

Comparison of acute appendicitis severity in pandemic and non-pandemic periods of COVID-19: a comparative study



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ABSTRACT

Background: Acute appendicitis is the most common cause of abdominal surgery. The delay of diagnosis and surgery increases the risk of perforated appendicitis, which is associated with increased morbidity and mortality. The COVID-19 pandemic has an impact on the delays in the diagnosis (time-to-diagnosis) and therapy (time-to-intervention). In this study, we aimed to analyze the profiles and characteristics of acute appendicitis patients in COVID-19 pandemic and non-pandemic periods in Indonesia.

Methods: We collected samples from all patients with acute appendicitis who visited the emergency department from November 10, 2018 – February 10, 2020 (non-COVID-19 pandemic) and March 11, 2020 – August 11, 2021 (COVID-19 pandemic). The data are secondary data taken from medical records. We collected the patient's demographic data (e.g., age and sex), operation description, length of stay, and duration of the operation.

Results: We recruited a total of 121 patients, consisting of 56 patients during the non-pandemic period and 65 patients during the pandemic. Based on the severity, patients with grade 1 were the most common during the non-pandemic period, while patients with grade 4 were the most common during the pandemic. There was a significant difference between the severity of acute appendicitis during the non-pandemic and the pandemic ($P < 0.0001$). During non-pandemic periods, the majority of patients were hospitalized for 3-4 days, while during the pandemic, the majority of patients required hospitalization of up to 5-6 days.

Conclusion: There was a substantial difference in the severity of acute appendicitis patients during the COVID-19 pandemic and non-pandemic periods.

Keywords: acute appendicitis, COVID-19, disease severity, pandemic.

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INTRODUCTION

Acute appendicitis is the most common medical emergency in the abdomen and the most common cause of abdominal surgery. Previous meta-analyses study reported that in the 21st century, the incidence of appendicitis was 100 per 100,000 person-years in North America.¹ The risk was 6.7% for females and 8.6% for males in the USA.² Acute appendicitis is a progressive disease that requires rapid diagnosis. In establishing the diagnosis, the Alvarado Score can be used, with the interpretation of having a high risk when the score is equal to or higher than 7. A delay in diagnosis can cause complications in the form of perforated appendicitis, peritonitis, septicemia, and even death.³ Delaying surgical treatment may increase

the risk of perforated appendicitis with peritonitis, which is associated with a significant increase in morbidity and mortality.^{4,5} A previous study used a modified Delphi method to obtain a consensus on a disease severity score for the assessment of appendicitis severity grade.⁶ This method divides the severity of appendicitis into 5, namely: grade 0, normal appendiceal shape; grade 1, inflammation without perforation; grade 2, gangrene of the appendix without perforation; grade 3, the appendix is perforated with localized fluid (fluid is within a radius of 10 cm); grade 4, perforation with abscess (pus is more than 5 cm from the appendix); and grade 5, perforation with generalized peritonitis.⁶

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by

infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that firstly emerged in Wuhan, China.⁷ The coronavirus was first identified as the cause of a cluster of pneumonia cases in Wuhan, Hubei Province, China, at the end of 2019 and was declared a global pandemic on March 11, 2020, by WHO. At the beginning of the pandemic, the lack of knowledge about the mechanisms of transmission, treatment, and prevention of COVID-19 resulted in people being afraid to go to the hospital. As a result, many medical conditions end up in delayed diagnosis. Although the main symptoms of COVID-19 are respiratory symptoms, gastrointestinal symptoms such as abdominal pain, nausea and vomiting were also commonly found in infected patients.⁸

The COVID-19 pandemic has resulted in a decrease in the number of patients undergoing emergency surgery; however, there has been an increase in emergency cases with concomitant viral infections, as well as more patients presenting with severe symptoms due to delays in diagnosis. Delays of more than 2 hours from the time the patient arrives until diagnosis (time-to-diagnosis), as well as delays in therapy (time-to-intervention) for emergency cases, are reported during the COVID-19 pandemic. This may be due to the quarantine/lockdown policy, the patient's fear of COVID-19, and the queue for COVID-19 check-ups in the emergency room.^{9,10}

Currently, there was no study that examined the comparison of the severity of acute appendicitis during the pandemic and non-pandemic periods of COVID-19. Therefore, in this study, we aimed to analyze the profiles and characteristics of acute appendicitis patients in COVID-19 pandemic and non-pandemic periods in Indonesia.

