



## Surgical Management Outcomes of Acute Appendicitis in Patients with Perioperative SARS-Cov-2 Infection

Asma Anan Mohammed<sup>1</sup>, Lubna Lutfi<sup>1</sup>, Zahr Alkhadem<sup>1</sup>, Dania Sajid<sup>2</sup> and Husni Sidieg Shalak<sup>3</sup>

<sup>1</sup>Medical Internship Program, Medical Education Department, Dubai, Dubai Health Authority, United Arab Emirates

<sup>2</sup>General Surgery Department, Tawam Hospital, Abu Dhabi Health Services Company (SEHA), Health Authority of Abu Dhabi, Al Ain, United Arab Emirates

<sup>3</sup>General Surgery Department, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates

### Summary

**Introduction:** It is important to note the risk COVID-19 poses to the demographic of recovering postoperative patients and ascertain identifiable factors which may reflect on their prognosis.

**Aim:** To explore the 30-day postoperative outcomes among COVID-19 positive patients operated for acute appendicitis (AA) in Dubai Hospital while surveying their relation to age, gender, modality of management, type of operative technique, presence of pre-existing conditions, smoking habits, preoperative vital signs and laboratory results, and other variables. In addition, we aim to assess the relation of length of hospital stay with the aforementioned variables.

**Methods:** Our study is a retrospective electronic medical record (EMR) review of 68 patients admitted to the general surgery department of Dubai Hospital and who underwent conservative or surgical management of acute appendicitis between March 1 and December 31, 2020. Analysis was performed with a 30-day follow up. The data was retrieved from electronic medical records (EMR) via the SALAMA (EPIC) system and then recorded using a Microsoft Excel spreadsheet.

**Results:** Our results showed that, out of the 68 patients included in the study, 6 (9%) patients were found to be COVID-19 positive. 7 patients (10%) were managed conservatively, 1 of which was COVID-19 positive, while the remaining 61 (90%) patients underwent operative management. Only 1 (1.5%) patient (COVID-19 negative) developed complications requiring ventilation and ICU (intensive care unit) admission. Length of hospital stay (LOS) for COVID-19 positive patients was 6.5 days  $\pm$ 4.57 while LOS for COVID-19 negative patients was shorter at 3.8 days  $\pm$ 2.14.

**Discussion/Conclusion:** Our data revealed no significant complications in COVID-19 positive patients who were diagnosed with AA regardless of the method of treatment adopted. However, LOS was prolonged for these patients in comparison to the COVID-19 negative group. Therefore, we recommend that the choice of treatment be made on a case-by-case basis.

**Keywords:** perioperative COVID-19, COVID-19, acute appendicitis, appendectomy

### Introduction

COVID-19, or Coronavirus disease 2019, caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), was declared a global pandemic by the WHO on March 11, 2020 [1]. Since then, the virus has spread across the globe, causing significant financial and economic burden. This has been in

#### \*Correspondence:

Lubna Lutfi, Medical Education Department, Dubai Health Authority, Medical Internship Program, Dubai Health Authority, 222 Al Khaleej Road, Deira, Dubai, United Arab Emirates

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part due to the creation of qualified and specialized medical teams, COVID-19 units, increase in ICU beds, enhancement of medical supply chains, increased requirements for personal protective equipment, creation of field hospitals, production and use of PCR swab tests, and rising health insurance costs. With nearly 90 per cent of the global economy being affected during lockdown [2], any means of alleviating the financial burden of healthcare during the pandemic are of paramount importance.

In order to cope with the increased medical demand in the initial phase of the COVID-19 pandemic, many hospitals and medical centers elected to suspend non-emergent and elective surgeries to reduce the transmission of COVID-19 between infected individuals, patients, and staff [3]. During this time, only emergent surgeries were performed. The most common surgical emergency, acute appendicitis, serves as an excellent target for assessing differences in surgical outcomes between SARS-CoV-2 negative and positive patients. Additionally, numerous factors may affect perioperative morbidity and mortality rates among this group of patients, such as changes in clinical presentation and severity [4], conversion of laparoscopic to an open surgical approach due to poor early guidelines [5] and fear of aerosolization of blood borne viruses [6], and delay in initiation of surgical management in favor of non-operative management (NOM) [7].

