

# Impact of the COVID-19 Pandemic on the Incidence of Complicated Appendicitis in a Tertiary Medical Center, Amman, Jordan: A Retrospective Cohort Study

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## Abstract

**Objective:** To assess the incidence of complicated appendicitis during the COVID-19 pandemic in Jordan University Hospital.

**Materials and Methods:** In this cohort study, we retrospectively investigated data on acute appendicitis cases. Two groups were established. The first was a pandemic group of patients who presented to hospital during the period of acute restrictions and shutdowns from 17 March to 6 June 2020. The second was a pre-pandemic group from the same period in 2019. These two groups were compared in terms of clinical characteristics and the prevalence of complicated appendicitis.

**Results:** A total of 45 patients were included in the study, with 24 in the pandemic group and 21 in the pre-pandemic group. Gender distribution was not significant between the two periods ( $p>0.05$ ). Rates of occurrence of overall complications, preoperative complications, and intraoperative complications were similar, indicating no significant difference between the two groups ( $p=0.526, 0.835$ , and  $0.547$ , respectively). The duration between symptoms and admission and ALVARADO score were also not significantly different between the two study groups. The duration of in-hospital stay was numerically but not significantly lower in the 2019 (March–June) group compared to 2020 (March–June).

**Conclusion:** In our study, there was no significant difference in the incidence of complicated appendicitis between pandemic and pre-pandemic groups.

**Keywords:** Acute appendicitis, complicated appendicitis, COVID-19, pandemic, quarantine

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## BACKGROUND

COVID-19 was first reported in late December 2019 after an outbreak in China of pneumonia of unknown cause, and this was followed by a rapid global spread [1]. By late December 2021, about one million COVID-19 cases had been confirmed in Jordan [2], with the first case confirmed on 2 March 2020; by 17 March, the country had been forced into a total lockdown [3]. Medical emergencies were dealt with by contacting the authorities for appropriate intervention, provided by the civil defense or hospitals [4].

The pandemic placed significant stress on healthcare workers and systems around the world [5, 6], and also created a fear of visiting medical

centers for treatment for non-COVID-related illnesses [7]. This led to a delay in presentation for various diseases and, in turn, to increased mortality and morbidity of non-COVID-related diseases [8, 9].

Acute appendicitis is a very common surgical emergency, accounting for almost 300,000 hospital visits in the USA alone [10]. The clinical course is typically periumbilical pain migrating to the right lower quadrant, and is also associated with anorexia, nausea, and vomiting [11]. The gold standard treatment for acute appendicitis is appendectomy by laparoscopy, which is preferred over the open approach except in cases of advanced disease [12]. Appendectomy is considered a safe procedure with quick recovery when early diagnosis and treatment are made [11].

The primary objective of this study is to determine whether the COVID-19 pandemic and the

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subsequent lockdowns influenced the incidence of complicated appendicitis in a tertiary medical center, Amman, Jordan.

## MATERIALS AND METHODS

### Study design and setting

This retrospective cohort study was conducted at Jordan University Hospital (JUH), a tertiary hospital that annually carries out 25,000 surgical operations and receives 94,000 emergency cases in the emergency room (ER) [13].

### Ethical approval

The Institutional Review Board (IRB) at JUH reviewed and approved the conductance of this research. Although obtaining consent was not feasible due to the nature of the retrospective cohort design, any data collected are confidential and patients' names are not shared by any party.

### Data collection

Patients admitted to JUH as cases of acute appendicitis in 2019 and 2020 were included. The universal standard International Classification of Diseases (ICD-10) diagnosis codes, K35 to K37, were used to search for records in the JUH databases used for reporting acute appendicitis, other appendicitis, and unspecified appendicitis [14]. The following patient data were obtained from the Department of Surgery's database and entered into a Microsoft Office Excel 2020 spreadsheet: age, gender, duration of symptoms before admission, and ALVARADO score. We also collected data on laboratory investigations, including: C-reactive protein (CRP) level, white blood cell (WBC) count, percentage of neutrophils and platelets count, intraoperative diagnosis, duration of operation, presence of complications before and during the operation, drain insertion, length of hospital stay, and imaging and histopathology results. Information on re-admission, reason for re-admission, and length of stay of re-admission were also collected.