METHODS

Study design and participants

This study is an observational retrospective study. We collected samples from all patients with acute appendicitis who visited the emergency department on November 10, 2018 – February 10, 2020 (non-COVID-19 pandemic) and March 11, 2020 – August 11, 2021 (COVID-19 pandemic). Data during the non-pandemic and pandemic periods are secondary data taken from medical records. We collected the patient's demographic data (e.g., age and sex), operation description, length of stay, and duration of surgery. All patients underwent surgical treatment, either appendectomy or laparotomy appendectomy. We included patients with acute appendicitis who underwent surgical management, adults aged more than 18 years, and patients with an Alvarado score of more than equal to 7.¹¹ We excluded patients with no complete medical record data and patients with diabetes mellitus and chronic renal failure. We used a total sampling method and included all patients who fulfilled the inclusion criteria.

Acute appendicitis severity grading

The acute appendicitis severity grading was performed using the disease severity score as previously described (6). In brief, the grading system divided the acute appendicitis patients into 5 grades: Grade 0, normal appearance; Grade 1, inflamed without perforation; Grade 2, gangrenous without perforation; Grade 3, perforated with localized fluid; Grade 4, perforated with a regional abscess; and Grade 5, perforated with generalized peritonitis. The data relating to the severity grading was obtained from the operative report.

Statistical analysis

The statistical analysis was performed using the SPSS statistical software package (version 23.0; IBM Corp., Armonk, NY, USA). Discrete variables were tested using the Chi-square test. Statistical significance was determined when the P value was less than 0.05.

RESULTS

Patient characteristics

We included a total of 121 patients in this study for further analysis. The majority of acute appendicitis patients were male (75 men; 62.0% vs. 46 women; 38.0%). There were 56 patients in the non-pandemic period and 65 patients in the pandemic period. During the non-pandemic period, there were 34 male patients (60.7%) and 22 female patients (39.3%), while during the pandemic, there were 41 male patients (63.1%) and 24 female patients (36.9%). In both non-pandemic and pandemic periods, men remained the predominant sex of patients with acute appendicitis.

In general, the mean age of patients with acute appendicitis was 32.36 ± 13.26 years. The mean age of the patients during the non-pandemic period was 31.93 ± 14.30 , and the mean age of the patients during the pandemic was 32.78 ± 12.39 . There was no significant difference between the age of the patients in the non-pandemic and during the pandemic ($P > 0.05$). The predominant age group was found to be the same both during the pandemic and non-pandemic, where the majority of patients were under the age of 30 years. We also found that the number of patients

with acute appendicitis tends to decrease with increasing age. The characteristics of the subjects are shown in [Table 1](#).

Appendicitis severity and duration of treatment (LOS)

We examined the acute appendicitis severity and the length of stay in the hospital during both the non-pandemic and pandemic periods ([Table 2](#)). Patients with grade 1 acute appendicitis (50/56; 89.3%) were the most common during the non-pandemic period, whereas patients with grade 4 (25/65; 38.5%) were the most common during the pandemic. The severity of acute appendicitis was significantly different between the non-pandemic and pandemic periods ($P < 0.0001$).

We also analyzed the distribution of patients based on length of stay (LOS). The majority of patients during the non-pandemic period require hospitalization for 3-4 days (38/56; 67.9%), while during the pandemic, the majority of patients require treatment time of up to 5-6 days (25/65; 38.5%). In fact, the number of patients who had to undergo treatment for more than 6 days was found to be higher during the pandemic than during the non-pandemic (non-pandemic: 2/56; 3.6% vs. pandemic: 18/65; 27.7%). There was a significant difference between the length of hospital stay during the non-pandemic and during the pandemic ($P < 0.0001$).

Duration of surgery and length of stay on the severity of appendicitis

We analyzed the differences in the duration of surgery and the length of stay for each grade of acute appendicitis ([Table 3](#)). Based on the duration of surgery, we found that the shortest average operating time was for patients with grade 1 (82.68 ± 25.49 minutes), and the longest operating time was for patients with grade 5 (163.0 ± 55.28 minutes). We found that the trend of surgery duration tends to increase with the increase of severity grade. Based on the length of hospital stay, patients with grade 1 required 3.89 ± 1.42 days of treatment, while patients with grade 3, grade 4, and grade 5 needed about 6 days before being discharged. This shows that the treatment

time also increases with the severity of appendicitis.

