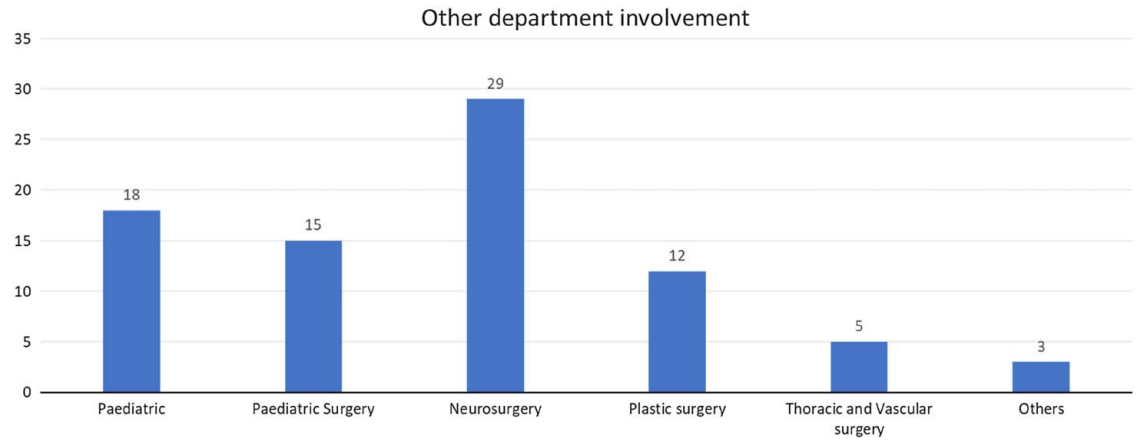

Figure 4. Involvement of other departments in the patients' treatment.

The prevalence of male patients in our research is consistent with prior studies. This predominance is most likely a result of biological causes as well as societal and sex-related disparities in activity levels. These characteristics could not be identified in this study, but they might be beneficial in the future, for example, to help identify fracture-prone populations in both sexes and to guide future preventative measures[13,14].

For the surgery timing, O'Hagan *et al.*[15] in 2021 reported resources were restricted and there was a resultant delay to the initial treatment of open fractures during the COVID-19 pandemic. Our results also showed some delays in the pediatric fracture surgery management due to limited resources, and therefore the number of surgeries was reduced to only 1–2 surgeries per day during the pandemic peaks. Meanwhile, during the prepandemic period there were also some delays of surgery due to insufficient resources relative to the high surgery demand.

Fear of COVID-19 transmission led some patients to delay or avoid seeking medical care in hospital[8]. Furthermore, in Indonesia, the traditional bonesetter practice is still common and widely accessible. Therefore, some patients prefer to seek fracture treatment from a bonesetter, and it might contribute to a reduction or delay in hospital visits for fractures during the pandemic period[16]. In these kinds of circumtances, better patient education is required, highlighting COVID-19 transmission, types of urgent or emergency cases, which should be immediately treated in hospital, and the risks of bonesetter treatment.

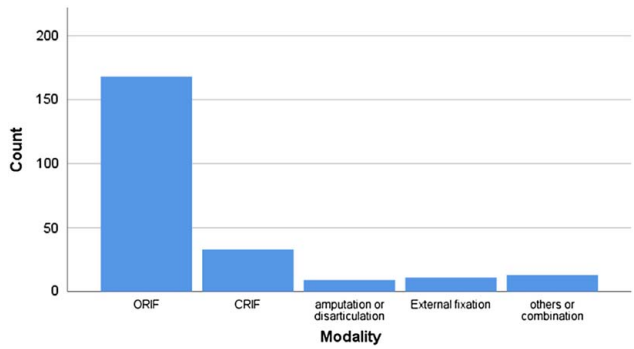

Figure 5. Modality of the surgical treatment. Others: debridement only, stump plasty, skin graft, flap, and endoscopic decompression.

