


ORIGINAL ARTICLE

Paediatric appendicitis during the COVID-19 pandemicChloe Sheath, Mohamed Abdelrahman, Andrew MacCormick  and David Chan

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Aim: The repercussions of the pandemic on patients without COVID-19 have been well documented. Although there is evidence that adult patients present later with complicated appendicitis, the impact on the paediatric population is unknown. Therefore, the aim of this study was to assess the impact of the COVID-19 pandemic on the presentation and management of paediatric appendicitis.

Methods: Data from consecutive paediatric patients admitted with right iliac fossa pain to a teaching hospital from 1 March 2020 until 30 June 2020 (COVID-19) were compared with patients admitted from 1 March 2019 until 30 June 2019 (control).

Results: One hundred and seventy-two patients were admitted with right iliac fossa pain (control = 97, COVID-19 = 75). Seven patients had a normal diagnostic laparoscopy in the control group compared with none in the COVID-19 group. The proportion of patients diagnosed with appendicitis was significantly higher during the COVID-19 pandemic (24% vs. 10%, $P = 0.03$). They presented later (3 days vs. 1 day, $P < 0.01$) with higher inflammatory markers (white cell count 15.8 vs. 13.2×10^9 cells per litre, $P = 0.02$; C-reactive protein 53 vs. 27 mg/L $P = 0.04$). The majority of patients underwent surgery within 1 day of admission (94% COVID-19 vs. 70% control, $P = 0.13$). Although there was a trend towards a greater proportion of complicated appendicitis (22% vs. 10%, $P = 0.6$) during COVID-19, this did not affect outcomes (no morbidity in both groups, length of hospital stay 4 vs. 2.5 days, $P = 0.29$).

Conclusion: Despite presenting later during COVID-19, paediatric patients with appendicitis were treated expediently with good outcomes.

Key words: appendicitis; COVID-19; surgery.

What is already known on this topic

- 1 The COVID-19 pandemic has led to unprecedented clinical, logistical and societal challenges within the health-care environment.
- 2 Acute appendicitis represents one of the most common acute surgical presentations and there is evidence that adult patients have presented later with complicated appendicitis during the pandemic.
- 3 However, there is a paucity of research analysing the impact on the paediatric population.

What this paper adds

- 1 The patients included within this study presented later with a greater inflammatory response and a trend towards an increased proportion of complicated appendicitis during the COVID-19 pandemic.
- 2 However, patients were treated expediently with good outcomes that were comparable with the previous year.
- 3 During the further extension of the COVID-19 pandemic, patients should be encouraged to seek medical treatment early and management should be undertaken in a timely fashion.

The World Health Organization declared the COVID-19 outbreak as a pandemic on 11 March 2020.¹ This has led to unprecedented clinical, logistical and societal challenges within the health-care environment. The impact of the COVID-19 outbreak on emergency surgery and other non-COVID-19-related conditions have been well documented with the early emergence of critical guidelines.^{2–5}

Acute appendicitis represents one of the most common acute surgical presentations and can represent up to one third of all surgical admissions.⁶ During previous pandemics, such as Middle

Eastern Respiratory Syndrome, there has been a dramatic shift in the emergency admission patterns.⁷ This has included admissions with acute surgical pathologies such as acute appendicitis, with the exact cause for these changes remaining unknown. Numerous studies have analysed the impact of the COVID-19 pandemic on the presentation and management of acute appendicitis in the adult population; however, there has been a paucity of research regarding the impact on the paediatric population. There is evidence that adult patients present later with complicated appendicitis, but the impact on the paediatric population is unknown. A recent case series⁸ of seven children identified numerous cases of complicated appendicitis and hypothesised that this may be due to delayed diagnosis. This was a small case series without a control group. The aim of this study was therefore to assess the impact of the COVID-19 pandemic on the presentation and management of paediatric appendicitis.

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Methods

Data from all consecutive patients under the age of 16 who presented with right iliac fossa (RIF) pain during a 3-month period between 1 March 2020 and 30 June 2020 in a large tertiary teaching hospital were collected retrospectively and compared with a control group from 1 March 2019 until 30 June 2019. Data collected included patient demographics, admission information, laboratory test results, radiological interventions, diagnosis, management strategy, post-operative complications, length of hospital stay and 30-day re-admission rates. Appendicitis was diagnosed either radiologically or histologically. Complicated appendicitis was defined as gangrenous or perforated appendicitis.

