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## Research Paper

# Conservative management of acute appendicitis in the era of COVID 19: A multicenter prospective observational study at the United Arab Emirates

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## ABSTRACT

**Background & Aims:** Since its emergence in December 2019, the COVID-19 pandemic resulted in a profound impact on the health care system worldwide. We propose herein to evaluate the impact of implementing conservative management as an alternative approach to surgical appendectomy during COVID19 pandemic.

**Materials and Methods:** Our study is a prospective multicenter study that includes a cohort of 158 patients admitted to the surgical departments in both Tawam Hospital and SSMC hospital, Abu Dhabi, UAE, from February 2020 till July 2020.

**Results:** Our results showed a significant decrease in length of hospital stay (LOS) ( $2.32 \pm 0.83$  days) among conservatively treated group compared to the surgically treated group ( $2.8 \pm 1.47$  days). Also, short term follow-up showed that 90% of those patients did not require further operative intervention or developed complications. Out of the 110 patients that were swabbed for COVID19, nine (8.18%) were confirmed to be positive. Our protocol was to avoid surgical management for COVID19 positive patients unless indicated. This resulted in (8/9) of COVID19 positive patients to be treated conservatively.

**Conclusions:** In conclusion, our results showed that the implementation of conservative management in treating patients with acute appendicitis who were COVID19 positive maybe essential in reducing viral transmission risks as well as avoiding operative risks on COVID19 positive patients.

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## 1. Introduction

The pandemic of the COVID-19 and its associated massive inflow of patients affected many aspects of life with special impact on the health care system [1]. The overload of hospitals with COVID-19 patients resulted in changing priorities for the benefit of patients as well as health care providers [2]. Also, due to the nature of transmission of the COVID-19 that was found to spread during aerosol generating procedures (AGPs) including surgeries, many concerns were raised on infection control and safety on patients as well as health care providers' [3,4]. For that reason, changes in the

management protocols and implementations of new guidelines along with novel practices were recommended with the aim of reducing the risk of infection as well as establishing more efficient use of the available resources. One of the strategies proposed to relieve the burden on the health care system is to avoid hospitalization and defer other non-urgent surgeries.

Acute appendicitis represents one of the most common cause of surgical emergencies and acute abdomen with a lifetime prevalence reaching to 7–9% [5]. The golden standard management plan for such patients is surgical appendectomy [6]. However, emerging evidence showed that the non-operative management by antibiotic therapy despite a lower effective rate, might be associated with significantly fewer complications and a shorter length of stay compared to surgical management [6–11]. Moreover, Park et al., 2017 also found that no-antibiotic regimen with only supportive care using only intravenous fluids, analgesia and antipyretics

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showed no difference in outcome when compared to antibiotics [12].

Such approach might have additional advantages compared to the surgical approach including the omission of surgery associated mortality and morbidity including pain, infections and bowel obstruction as well as risks and complications associated with anesthesia and hospitalization [13].

Implementation of non-operative management in acute appendicitis may represent an optimal option during the COVID19 pandemic due to its advantages in reducing the length of hospital stay (LOS) and avoiding surgical management with all its risks [14]. In addition, patients diagnosed with COVID-19 may also benefit from such approach due to the fact that they are more vulnerable to the complications owing to their compromised lung functions as well as suppressed immunity and multiple organ dysfunction [15]. Moreover, such approach might impact the safety of the staff and health care providers through reduction of their exposure to COVID-19 patients.

Here we investigate the effects of implementing non-operative approach for the management of acute appendicitis on patient's outcomes including, length of hospital stay (LOS), duration of antibiotic use, cost, complications and recurrence, during the COVID-19 outbreak.

### 1.1. Patients and methods

Our study is a prospective multicenter study that included recruitment of patients admitted to the surgical departments in two tertiary referral university hospitals (Tawam Hospital and Sheikh Shakhbout Medical City) in Abu Dhabi, the capital of the United Arab Emirates, for the period from February 2020 till July 2020. All the epidemiological, clinical as well as the laboratory data of the patients were retracted from Abu Dhabi Health Services Co. (SEHA) electronic file system. This research obtained ethical approval from Abu Dhabi COVID19 Research IRB Committee with reference no. DOH/NCVDC/2020/1045. Moreover, our approach is aligned with the STROCSS criteria [16]. The Research Registry UIN is researchregistry7014 (<https://www.researchregistry.com/register-now#home/registrationdetails/61039e8c7942e0001f5198c4/>).

Diagnosis of all cases was confirmed by imaging (CT scan and Ultrasound) reporting size of the appendix, presence of appendicolith as well as presence of signs of severe complicated acute appendicitis like perforation with intra-abdominal contamination and/or appendicular mass/abscess as we previously describe [17].