A summary of the computed topography (CT) and

ultrasound (US) results was extracted from the database and the complications were reported based on imaging in the form of: appendicitis with purulent fluid, gangrenous appendicitis, perforated appendicitis, and appendicitis with phlegmon. The data were entered, reviewed and checked twice by the authors to ensure accuracy. Patients with incomplete records were excluded, as this indicates that they did not undergo surgery at the hospital. The primary outcome of interest was the occurrence of postoperative complications. Secondary outcomes included the length of in-hospital stay, the imaging method used for diagnosis (CT or US), and the type of operation (open or laparoscopic).

### Data analysis

The data were analyzed using IBM SPSS v.25 software. Frequencies and percentages were calculated for categorical variables. Additionally, mean and standard deviation scores were calculated for continuous variables. The differences in patient characteristics and outcomes between 2019 and 2020 were tested using Chi-square and *t*-tests for categorical and continuous variables, respectively. Similarly, Chi-square for categorical variables and *t*-tests for continuous variables were used to compare the characteristics and outcomes between the COVID-19 lockdown period in 2020, starting from 17 March until 5 June, and the same period in 2019.

## RESULTS

### General demographics

This study retrieved 323 medical reports of patients diagnosed with appendicitis and admitted to JUH in 2019 and 2020. A total of 66 reports were excluded as their data were incomplete or the patient did not undergo appendectomy surgery. Most included patients were males (57.6%). The mean and standard deviation for age and Alvarado scores were  $26.17 \pm 16.19$  and  $7.00 \pm 1.5$ , respectively. Most of the patients were diagnosed using ultrasound (57.6%), whereas the rest were diagnosed by CT scan (42.4%) (Table 1).

**Table 1. General Demographics of the Participants**

| Variable            | Response   | Frequency<br>(n = 257) | Percentage<br>(%) |
|---------------------|------------|------------------------|-------------------|
| Gender              | Male       | 148                    | 57.6              |
|                     | Female     | 109                    | 42.4              |
| Method of Diagnosis | Ultrasound | 148                    | 57.6              |
|                     | CT         | 109                    | 42.4              |
| Variable            | Mean       | SD                     | Range             |
| Age (years)         | 26.17      | 16.19                  | 2–87              |
| Alvarado Score      | 7.00       | 1.5                    | 2–10              |

### Differences in patient characteristics in 2019 and 2020

From the 257 patients, 136 had undergone an appendectomy in 2020, while 121 had an appendectomy in 2019. The distribution of age and sex between the two years indicates no significant difference ( $p>0.05$ ). The use of CT for establishing the diagnosis was higher numerically in the 2020 group (46.3%) compared to 2019 group (38.2%), but was not significant ( $p=0.192$ ). The incidence of complications was numerically but not significantly higher in the 2020 group (29.1) compared to the 2019 group (27.6) ( $p=0.795$ ). Furthermore, the rate of preoperative complications was numerically higher in the 2020 group (23.1%) compared to the 2019 group (15.6%). However, the rate of intraoperative complications was almost the same in the 2020 group (19.4%) and 2019 group (19.8%). The incidence of pre-operative and intraoperative

complications was not significantly different between the two groups ( $p=0.129$  and  $p=0.931$ , respectively). The distribution of the types of complications was also not significantly different ( $p=0.761$ ), and neither was the distribution of histopathological complication types ( $p=0.809$ ). The rates for drain insertion and readmission were numerically higher in the 2020 group compared to 2019 group, but again were not significantly different. Moreover, the duration between symptoms and admission and the Alvarado score was numerically but insignificantly higher in the 2020 group compared to 2019 group ( $p=0.494$  and  $0.125$ , respectively). WBC, neutrophils and platelet counts were not significantly different between the 2019 and 2020 groups ( $p>0.05$ ). Furthermore, the length of hospital stay was significantly higher in the 2019 group ( $2.14 \pm 1.99$ ) compared to the 2020 group ( $1.67 \pm 1.43$ ) ( $p=0.03$ ) (Table 2).