Admission pathway

All patients were admitted to hospital either by primary care or through the emergency department. All were subsequently admitted to a general paediatric assessment ward and were either managed under the care of the general surgical on-call team or managed jointly with the paediatric team. All patients underwent a COVID-19 swab test during the pandemic.

Statistical analysis

Continuous data were expressed as median. Statistical analysis was performed with SPSS 23 (IBM Corp, Armonk, NY, USA). Data were analysed using the Mann–Whitney for continuous data and χ^2 or Fishers exact tests for categorical data. A level of statistical significance was set at P value of <0.05 .

Results

One hundred and seventy-two paediatric patients were admitted with RIF pain during the study period with 97 in the Control group and 75 during COVID-19. Patient demographics, admission

investigations and outcomes for all patients admitted with RIF pain are outlined in Table 1. The same variables are outlined in Table 2 for patients who were diagnosed with acute appendicitis. All patients had a COVID-19 swab test taken on admission. No patients tested positive for COVID-19. No patients underwent computed tomography or magnetic resonance imaging.

All patients diagnosed with appendicitis underwent surgery except for one patient with appendicitis confirmed on ultrasound during COVID-19 who settled with intravenous antibiotics overnight and was discharged the following morning. The patient will be reviewed in clinic to consider an interval appendicectomy. During all of the reported normal diagnostic laparoscopies, the appendix was removed. A normal appendix was confirmed histologically in these patients. Of these negative laparoscopies, four (57%) had a pre-operative ultrasound scan which was normal.

The majority of patients underwent surgery within 1 day of admission (70% in the control group vs. 94% during COVID-19, $P = 0.13$). Three patients underwent open appendicectomies (two during COVID-19 and one in the control group). This was due to surgeon preference especially during the initial phase of the pandemic due to the concerns surrounding the safety of laparoscopic surgery and transmission of COVID-19. No patients required conversion to open from laparoscopic surgery. No patients developed complications following surgery.

Pain was noted to be the only reason for readmissions, and all patients who re-attended were discharged after review within a 1-day period with no further interventions required.

Discussion

At the start of the COVID-19 pandemic, people were advised to stay at home and not to attend hospital unless absolutely necessary. This was to limit exposure to the virus and also to prevent the emergency services from being inundated. However, the negative impact on the delayed presentation of patients without COVID-19 has been well documented.⁹ This is the first study to

Table 1 Demographic and outcome details of all patients with RIF pain

	Control	COVID-19	P value
Number of admissions	97	75	
Male:female (%)	50:47 (52:48)	43:32 (57:43)	0.45
Age, years (range)	10 (2–16)	10 (4–15)	1
Time from symptom onset to presentation, days (range)	2 (1–10)	4 (1–14)	0.01
Admission white cell count, $\times 10^9$ cells per litre (range)	7.8 (3.1–18.7)	9.7 (2.6–26.6)	<0.01
Admission C-reactive protein, mg/L (range)	10 (1–106)	24 (1–299)	0.04
Admission ultrasound scan (%)	36 (37)	26 (35)	0.75
Negative diagnostic laparoscopies	7	0	
Diagnoses (%)	0.013		
Non-specific abdominal pain	45 (46)	21 (28)	
Viral illness	27 (28)	18 (24)	
Appendicitis	10 (10)	18 (24)	
Constipation	9 (9)	10 (13)	
Urinary tract infection	6 (6)	8 (11)	
Length of stay, days (range)	1 (0–6)	1 (0–10)	1
30 day re-admission (%)	7 (7)	7 (9)	0.78

Table 2 Demographic and outcome details of patients with appendicitis

	Control	COVID-19	P value
Number of cases (%)	10 (10)	18 (24)	0.03
Male:female (%)	6:4 (60:40)	13:5 (72:28)	0.5
Age, years (range)	12 (5–15)	11 (3–15)	0.67
Time from symptom onset to presentation, days (range)	1 (1–2)	3 (1–14)	<0.01
Admission white cell count, $\times 10^9$ cells per litre (range)	13.2 (7.3–18.3)	15.8 (5.2–29.1)	0.02
Admission C-reactive protein, mg/L (range)	27 (4–95)	53 (1–299)	0.04
Admission ultrasound scan (%)	2 (20)	6 (33)	0.45
Complicated:uncomplicated appendicitis (%)	1:9 (10:90)	4:14 (22:78)	0.6
Treatment (%)	1		
Open appendicectomy	1 (10)	2 (11)	
Laparoscopic appendicectomy	9 (90)	15 (83)	
Antibiotics	0 (0)	1 (6)	
Patients discharged on antibiotics (%)	2 (20)	9 (50)	0.12
Length of stay, days (range)	2.5 (1–6)	4 (2–10)	0.29
30-day readmission (%)	2 (20)	2 (11)	0.52