Decisions of the management strategy were made depending on the patient's clinical condition, taking into account the radiological findings and inflammatory markers.

All hemodynamically stable cases of appendicitis were managed with antibiotics until COVID-19 RT-PCR results were released which was between 12 and 24 h.

Patient's treated with non-operative management received 1.5g of cefuroxime and 500 mg of metronidazole every 8 h for a total duration of 14 days. And for those who underwent operative management Laparoscopic appendectomy was the procedure of choice.

The criteria for when to operate was hemodynamic instability (low blood pressure in light of sepsis due to appendicitis), perforated appendicitis, appendix size of more than 1 cm with presence of appendicolith and rising or persistently elevated inflammatory markers (WBC >14000, CRP >50) despite antibiotic therapy and persistent complain of pain as well as rebound tenderness in the right lower quadrant on abdominal exam.

Patients treated with non-operative management were discharged once symptoms had resolved and inflammatory markers showed improvement, advice to return to Emergency department if

worsening was given on discharge and follow-up appointments were arranged.

### 1.2. Statistical analysis

Descriptive patients' data including demographic and laboratory parameters were tabulated and presented as mean and standard deviation in the case of continuous variables. In contrast, frequencies and percentages were used in case of categorical variables. SPSS 26.0 (IBM Corporation, Armonk, NY) software was used for statistical analysis. A p-value of <0.05 was used as a cut-off value to differentiate between significant and non-significant differences. Chi-squared or Fisher's exact test, in addition to student's t-test as well as analysis of variance (ANOVA) test were used whenever needed.

## 2. Results

### 2.1. Patients demographic features

Our cohort consists of 158 patients. The mean age of our patients was  $29.61 \pm 10.33$ , with the majority of them being male patients (68.35%) and female patients representing (31.64%). The mean duration of hospitalization was  $2.7 \pm 1.42$  days. In addition to clinical evaluation, CT scan was the most common imaging method to confirm the diagnosis (69.62%), followed by US (19.62%). Other demographic and clinical features are described in Table 1.

### 2.2. Management option

Out of the 158 patients, 56 patients (35.5%) were treated non-operatively, the other 102 (65.5%) underwent surgical management. Analysis of the demographic features of both groups revealed no significant difference in the age and sex distribution between both groups (Table 1). Worth mentioning that the group with initial non-operative treatment was shown to have smaller size of the appendix ( $9.78 \pm 2.79$  mm) compared to the surgical management group ( $11.14 \pm 3.82$ ) ( $P = 0.045$ ). Appendicolith was confirmed to be present in 26.47% of the surgical managed group compared to only 16% in the non-operatively managed group ( $P = 0.13$ ). Indeed, this might be attributed to our inclusion criteria for surgical approach that includes appendix size of more than 1 cm with presence of appendicolith.

As expected, patients with non-operative management plan had a significant decrease in length of hospital stay (LOS) ( $2.32 \pm 0.83$  days) compared to patients that underwent surgical management ( $2.8 \pm 1.47$  days). In contrast, the non-operatively managed group had longer duration of antibiotic coverage that reached in total to  $9.6 \pm 1.65$  days compared to only  $1.08 \pm 0.63$  days for patients who were surgically managed ( $P < 0.001$ ). Moreover, the mean total cost per patient for the non-operative approach was significantly lower ( $5804 \pm 6254$  United Arab Emirates Dirham (AED) compared to ( $9423 \pm 5812$  AED) for the surgical approach ( $P = 0.02$ ).