**Table 2. Differences in before and after COVID-19 outcomes**

| Variable  |                     | 2019<br>(n=123)   | 2020<br>(n=134)   | p value |
|---|---------------------|-------------------|-------------------|---------|
| Gender  | Females             | 51<br>(41.5)      | 58<br>(43.3)      | 0.768   |
|   | Males               | 72<br>(58.5)      | 76<br>(56.7)      |         |
| Age   |                     | 25.93 $\pm$ 15.54 | 26.40 $\pm$ 16.83 | 0.817   |
| Method of Diagnosis                             | Ultrasound          | 76<br>(61.8)      | 72<br>(53.7)      | 0.192   |
|   | CT                  | 47<br>(38.2)      | 62<br>(46.3)      |         |
| Duration between symptoms and admission (hours) |                     | 32.76 $\pm$ 31.09 | 35.43 $\pm$ 31.30 | 0.494   |
| Alvarado Score                                  |                     | 6.83 $\pm$ 1.90   | 7.16 $\pm$ 1.59   | 0.125   |
| Complications                                   | No                  | 89<br>(72.4)      | 95<br>(70.9)      | 0.795   |
|   | Yes                 | 34<br>(27.6)      | 39<br>(29.1)      |         |
| Preoperative Complications                      | No                  | 103<br>(84.4)     | 103<br>(76.9)     | 0.128   |
|   | Yes                 | 19<br>(15.6)      | 31<br>(23.1)      |         |
| Intraoperative Complications                    | No                  | 97<br>(80.2)      | 108<br>(80.6)     | 0.931   |
|   | Yes                 | 24<br>(19.8)      | 26<br>(19.4)      |         |
| Complications                                   | None                | 99<br>(80.5)      | 110<br>(82.1)     | 0.761   |
|   | Purulent Fluid      | 3<br>(2.4)        | 2<br>(1.5)        |         |
|   | Suppurative         | 3<br>(2.4)        | 3<br>(2.2)        |         |
|   | Gangrenous          | 14<br>(11.4)      | 17<br>(12.7)      |         |
|   | Perforation         | 2<br>(1.6)        | 2<br>(1.5)        |         |
|   | Other Complications | 2<br>(1.6)        | 0<br>(0.0)        |         |
| Drain Insertion                                 | No                  | 114<br>(93.4)     | 120<br>(89.6)     | 0.267   |
|   | Yes                 | 8                 | 14                |         |

| Variable                        |  | 2019<br>(n=123) | 2020<br>(n=134) | p value |
|---------------------------------|--|-----------------|-----------------|---------|
| Readmission                     | No                                     | (6.6)           | (10.4)          | 0.835   |
|                                 | Yes                                    | 118<br>(96.7)   | 128<br>(96.2)   |         |
| Histopathology                  | Unremarkable                           | 4<br>(3.3)      | 5<br>(3.8)      | 0.809   |
|                                 | Anything indicating acute appendicitis | 12<br>(9.8)     | 12<br>(9.0)     |         |
|                                 | Suppurative                            | 68<br>(55.3)    | 76<br>(56.7)    |         |
|                                 | Gangrenous                             | 28<br>(22.8)    | 32<br>(23.9)    |         |
|                                 | Phlegmon                               | 0<br>(0.0)      | 1<br>(0.7)      |         |
|                                 | Other                                  | 14<br>(11.4)    | 13<br>(9.7)     |         |
| WBC (10 <sup>3</sup> )          |  | 1               | 0               |         |
| Neutrophils (% from WBCs)       |  | 0<br>(0.8)      | 0<br>(0.0)      |         |
| Platelets (10 <sup>3</sup> )    |  | 14.64 ± 14.48   | 13.48 ± 4.63    | 0.379   |
| Duration of Operation (Minutes) |  | 77.50% ± 11.18% | 78.63% ± 12.19% | 0.442   |
| Length of Hospital Stay (Days)  |  | 258.43 ± 77.85  | 269.67 ± 76.84  | 0.245   |
|                                 |  | 66.15 ± 19.22   | 65.75 ± 23.27   | 0.881   |
|                                 |  | 2.14 ± 1.99     | 1.67 ± 1.43     | 0.03*   |

\* Significant ( $p < 0.05$ ).