Surgical patients are especially vulnerable to SARS-CoV-2 infection as the derangements of metabolic and physiological processes linked to surgically-induced stress response can lead to deviations in acute phase inflammatory responses. Hypermetabolism and hypercatabolism associated with this stress response can lead to impaired immune function through elevations of catecholamines, cortisol, and inflammatory cytokines. In addition, this group of patients is at a higher risk of pulmonary complications due to immunosuppressive responses to mechanical ventilation [8]. It is imperative that measures are taken to identify predictors of perioperative morbidity and mortality in COVID-19 positive patients, in order to reduce patient suffering, mortality rates, and the national financial and medical burden.

## Materials and Methods

This study is a retrospective chart review of the electronic medical records of 68 patients diagnosed with acute appendicitis (AA) and admitted to the general surgery department of Dubai Hospital, UAE, for conservative or surgical management of acute appendicitis between March 1 and December 31, 2020. Conservative treatment was defined as treatment with antibiotics and supportive management alone. Ethical approval was obtained from the Dubai Scientific Research Ethics Committee (DSREC). Patients admitted within this time period without a

nasopharyngeal RT-PCR swab for COVID-19 on admission were excluded from the study. All demographic, clinical, radiological, and laboratory data was retrieved from the SALAMA electronic file system.

Variables evaluated for each patient include: age, sex, COVID-19 status, modality of management (conservative or operative), incidence of complications, type of surgical technique if managed operatively (open or laparoscopic appendectomy), past medical and drug history, presence of pre-existing comorbidities, smoking status, preoperative vital signs (temperature, heart rate, respiratory rate, and blood pressure), radiological findings on chest x-ray if COVID-19 positive, preoperative laboratory markers, and length of hospital stay. The data was entered into the data collection tool (Microsoft Excel spreadsheet), exported, and analyzed in SPSS Version 22 software using Fisher's exact test. The analysis was carried out in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines for observational studies.

## Statistical Data and Analysis

Categorical data was presented as number/ total or percentage (%). Descriptive data (such as age and length of hospital stay) was reported as mean with standard deviation. Fisher's exact test was used to compare groups with nominal outcomes. Due to the limited number of cases studied, statistical analysis yielded no significant results and data was presented descriptively with appropriate interpretation.

## Results

84 patients were diagnosed with acute appendicitis between March 1 and December 31, 2020. Most patients were diagnosed clinically. Out of this group, 16 patients were excluded due to lack of nasopharyngeal RT-PCR COVID-19 swab on admission. The remaining 68 patients were entered in the study. 20 (30%) patients were female and 48 (70%) patients were male. 6 (9%) patients were found to be COVID-19 positive. Analysis of the demographic characteristics revealed no significant difference in the age or sex between both groups (conservative or operative). 7 (10%) patients were managed conservatively with antibiotics alone, 1 of them was COVID-19 positive. 61 (90%) patients underwent operative management, of which 8 (13%) patients had an open appendectomy - 3 (4.4%) of them were COVID-19 positive - and 53 (87%) patients had a laparoscopic appendectomy.

7 (10%) patients were found to have pre-existing comorbidities, none of which were respiratory in nature. 10 (15%) patients were found to be current smokers. Only 1 (1.5%) patient, COVID-19 negative, developed complications requiring ventilation and ICU (intensive care unit) admission. There were no mortalities among this patient group.