Duration of surgery and length of stay in the pandemic and non-pandemic periods

We also analyzed the differences in the duration of surgery and length of stay in the non-pandemic and pandemic periods (Table 4). Based on the duration of the operation, we found that during the non-pandemic period, the average operating time was 83.32 ± 31.21 minutes. Meanwhile, during the pandemic, the average operating time was 115.62 ± 40.40 minutes. Our data showed that the duration of surgery was longer during the pandemic.

Based on the length of hospital stay, we found that the average length of stay was longer during the pandemic than during the non-pandemic (pandemic: 5.43 ± 2.10 days vs. non-pandemic: 3.86 ± 1.18) days.

DISCUSSION

In this study, we aimed to compare the severity of acute appendicitis patients during non-pandemic and pandemic periods. According to the findings of this study, the severity of acute appendicitis patients tends to be higher during pandemics, showed by the acute appendicitis grade, duration of surgery, and length of stay.

In this study, we utilized a previously described grading system to measure the severity of acute appendicitis.⁶ The severity was determined based on the findings during the operation. Interestingly, we discovered a different pattern of patient characteristics in the non-pandemic and pandemic periods. During the pandemic, the majority of patients were grade 1 acute appendicitis, while during the pandemic, the majority of patients were grade 4 acute appendicitis. This shift in pattern could be explained by a patient trend that emerged during the pandemic. Due to the high prevalence of COVID-19 in Indonesia during the epidemic, patients are hesitant to seek treatment right away. Our result was in concordance with a recent study that reported that the severity of acute appendicitis might increase during the COVID-19 pandemic because patients with mild appendicitis (or abdominal

Table 1. The characteristics of the acute appendicitis.

Characteristics	n (%)	n Non-pandemic (%)	n Pandemic (%)
Total	121	56	65
Sex			
Male	75 (62.0)	34 (60.7)	41 (63.1)
Female	46 (38.0)	22 (39.3)	24 (36.9)
Age			
<30	61 (50.4)	30 (53.6)	31 (47.7)
30-39	26 (21.5)	11 (19.6)	15 (23.1)
40-49	18 (14.9)	7 (12.5)	11 (16.9)
50-59	12 (9.9)	5 (8.9)	7 (10.8)
≥60	4 (3.3)	3 (5.4)	1 (1.5)
Average	32.39	31.93	32.78
Standard deviation	13.26	14.30	12.39
Minimal	14	14	18
Maximal	69	69	62

Table 2. The acute appendicitis severity and the length of stay in the hospital during both the non-pandemic and pandemic periods.

Characteristics	n Non-pandemic (%)	n Pandemic (%)	P value
Total	56	65	
Appendicitis grade			
Grade 1	50 (89.3)	24 (36.9)	
Grade 2	0 (0.0)	0 (0.0)	
Grade 3	4 (7.1)	11 (16.9)	<0.0001
Grade 4	2 (3.6)	25 (38.5)	
Grade 5	0 (0.0)	5 (7.7)	
Length of stay			
1-2 days	3 (5.4)	4 (6.2)	
3-4 days	38 (67.9)	18 (27.7)	
5-6 days	13 (23.3)	25 (38.5)	<0.0001
7-8 days	2 (3.6)	12 (18.5)	
≥8 days	0 (0.0)	6 (9.2)	

pain) may hesitate to seek help.¹² Delays in seeking therapy and receiving prompt care might lead the patient's condition to deteriorate to the point where, by the time the patient decides to go to the hospital, the patient is already in a worse state. In grades 3 and 4, acute appendicitis, there has been a perforation resulting in local or regional pus collection, leading the patient's signs and symptoms to become too severe if they do not go to the hospital. The length of stay in the hospital parameter reflects the severity of the condition. In the non-pandemic and pandemic periods, we discovered a substantial difference in the length of stay

for acute appendicitis patients. Patients treated during a pandemic are more likely to require a longer hospital stay than those treated during other times of the year. This is understandable, given that our statistics revealed that during the pandemic, the majority of patients had a higher degree of severity, indicating that the infection process in the abdominal cavity has progressed.