### Differences in patient characteristics between 2019 (March–June) and 2020 (March–June)

Between March and June in 2019 and 2020, 45 medical records for patients who had undergone appendectomy were retrieved. Of these, 24 patients had an appendectomy during 2020, while 21 had done so during 2019. The distribution of gender was not significantly different between the two periods ( $p > 0.05$ ). On the other hand, mean age was significantly higher in the 2020 group compared to 2019 group ( $p = 0.032$ ). The use of a CT scan was numerically higher in the 2020 group compared to 2019 group. However, the use of CT and US in the diagnosis of appendicitis was not significantly different between the two groups ( $p = 0.143$ ). The rates of occurrence of overall complications, preoperative complications and

intraoperative complications were similar, indicating no significant difference between the two groups ( $p = 0.526$ ,  $p = 0.835$  and  $p = 0.547$ , respectively). The distribution of types of complications was not significantly different between the two groups ( $p = 0.421$ ). The drain insertion rate was similar, indicating no significant difference between the two groups ( $p = 0.632$ ). The distribution of histopathology complications was not significantly different ( $p = 0.892$ ). The duration between symptoms and admission and ALVARADO score were also not significantly different. The WBC, neutrophils and platelet counts were not significantly different ( $p = 0.599$ ,  $p = 0.588$  and  $p = 0.094$ , respectively). The duration of in-hospital stay was numerically but not significantly lower in the 2019 group compared to 2020 (Table 3).

**Table 3. Comparison of the quarantine period of 2020 and the pre-COVID year 2019**

| Variable  |            | 2019 (March–June)<br>(n=21) | 2020 (March–June)<br>(n=24) | p value |
|---|------------|-----------------------------|-----------------------------|---------|
| Gender  | Females    | 11<br>(52.4)                | 14<br>(58.3)                | 0.688   |
|   | Males      | 10<br>(47.6)                | 10<br>(41.7)                |         |
| Age   |            | 19.71 ± 13.94               | 30.75 ± 18.75               | 0.032*  |
| Method of Diagnosis                             | Ultrasound | 15<br>(71.4)                | 12<br>(50.0)                | 0.143   |
|   | CT         | 6<br>(28.6)                 | 12<br>(50.0)                |         |
| Duration between symptoms and admission (Hours) |            | 30.67 ± 21.36               | 36.75 ± 33.52               | 0.479   |
| Alvarado Score                                  |            | 7.14 ± 1.06                 | 7.25 ± 1.70                 | 0.804   |
| Complications                                   | No         | 13<br>(61.9)                | 17<br>(70.8)                | 0.526   |
|   | Yes        | 8<br>(38.1)                 | 7<br>(29.2)                 |         |