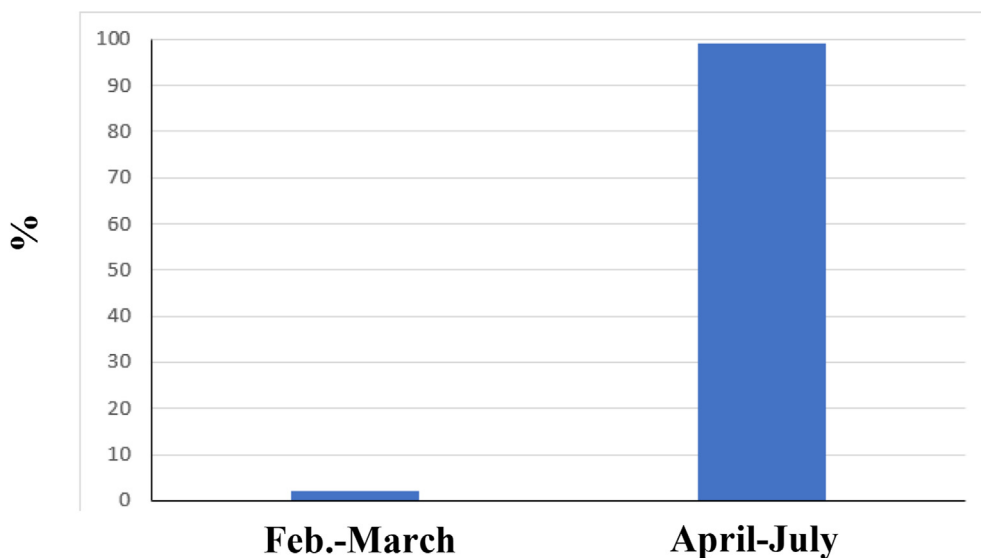
### 2.3. COVID19 status

In total, out of the 160 patients, COVID-19 PCR swab test was performed for 110 patients (Fig. 1). Nine of those patients (8.18%) were confirmed to be COVID-19 positive and the other 101 (91.81%) were confirmed to be negative. Our policy was to avoid surgical management for COVID-19 positive patients unless indicated. For that reason, the majority (8/9) of patients that were confirmed to be COVID-19 positive, were treated non-operatively (Table 1). Off note, non-operative approach was also encouraged for patients with COVID19 negative results with the aim of reducing the risk of

**Table 1**  
Comparison of the demographic and clinical parameters of our patient's cohort consist of 158 patients.

|   | Total         | %     | Operative management (102) |       | Non-operative management (n = 56) |        | P      |
|---|---------------|-------|----------------------------|-------|-----------------------------------|--------|--------|
|   |               |       | No.                        | %     | No.                               | %      |        |
| Age (years), mean ± SD                        | 29.61 ± 10.33 |       | 30.62 ± 11.89              |       | 29.05 ± 9.38                      |        | 0.397  |
| <b>Gender</b>                                 |               |       |                            |       |                                   |        |        |
| Male  | 108           | 68.35 | 68                         | 66.67 | 40                                | 71.42  | 0.088  |
| Female  | 50            | 31.64 | 34                         | 33.33 | 16                                | 28.57  |        |
| <b>Imaging</b>                                |               |       |                            |       |                                   |        |        |
| US  | 31            | 19.62 | 21                         | 20.58 | 10                                | 17.85  | 0.41   |
| CT scan                                       | 110           | 69.62 | 68                         | 66.67 | 42                                | 75     |        |
| None  | 17            | 10.75 | 13                         | 12.74 | 4                                 | 7.14   |        |
| Size of appendix (mm), mean ± SD              | 10.58 ± 3.51  |       | 11.14 ± 3.82               |       | 9.78 ± 2.79                       |        | 0.045  |
| Presence of Appendicolith                     | 36            | 22.78 | 27                         | 26.47 | 9                                 | 16.07  | 0.13   |
| Absence of Appendicolith                      | 122           | 77.21 | 75                         | 73.52 | 47                                | 83.92  |        |
| Duration of hospitalization (days), mean ± SD | 2.7 ± 1.42    |       | 2.8 ± 1.47                 |       | 2.32 ± 0.83                       |        | 0.01   |
| COVID19 negative                              | 101           | 91.81 | 55                         | 98.21 | 46                                | 85.18% | 0.031  |
| COVID19 positive                              | 9             | 8.18  | 1                          | 1.78  | 8                                 | 14.81  |        |
| In patient antibiotic duration, mean ± SD     | 1.69 ± 1.3    |       | 1.08 ± 0.63                |       | 2.80 ± 1.48                       |        | <0.001 |
| Total antibiotic duration, mean ± SD          | 4.07 ± 4.2    |       | 1.08 ± 0.63                |       | 9.60 ± 1.65                       |        | <0.001 |
| Coast (UAE dirhams), mean ± SD                | 9335 ± 4517   |       | 9423 ± 5812                |       | 5804 ± 6254                       |        | 0.02   |

### COVID19 test



**Fig. 1.** The percentage of COVID19 test for patients in the time period from February to July.

infection exposure to patients and protect health care personnel, in addition to the effective use of the available resources including operative rooms for more critical and emergency conditions.