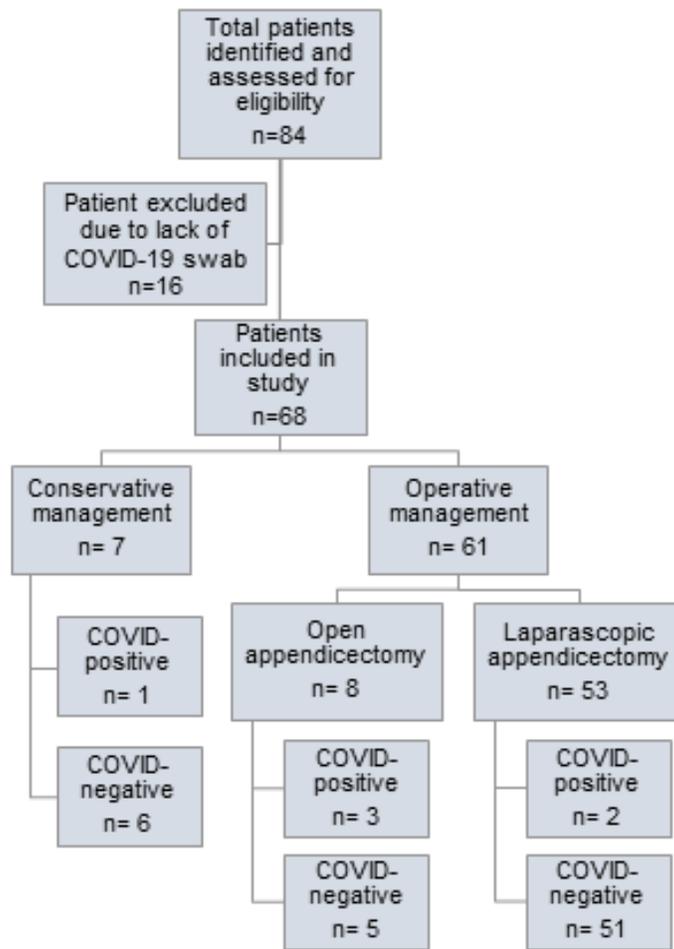


Figure 1: Flow chart for recruitment of patients in retrospective chart review.

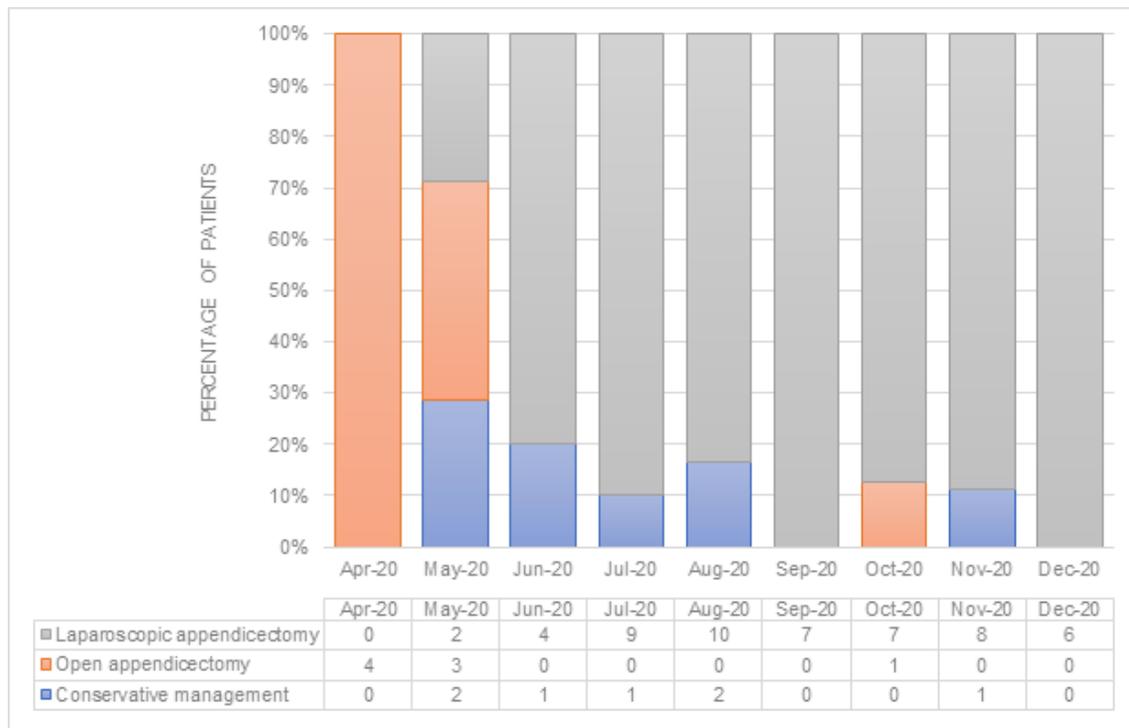


Figure 2: Percentage of patients treated conservatively (blue), or operatively with open appendicectomy (orange), and with laparoscopic appendicectomy (grey) on a monthly basis during the study period.

Table 1: Comparison of patient characteristics by treatment group. Continuous data is presented as a mean with standard deviation. Categorical data are presented as numbers/denominators.