| Variable                        |  | 2019 (March–June)<br>(n=21) | 2020 (March–June)<br>(n=24) | p value |
|---------------------------------|--|-----------------------------|-----------------------------|---------|
| Preoperative Complications      | No                                     | 17<br>(81.0)                | 20<br>(83.3)                | 0.835   |
|                                 | Yes                                    | 4<br>(19.0)                 | 4<br>(16.7)                 |         |
| Intraoperative Complications    | No                                     | 15<br>(71.4)                | 19<br>(79.2)                | 0.547   |
|                                 | Yes                                    | 6<br>(28.6)                 | 5<br>(20.8)                 |         |
| Complications                   | None                                   | 15<br>(71.4)                | 20<br>(83.3)                | 0.421   |
|                                 | Purulent Fluid                         | -                           | -                           |         |
|                                 | Suppurative                            | 1<br>(50.0)                 | 1<br>(50.0)                 |         |
|                                 | Gangrenous                             | 5<br>(23.8)                 | 2<br>(8.3)                  |         |
|                                 | Perforation                            | 0<br>(0.0)                  | 1<br>(4.3)                  |         |
|                                 | Other Complications                    | -                           | -                           |         |
| Drain Insertion                 | No                                     | 20<br>(95.2)                | 22<br>(91.7)                | 0.632   |
|                                 | Yes                                    | 1<br>(4.8)                  | 2<br>(8.3)                  |         |
| Readmission                     | No                                     | 21<br>(100.0)               | 23<br>(100.0)               | -       |
|                                 | Yes                                    | 0<br>(0.0)                  | 0<br>(0.0)                  |         |
| Histopathology                  | Unremarkable                           | 3<br>(14.3)                 | 3<br>(12.3)                 | 0.892   |
|                                 | Anything indicating acute appendicitis | 11<br>(52.4)                | 15<br>(62.5)                |         |
|                                 | Suppurative                            | 4<br>(19.0)                 | 4<br>(16.7)                 |         |
|                                 | Gangrenous                             | 0<br>(0.0)                  | 0<br>(0.0)                  |         |
|                                 | Phlegmon                               | 3<br>(14.3)                 | 2<br>(8.3)                  |         |
|                                 | Other                                  | 0<br>(0.0)                  | 0<br>(0.0)                  |         |
| WBC ( $10^3$ )                  |  | 14.223 $\pm$ 3.96           | 13.60 $\pm$ 3.90            | 0.599   |
| Neutrophils (% from WBCs)       |  | 80.87% $\pm$ 8.4%           | 79.22% $\pm$ 11.17%         | 0.588   |
| Platelets ( $10^3$ )            |  | 241.05 $\pm$ 69.94          | 280.38 $\pm$ 82.41          | 0.094   |
| Duration of Operation (Minutes) |  | 62.24 $\pm$ 15.21           | 71.04 $\pm$ 31.032          | 0.244   |
| Length of Hospital Stay (Days)  |  | 2.10 $\pm$ 1.09             | 1.75 $\pm$ 1.07             | 0.291   |

\* Significant ( $p < 0.05$ ).

## DISCUSSION

Our results show that the patients did not delay seeking help during the pandemic period as we initially hypothesized and, as a result, there was no significant difference in complication rates between the two years studied. Moreover, when we compared the quarantine period of 2020 and the same period of 2019, no significant differences were found. These results contradict many previous studies conducted in the USA, China, and Spain, which all showed that the pandemic was associated with an increase in the rate of complicated appendicitis [15–17]. On the other hand, our results align with a study in Lithuania, where no difference in complication rates was reported [18]. These insignificant differences

can be explained by the fact that postponing elective surgeries due to the COVID-19 pandemic decreased the workload on surgeons [19], which may have resulted in fewer medical errors and better patient outcomes [20].

A recent study conducted in at JUH reported that the pandemic caused significant delays in presentation for various surgical emergencies, in contrast to our results. However, this study included emergency cases other than appendicitis, which might make the comparison invalid [21]. The only significant difference between the 2020 and 2019 cohorts was the decrease in the duration of in-hospital stay for patients who had undergone an appendectomy during 2020. However, this

difference was not significant in the comparison between the quarantine period of 2020 and the same period in 2019. This could be explained by the fact that limited beds were available in the surgical ward due to the utilization of most hospital capacity for isolating COVID-19 patients. This forced surgeons to discharge patients as quickly and safely as possible to make the already limited surgical ward beds available for other surgical emergency cases.

Previous studies have shown that the performance of emergency surgeries during the COVID-19 pandemic was associated with a low incidence of postoperative complications [22]. They also reported that the COVID-19 infection rate among such patients was low. Thus, it was recommended that emergency surgeries should not be delayed due to the fear of COVID-19 or its related complications [22]. Accordingly, emergency cases were managed without delay during the pandemic and a comprehensive triaging system is required to manage emergency surgeries during such challenging situations [23, 24].