The majority of acute appendicitis patients were male, and this pattern was observed in both pandemic and non-pandemic periods. These findings were in concordance with prior studies that reported that men were more likely to

develop acute appendicitis than women at various ages.^{13,14} In this study, we also observed that acute appendicitis was more common in young patients compared to the elderly. The incidence of acute appendicitis declines along with the increase of age, according to the pattern we revealed in this study. A previous study has found that young patients were more vulnerable to acute appendicitis. The exact origin of this phenomenon is unknown, although most research indicates that males and young people are more likely to have acute appendicitis. To investigate the causes of this occurrence, more in-depth investigations using clinical trials are necessary. Unfortunately, elderly patients have more underlying disorders and sluggish physical and physiological reactions than younger patients, resulting in a higher rate of morbidity and mortality.¹⁵ Therefore, acute appendicitis in the elderly should not be taken lightly, as careful examination, early diagnosis, and proper treatment should be performed to prevent uneventful complications.

The severity of appendicitis was likewise linked to the duration of operation and hospital stay. As expected, the average time required for surgery is shorter at lower grades and the duration of surgery is expected to increase as the severity of acute appendicitis increases. Extravasation of the intraluminal component into the abdominal cavity occurs in individuals with perforation, i.e., grades 3-5, causing peritonitis symptoms that will worsen with time. In order to remove the pus and infection products in the abdominal cavity after a perforation, it is suggested to cleanse the abdominal cavity or perform peritoneal lavage with an adequate amount of warm saline during surgery. Subsequently, this will be reflected in the greater surgical time when compared to when there is no perforation. The operation will take less time in grades 1 and 2 because the surgeon does not need to do major peritoneal lavage when the appendix is still intact. The style of incision used also has an impact on how long the surgery takes. Using the Gridiron incision, surgeons can still produce incisions with a minimum incision length in grades 1 and 2 patients. The length of the incision has a direct impact on the length of the

Table 3. The duration of surgery, the length of stay, and acute appendicitis grades.

Parameter	Acute appendicitis grade			
	Grade 1	Grade 3	Grade 4	Grade 5
Duration of operation*				
Average	82.68	113.67	131.22	163.0
Standard deviation	25.49	39.68	35.46	55.28
Minimal	40	60	85	90
Maximal	165	190	220	250
Length of stay**				
Average	3.89	6	6	6
Standard deviation	1.42	1.71	1.96	1.67
Minimal	2	3	1	4
Maximal	10	10	9	9

*In minutes

**In days

Table 4. Duration of surgery and length of stay in the non-pandemic and pandemic periods.

Characteristics	n Non-pandemic (%)	n Pandemic (%)
Duration of operation*		
Average	83.32	115.62
Standard deviation	31.21	40.40
Minimal	40	45
Maximal	185	250
Length of stay**		
Average	3.86	5.43
Standard deviation	1.18	2.10
Minimal	2	1
Maximal	7	10

* = In minutes; ** = In days

surgical procedure the patient will have to endure. The length of stay in the hospital is also proportional to the severity of acute appendicitis. Patients with grade 1 need to be treated for a longer period of time than those with higher grades. Furthermore, patients who have larger incisions, such as a midline laparotomy, have a higher risk of secondary infection than patients who have smaller incisions, which may increase the length of stay in the hospital. In this study, we also discovered that the length of surgery and hospital stay was significantly longer during the pandemic than during the non-pandemic period. This result may be explained by the reality that many patients with a higher degree of severity, such as grade 4 and grade 5 were treated during the pandemic. This is

directly reflected in the length of surgery duration, as previously explained.

There are several limitations to this study. First, this study was conducted in only one hospital, and the findings are insufficient to characterize circumstances in Indonesia as a whole. Our data, on the other hand, can still be used to compare the severity of acute appendicitis in non-pandemic and pandemic periods. Second, the number of subjects in this study is relatively low. Further study with a higher number of subjects or nationwide study might be able to provide more detailed results.

CONCLUSION

There was a substantial difference in the severity of acute appendicitis patients

during the COVID-19 pandemic and non-pandemic periods.

CONFLICTS OF INTEREST

No competing interests were declared.

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AUTHOR CONTRIBUTION

All authors have the same contribution in writing the report on the results of this study, from the stage of proposal preparation, data search, and data analysis, to the interpretation of research data and presentation of the final report.

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