Breakdown of patient characteristics			
Characteristic	Total (n = 68)	Operative management (n = 61)	Conservative management (n = 7)
Age (years) median, range		28.08 ±12.07	25.29 ±8.73
Male	48/68	45/61	3/7
Female	20/68	16/61	4/7
Pre-existing comorbidities			
Yes	7/68	6/61	1/7
No	61/68	55/61	6/7
Smoking status			
Never smoked	58/68	52/61	6/7
Current smoker	10/68	9/61	1/7
Admission COVID-19 swab			
Positive	6/68	5/61	1/7
Negative	62/68	56/61	6/7
Presence of complications	1/68	1/61	0/7
Predictive laboratory markers			
Elevated CRP (C-reactive protein)	48/68	43/61	5/7
Elevated WBC count	51/68	46/61	5/7
Elevated Neutrophil count	54/68	47/61	7/7
Length of hospital stay (LOS)		4.00 ±2.16	4.43 ±5.29

Table 2: Laboratory markers reference ranges and units.

Laboratory marker	Reference ranges and units
C-Reactive Protein	<5.0 mg/L
WBC COUNT	3.6 - 11.0 10 <sup>3</sup> /uL
NEUTROPHIL (Absolute)	2.0 - 7.0 10 <sup>3</sup> /uL
Ferritin	30 - 400 ng/mL
Dimer Test	<0.5 ug/ml FEU
Lactate Dehydrogenase (LDH)	105 - 222 U/L

Preoperative vital signs were analyzed for all patients. 17 (25%) patients were febrile on pre-operative assessment, of which 2 were COVID-19 positive. 9 (13%) patients were tachycardic, of which 1 was COVID-19 positive. 6 (9%) patients had an elevated blood pressure. 1 (1.5%) patient was tachypneic. C-Reactive Protein (CRP) was elevated in 48 (71%) patients, of which 5 were COVID-19 positive. White blood cell count was elevated in 51 (75%) patients, of which 5 were COVID-19 positive. Neutrophil value was elevated in 54 (79%) patients, of which 5 were COVID-19 positive. Laboratory reference ranges are shown in Table 2. Among those testing COVID-19 positive, 6 (100%) patients had positive radiological findings on chest x-ray, 3 (50%)

had elevated ferritin levels, 2 (33.3%) had elevated d-dimer levels, and 1 (16.67%) had elevated lactate dehydrogenase (LDH). Laboratory reference ranges are shown in Table 2.

There was no significant difference in the length of hospital stay (LOS) between the conservatively and operatively managed groups; the LOS in conservatively managed patients was 4.43 days ±5.29. The LOS in operatively managed patients was 4.00 days ±2.16. However, LOS for COVID-19 positive patients was 6.5 days ±4.57 while LOS for COVID-19 negative patients was shorter at 3.8 days ±2.14. Furthermore, the mean hospital stay for those who swabbed positive and underwent open laparotomy was 5.3±2.05 in comparison to a mean of 4±2.68 in those who

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were negative. As for laparoscopic appendectomy, there was less difference in the LOS, with the LOS for COVID-19 positive patients at  $3.5\pm 0.5$  in contrast to  $3.94\pm 2.09$  for negative patients.

## Discussion

Appendicitis is defined as an inflammation of the vermiform appendix which results from an obstruction of the appendix lumen either mechanically or through fecalith impaction resulting in bacterial overgrowth. It is one of the most common surgical emergencies with a global incidence rate of 1%. [9] The classical presentation of the disease manifests as periumbilical abdominal pain that migrates to the right lower quadrant, in association with anorexia, nausea, vomiting, and fever. Appendicitis is most often diagnosed clinically, however, a diagnostic computed tomography (CT) scan of the abdomen carries a sensitivity of 98.5% [10]. Management is typically surgical, either through laparoscopy, or through open laparotomy reserved for complicated cases. Furthermore, conservative management through antibiotics and supportive measures can also be adopted. Complications may include appendicular abscess, perforation, and peritonitis. Following the emergence of SARS-CoV-2, the declaration of the COVID-19 pandemic had an immense impact on healthcare systems worldwide. Surgical procedures were affected through major delays or cancellations as hospitals sought to decrease surgical caseload and capacity pressures as a result of the pandemic. Non-emergent or elective surgeries were similarly cancelled in our facilities due to the emergence of COVID-19 cases. However, appendicitis was managed in a very compelling way. Diagnosis was reliant on CT scans rather than clinical diagnosis and scans were performed for every patient regardless of their age group, in an effort to treat the case appropriately.