#### 2.4. Patients discharge and short outcome

Monitoring of patients from the time of admission until discharge revealed that both groups of patients showed a similar pattern of improvement that was evident in the improvement of the clinical exam as well as laboratory profile (Table 2). Among the inflammatory markers, our results showed that white blood count (WBC) count was a more sensitive parameter in predicting the clinical improvement compared to the C-reactive protein (CRP) (Table 2). Both groups showed a significant reduction in the WBC at the time of discharge compared to patient's admission. Indeed, WBC was found to be reduced in the operative group from

12.425 ± 4.636 at time of admission to 8.542 ± 2.553 at the time of patient's discharge (P < 0.001). Similarly, the WBC was also found to be significantly reduced in the non-operatively treated group from 11.929 ± 4.313 to 5.331 ± 1.516 at time of discharge (P < 0.001).

#### 2.5. Patients follow up and outcome

As shown in Table 3, follow up of the patients who received non-operative management revealed that only three patients (5.35%) return to the ED department within the first week. We were able to follow 28 patients out of 56 (50%) from the same group within six months from discharge through either clinic visits or Tele-consultation. Among those, only three patients were found to subsequently underwent a surgical appendectomy (10.82%), while the other 25/28 (89.28%) stated no recurrence of symptoms. Importantly, remote follow-up through Tele-consultation was

**Table 2**  
The change in inflammatory markers of non-operative and operative treated groups at admission and at discharge.

| Inflammatory markers     | WBC (x10(3)/mcl) |                  | P value | CRP, mg/L     |                  | P value |
|--------------------------|------------------|------------------|---------|---------------|------------------|---------|
|                          | At admission     | Before discharge |         | At admission  | Before discharge |         |
| Non-operative management | 11.92 ± 4.31     | 5.33 ± 1.51      | <0.001  | 42.86 ± 57.4  | 46.51 ± 50.73    | 0.81    |
| Operative management     | 12.42 ± 4.63     | 8.54 ± 2.55      | <0.001  | 63.52 ± 95.29 | 80.68 ± 90.50    | 0.54    |
| P-value                  | 0.4593           |                  |         | 0.2016        |                  |         |

**Table 3**  
The follow up and outcome of non-operative treated group.

| Non-operative management | Return to ED within 1 week |            | Follow-up within 6 months including phone follow-up |                |
|--------------------------|----------------------------|------------|---|----------------|
|                          | Yes                        | No         | No recurrence/pain resolved                         | Appendicectomy |
|                          | 3 (5.35%)                  | 53(94.64%) | 25 (89.28%)   | 3 (10.82%)     |

performed in 19 patients out of the 28 cases that were followed up (Fig. 2).

### 3. Discussion

Since its emergence in December 2019, COVID-19 pandemic resulted in a profound impact on the health care systems worldwide [18]. The impact of this disease on surgical practices was also significant. This includes its effect on the surgical workforce and hospitals' infrastructures [19].

Many actions were implemented to improve our response to the disease pandemic with the aim of protecting our patients as well as our health-care providers in addition to increasing hospitals bed capacity to insure a more dynamic use of the available resources [20]. One of the main actions taken was surgical prioritization with delaying and deferring hospitalization of non-urgent procedures [20]. For that reason, we investigated the effects of implementing non-operative approach and compare it to the classical surgical approach in the treatment of confirmed acute appendicitis and its impact on patient's outcome during COVID-19 pandemic. Our results showed that the implementation of the non-operative approach resulted in resolving of symptoms and improvement of the inflammatory markers. In addition, patients with in the non-operatively treated group showed a significant reduction in the length of hospital stay (LOS) compared to the operatively treated

group. Furthermore, short term follow-up of those patients showed that the majority (90%) did not need further operative intervention or develop serious complications. Indeed, this correlates well with other reports implementing non-operative management in acute appendicitis to be associated with shorter hospital stay and a low risk of short-term recurrence [21–23].

However, Sippola et al., 2017 study [21], which is a multicentre, open-label, non-inferiority randomized controlled trial, showed a 40% recurrence rate after 5 years of follow up, similarly, Salminen et al., 2018 study [22], which is an observational multicenter randomized clinical trial that also includes follow up for five years also showed a recurrence rate of 39.1% at 5 years. This clearly demonstrated the need of long term follow up of those patients to improve our standing of the role of non-operative therapy in treating acute appendicitis.