This study had several limitations. First, this study included patients with complicated appendicitis from a single institution, which limits the generalization of its results. Second, before the start of the pandemic, a large portion of JUH emergency department visitors were from all over the country, including from governorates with reduced healthcare services, and hence patients with uncontrolled comorbidities. However, the transportation ban between different governorates due to the pandemic meant that most of the patients presenting to the emergency department were from the capital, which has better healthcare services and therefore patients with better health status. Accordingly, the 2019 cohort may have included more patients with uncontrolled comorbidities and

lower health status compared to the 2020 cohort, which may have biased the findings. Third, our analysis was performed utilizing ICD codes to identify every patient with a diagnosis of uncomplicated or complicated acute appendicitis; thus, it is possible that some patients were missed. Fourth, the retrospective design of the study predicts an association but not causality between the variables of the study. Finally, the relatively low sample size could have influenced the accuracy of the predicted effect of the pandemic on the management of appendicitis. Thus, this article must be taken as an exploratory study and not a confirmatory one until a large-scale prospective study can be conducted to confirm our findings.

## **CONCLUSION**

The COVID-19 pandemic has placed a huge burden on all sectors in every country around the world, especially healthcare and emergency response systems; all these burdens could have delayed the presentation, and increased the severity of, acute appendicitis. However, our study showed that acute appendicitis can be managed during future pandemics and lockdowns without an increase in its severity or complications.

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All authors declare no conflict of interest

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All authors certify that they have no affiliations with, or involvement in, any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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## أثر جائحة كوفيد-19 على حدوث التهاب الزائدة الدودية المعقد في مستشفى جامعي في عمان، الأردن. دراسة بأثر رجعي للمجموعات

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### الملخص

**الخلفية والأهداف** تقييم حدوث التهاب الزائدة الدودية المعقد خلال جائحة كوفيد-19 في مستشفى الجامعة الأردنية. **منهجية الدراسة** : في هذه الدراسة، بحثنا بأثر رجعي في البيانات المتعلقة بحالات التهاب الزائدة الدودية الحادة، حيث تم عمل مجموعتين، المجموعة الأولى هي مجموعة جائحة كورونا، والتي تشمل المرضى الذين قدموا إلى المستشفى خلال فترة الحظر والإغلاقات الحادة الممتدة من 17 مارس (آذار) إلى 6 يونيو (حزيران) 2020، والمجموعة الثانية وهي مجموعة ما قبل جائحة كورونا والتي تمثل نفس الفترة في العام السابق. تم مقارنة المجموعتين من حيث الخصائص السريرية ومدى انتشار التهاب الزائدة الدودية المعقد.

**النتائج:** تم ضم مجموعة من 45 مريضاً في الدراسة، 24 في مجموعة جائحة كورونا و 21 في مجموعة ما قبل جائحة كورونا. لم يكن توزيع الجنس ملحوظاً بين الفترتين (قيمة  $p < 0.05$ ). كانت معدلات حدوث المضاعفات بشكل عام والمضاعفات ما قبل الجراحة والمضاعفات الجراحية الداخلية مماثلة، مما يشير إلى عدم وجود فرق ملحوظ بين المجموعتين (قيمة  $p = 0.526$ ،  $0.835$ ، و  $0.547$ ، على التوالي). كما لاحظنا أنه لم يكن هناك فرق ملحوظ بين الفترة الزمنية لظهور الأعراض، دخول المستشفى بين المجموعتين. كما لم يكن هناك فرق ملحوظ ب نتيجة ALVARADO score للمجموعتين. إضافة إلى ذلك، لاحظنا أنه كانت مدة البقاء في المستشفى أقل في مجموعة ما قبل جائحة كورونا، لكن هذا الفرق لم يكن له دلالة إحصائية. **الاستنتاجات:** في دراستنا، لم يكن هناك فرق ملحوظ في حدوث التهاب الزائدة الدودية المعقد بين مجموعة ما قبل جائحة كورونا ومجموعة جائحة كورونا.

**الكلمات الدالة:** التهاب الزائدة الدودية الحاد؛ التهاب الزائدة الدودية المعقد؛ كوفيد 2019 جائحة؛ الحجر الصحي.