To understand the timing of surgery it is important to consider other factors that co-exist which will predict the outcome of surgery. The most appropriate timing for surgery remains controversial and continued research efforts are required in this area. Surgical timing is not the only factor that plays a role within the process of fracture healing and preventing further complications[17]. The longer the delay might cause greater morbidity in some patients. Kluijfhout *et al.*[18] in 2020 reported that the incidence of complications was significantly higher among patients who underwent delayed fixation (>1 week) (31.3%) versus those who underwent primary fixation (12.3%). Emergency surgery should not be delayed unless the patient is nonviable then damage control surgery comes as an option. A meta-analysis of observational studies revealed that there was a higher risk of infection in grade IIIA fractures and that this risk was higher when irrigation and debridement were postponed for longer than 12 h[19]. However, a study from Sakti and Khadafi[20] in 2021 reported that delayed surgery for spine emergency cases was still beneficial during the pandemic period.

In our study, the necessity for medical condition improvement was the main cause of this lengthy delay. During the pandemic, one patient had COVID-19, necessitating treatment and isolation of the patient until his COVID-19 status was negative. Traumatic brain damage, which required mannitol therapy, as well as viral or noninfectious fever, were other medical conditions that contributed to the lengthy delay in surgical stabilization of the fracture.

According to our study, the delay in surgical fixation of fractures was significantly associated with the necessity of a multidisciplinary approach for the patient treatment. Consequently, good and effective collaboration among the departments is crucial so that the patient's condition can be quickly improved, and the surgical fixation can be performed as soon as possible. Moreover, a multidisciplinary approach may improve recovery so that the patient can return to his/her preinjury state as soon as possible.

The most common associated medical condition found in the pediatric fracture patients in our study was anemia. Besides the hemorrhage caused by the trauma itself, the high proportion of pediatric fracture patients suffering anemia in our study might be due to the pre-existing anemia, mainly the iron deficiency anemia. According to a survey conducted by Basic Health Research in

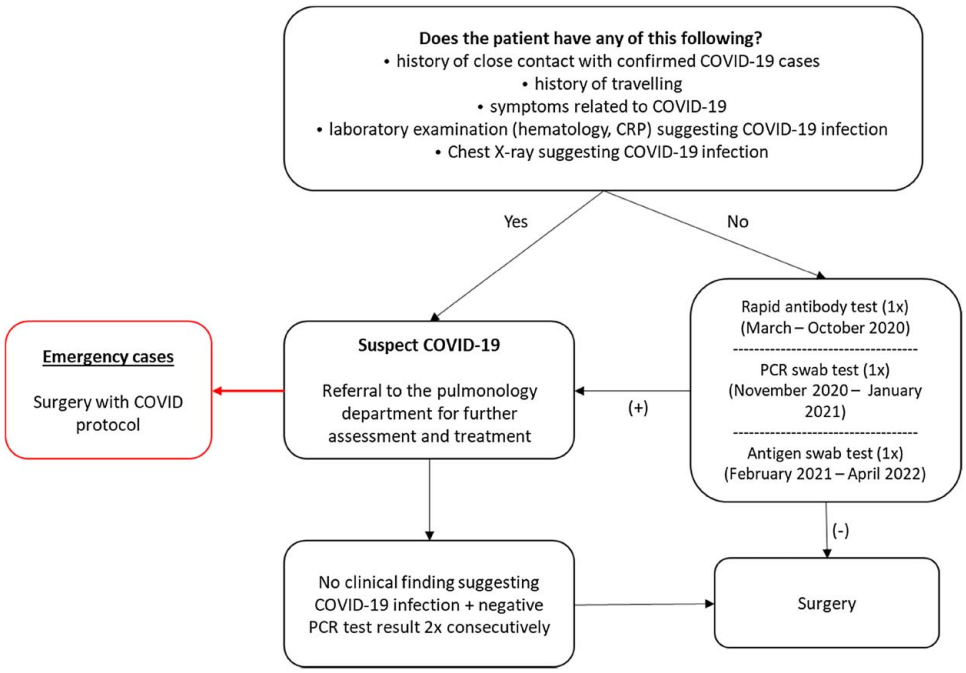

Figure 6. Our institution flowchart to define patients' coronavirus disease status and eligibility for surgery.