A conservative approach using antibiotics was instilled in our facility whenever possible in treating uncomplicated cases of acute appendicitis in accordance with national guidelines [11]. On the other hand, complicated cases, along with those patients who did not respond to conservative management, were treated operatively with appendectomy. Patients managed conservatively were given empiric broad-spectrum antibiotics (metronidazole and ceftriaxone) for a duration of 10 days. 86% of patients in this group were COVID-19 negative; with 50% of them being hemodynamically unstable, according to the normal ranges of vital signs established by the American College of Emergency Physicians (ACEP) guidelines. The mean LOS was  $2.5\pm 1.38$ . The remaining 14% of patients were COVID-19 positive, hemodynamically stable, with normal laboratory parameters and a mean LOS of 16 days due to the isolation period of 14 days being included in the calculation. Furthermore, both groups had abnormal inflammatory

marker values and neither group had long lasting complications. These findings are consistent with existing published articles stating that conservative management is an effective means of treating appendicitis in patients that are COVID-19 positive [12-14].

50% of the population who tested positive underwent open laparotomy in comparison to only 9% of those who did not. This notable difference could be attributed to early guidelines set in place during the start of the pandemic, as many sources encouraged surgeons to minimize laparoscopic procedures for COVID-19 positive patients in fear of viral transmission through aerosolization. However, as ongoing research is being conducted regarding the matter, many recent publications have since revealed that there is no strong evidence of increased risk [15-17]. Our data revealed only one COVID-19 negative patient who developed postoperative complications out of all the patients included in this study who were surgically managed for AA, regardless of COVID status. The patient, a 71 years old male known to have diabetes mellitus and hypertension treated with regular medication, developed pulmonary complications requiring ventilation and ICU admission which increased his length of hospital stay to 12 days. This comes in contrast to the expected outcomes of increased postoperative complications in COVID-19 positive patients who underwent emergency surgery according to a report [18]. However, it is worth noting that most of our patients are young and had no previous comorbidities, therefore, decreasing their chance of developing postoperative morbidity or mortality.

Keeping in mind that open appendectomy can increase the length of hospital stay, thus placing COVID-19 negative patients at an increased risk of developing the infection during hospitalization, we recommend that the length of hospital stay be reduced to the minimum to decrease this risk. In addition, as our results show no difference in outcome between conservative and surgical management, we also recommend that the choice of treatment be made on a case-by-case basis and evaluation of the risk-to-benefit ratio for each individual, as well as taking into consideration the performing surgeon's expertise and comfort. As is now standard in many hospitals, incorporating pre-operative swabbing as part of routine procedures allows the physician to plan accordingly. Furthermore, we highly recommend for surgeons to adamantly follow protective measures to reduce the risk of contracting the virus as much as possible; this includes proper handwashing and hygiene as well as the proper use of personal protective equipment (PPE). Limitations in our research included lack of postoperative follow up and inadequate information about the patients' past medical and social history.

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## Conclusion

Our retrospective chart review of patients diagnosed with and treated for acute appendicitis between March 1 and December 31, 2020 in Dubai Hospital included a total of 68 patients. Cases of acute uncomplicated appendicitis were managed conservatively, while complicated cases or those who failed to respond to medical management were operated. In summary, our data revealed no significant postoperative complications in COVID-19 positive patients undergoing appendectomy regardless of the method of treatment adopted (open vs. laparoscopic). However, the LOS was prolonged for these patients in comparison to the COVID-19 negative group. Therefore, COVID-19 infection should not be used as a singular variable when deciding the modality of treatment, but rather each case should be considered independently to assess existing risk factors, deliver the best management plan, and avoid complications.

## Statements

### Acknowledgment

Not applicable

### Statement of Ethics

Study approval statement: This study protocol was reviewed and approved by the Dubai Scientific Research and Ethics Committee (DSREC) on 21/03/2021, approval number DSREC-02/2021\_11. Consent to participate statement: Written informed consent was not required (and exempted for this study by the Dubai Scientific Research and Ethics Committee) as no human participants were involved and their medical records were insured for anonymity and confidentiality.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare and state that this research was held in the absence of any commercial or financial relationships that could be labeled as a potential conflict of interest.

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### Author Contributions

All authors contributed to the survey design. All authors analyzed the results. All authors contributed to the writing of the manuscript. All authors listed have made significant contributions to the study and approved it for publication. HSS is credited for supervision.

### Data Availability Statement

The data that support the findings of this study are not

publicly available as they were obtained from Dubai Health Authority electronic filing system where restrictions may apply. They are available from the corresponding author (AAM) upon reasonable request.

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