assess the impact of the pandemic on paediatric patients presenting with RIF pain and appendicitis. As expected, there was a reduction in the overall number of admissions with RIF pain within the paediatric population during the pandemic. This is in keeping with recent literature which has identified a similar pattern within the adult population.¹⁰ The proportion of patients with non-specific abdominal pain was also much lower. This, along with a shift towards a more conservative approach in the management and investigation of patients with RIF pain resulted in no negative laparoscopies being performed during the pandemic.

Of those that were admitted to hospital, there was a statistically significant increase in the time from the onset of symptoms to presentation to hospital or primary care. This is likely to highlight a degree of fear and apprehension from both parents and patients about liaising with health-care services during the COVID-19 pandemic. Other factors such as initial treatment within primary care and repeated attendance to primary care or the emergency department prior to admission may have also contributed. Delays in presentation to hospital can result in an increased likelihood of complicated appendicitis.¹¹ Although this study demonstrated that the rate of complicated appendicitis was higher during the COVID-19 period, this was not a statistically significant increase compared to the previous year. This could be the result of a type II error and the effect could be more apparent in a larger study. However, increasing the sample size in our study by extending the study periods would not adequately reflect the effect of lockdown during the pandemic which was gradually lifted from June 2020 in England. Combining data in an international multi-centre study could overcome this but the wide variation in the prevalence of COVID-19, varying degrees of lockdown and the general population's reaction could be significant confounding factors.

This study has potential limitations. Observational studies have the potential for selection bias. To minimise this, all patients with RIF pain were identified *via* an admission database to the paediatric ward and included in this study. Appendicitis was

confirmed radiologically or histologically to avoid bias in variation during clinical assessment. This study also mitigated the confounding factor of the previously demonstrated¹² seasonal variations in acute appendicitis by analysing the same time period across two separate years in the same hospital.

Antibiotics alone can successfully treat adult patients with uncomplicated appendicitis.^{13,14,15} However, the evidence of the efficacy of antibiotics alone in the paediatric population is less clear. Therefore, clinicians are usually likely to be more cautious in attempting conservative management in the paediatric population compared to adults. Only one patient in this study was treated with antibiotics successfully and is being considered for an interval appendicectomy during the tail end of this pandemic. However, it has been shown that there has been a global shift in practice towards the utilisation of conservative management. Recent research¹⁶ taking into account the views of specialists from over 66 countries demonstrated a significant increase in the proportion of surgeons using a conservative approach during the pandemic compared with prior to this. This again raises the possibility of patients being treated with conservative management followed by an interval appendicectomy. Research¹⁷ has demonstrated that the utilisation of an early discharge score may allow for conservative management followed by an interval surgical procedure to be a safe management option. This may have particular significance during a continued or further pandemic period.

In addition to delays in presentation, any delays in treatment can increase the likelihood of patients developing complicated appendicitis. The majority of patients in this study underwent surgery within 1 day of presentation. As elective theatre capacity was reduced during the peak of the pandemic and fewer patients were admitted to hospital, a greater proportion of patients were able to be operated on within a day compared to the year before.

During the initial phase on the pandemic, expert groups announced recommendations to change approach from laparoscopic to open surgery.¹⁸ However, this advice was lacking in strong evidence and a recent study has demonstrated that the majority of surgeons retained a laparoscopic preference.¹⁶ This

was also shown during this study, with very few open procedures performed and these occurred only in young patients with suspected complicated appendicitis. With complicated appendicitis being significantly more common in the paediatric population, it has been shown to still be feasible to perform laparoscopic surgery in these cases rather than having to take an open approach.¹⁹ This may lead to a reduced length of stay and more positive overall outcomes. Laparoscopic surgery is capable of managing a range of emergency surgical conditions and this should be particularly regarded in the eventuality of a recrudescence of the pandemic.²⁰

Conclusion

Despite presenting later with a greater inflammatory response and a trend towards an increased proportion of complicated appendicitis during the COVID-19 pandemic, paediatric patients with appendicitis were treated expediently with good outcomes. Should there be a second wave and further lockdowns in the future, patients should be encouraged to seek medical treatment early and management should be undertaken in a timely fashion to avoid unnecessary morbidity.

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