2013, more than 50% of Indonesian children and adolescents were anemic, including 28% of children under the age of 5 and 26% of children aged 5–14[21].

During the pandemic, prior to the surgery, isolation and examination were done intensively to prevent the transmission of COVID-19. As also for the postoperative settings, in patients with upper extremities fracture, we advised to perform early passive and active exercise while in the lower extremities fracture, we performed a set of exercises to obtain optimal range of motion as soon as possible. Although we hypothesized these factors might influence the duration of hospital stay during the pandemic period, our study revealed that there was no significant difference in hospital stay duration.

In contrast to previous studies which demonstrated numerous changes in the epidemiology of the fractures during the COVID-19 pandemic[9,10,12], our study only demonstrated a decrease in the incidence, and no difference in the proportions of the studied parameters. The reasons for these phenomena were because we collected the data longer than the previous study (2 years period) and during the period, there was a long duration between the peaks of the pandemic in which the activity of people in our region almost went back to the prepandemic state. In addition, the main daily activity of children in our region was at home and therefore, it was not actually affected by the decrease of traffic accidents during the pandemic period.

We recognized that our study is without its limitations. The data utilized in this study was taken secondarily from medical records, leaving the possibility of biases in reporting especially regarding reasonings for delayed treatment. We also understand the impact of our moderate sample size to the generalization of this study result, as we obtained data from one center only. Taking into account of these limitations, the result from our study presented an important epidemiology report of pediatric fracture case management during the COVID-19 pandemic, which caused constraints in health service provision. We recommend further research to evaluate the acceptable time interval between injury to the surgical treatment for pediatric fractures that will be an important guide in times when the resources are limited relatively to the surgery demand. In addition, further research is suggested regarding the incidence of fracture complications such as malunion or nonunion, in patient who experienced fracture during the pandemic period.

Conclusions

This study showed a decrease in the pediatric fracture cases presented in our hospital during the 2 years pandemic period compared to the prepandemic period. There was no significant difference in the evaluated parameters of demographic, fractured bone and type, hospital stay duration, treatment, other department involvement, and delayed surgical treatment for the fractures. The most common reason for the delay was it was needed for the patient's medical condition improvements.

Ethical approval

This study has been approved by the Medical and Health Research Ethics Committee Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada (no. KE/FK/0813/EC/2020).

Consent

Patient consent was waived as the study did not use any of the patient data.

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This study received no funding.

Author contribution

H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P.R., A.K., and Y.M.S.: Conceptualization; H.M., B.F.P.R., A.K., and Y.M.S.: data curation; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., and Y.M.S.: formal analysis; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P.R., A.K., and Y.M.S.: investigation; H.M., R.M., T.R., and Y.M.S.: methodology; H.M., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B. F.P.R., A.K., and Y.M.S.: project administration; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P.R., A.K., and Y.M.S.: resources; H.M., B.F.P.R., A.K., and Y.M.S.: software; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., and Y.M.S.: supervision; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y. A.P.P., Z.A.L., and Y.M.S.: validation; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P.R., A.K., and Y.M.S.: visualization; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P.R., A.K., and Y.M.S.: writing - original draft; H.M., R.M., T.R., M.H., L.H., A.F.R.T., Y.A.P.P., Z.A.L., B.F.P. R., A.K., and Y.M.S.: writing – review and editing.

Conflicts of interest disclosure

The authors have no conflicts of interest.

Research registration unique identifying number (UIN)

As this study utilized secondary data from medical records, no human patient was directly involved.

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Data availability statement

Study protocol is available upon request.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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