Our results also highlighted that the non-operative approach for the management of acute appendicitis represents a feasible, safe and effective alternative to the surgical approach. In addition, our findings revealed that the mean cost of non-operative management was around half of the cost of the surgical management. This compares well with other reports that also showed less financial cost of non-operative approach compared to the surgical one [21–26]. It helped in reducing the financial burdens on patients as well as the healthcare system. Our results showed that (8.18%) of the swapped patients in our cohort were confirmed to be COVID19

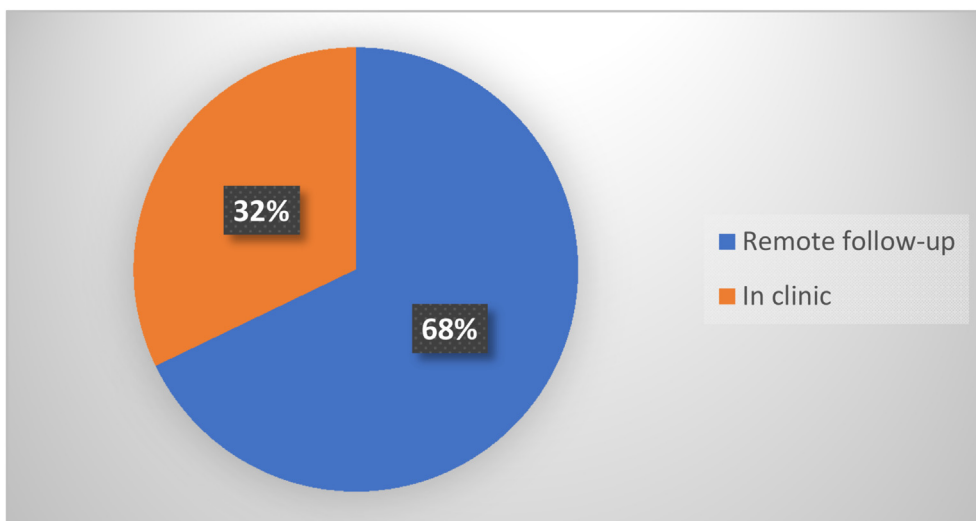


Fig. 2. Method of patient's follow-up.

positive without classical respiratory symptoms like cough and fever highlighting the importance of our modified protocol that includes testing all patients admitted to our department during the COVID19 pandemic. In addition, our approach resulted in reduction in the number of patients presenting with acute abdomen, who tested positive for COVID19 and needed surgical intervention to only 1 patient (11.11%) out of the 9 COVID19 patients. This is essential in reducing the possible preoperative, intraoperative and postoperative viral transmission risks [19]. Non-operative approach is also essential in reducing the risk of surgery related complications in COVID19 patients who were found to suffer from higher mortality rates following different types of surgeries including minor procedures [27]. This is attributed to their compromised lung functions, in addition to multiple organ dysfunction [15].

Interestingly, our protocol also included the implementation of telemedicine-based follow-up as a feasible and safe approach for follow up and evaluation of patient outcome. Such practices might be beneficial for both patients and healthcare providers through empowering social distancing to reduce the risk of viral transmission as well as reducing the pressure on the health care system.

In conclusion, our results showed that the implementation of non-operative management in treating patients with acute appendicitis who were COVID19 positive is a safe and feasible approach that maybe essential in reducing preoperative, intraoperative and postoperative viral transmission risks as well as avoiding operative risks on COVID19 positive patients. Longer follow-ups to determine the true recurrence rate among the non-operatively treated group as well as a larger number of patients might be needed in future studies.

### 3.1. Limitations

The fact that this study is a non-randomized study might limit our conclusions due to the fact that some of the inclusion and exclusion criteria in both groups might affect some of the clinical parameters as well as patient's outcome, for example, the appendix size and the presence or absence of appendicolith in the inclusion criteria for the surgical approach might have some impact on our results. However, we still believe such studies are essential to investigate the feasibility and safety of the non-operative approach, especially in our region. Another limitation is the low number of COVID 19 patients in our cohort that might also be considered as a weakness in this study.

### Provenance and peer review

Not commissioned, externally peer-reviewed.

### Ethical Approval

Abu Dhabi COVID19 Research IRB Committee with reference no. DOH/NCVDC/2020/1045.

### Consent

Consent has been given

### Author contribution

Fatima Y. AL Hashmi : study concept or design, data collection, data analysis or interpretation, writing the paper  
Abeer Al Zuabi : data collection , data analysis  
Ibrahim Yaseen Hachim : data analysis or interpretation , writing the paper

Guido H.H. Mannaerts : study concept & design , data interpretation, writing the paper

Omar Bekdache : study concept & design, data interpretation, writing the paper

### Registration of Research Studies

DOH/NCVDC/2020/1045 from Abu Dhabi COVID19 Research IRB Committee

### Guarantor

Ibrahim Yaseen Hachim

### Declaration of competing interest

This is to acknowledge any financial interest or benefit that has arisen from the direct applications of your research. The authors declare no conflict of interest.

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### Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.ijso.2021.100389>.

### References

- [1] Richez C, Lazaro E, Lemoine M, Truchetet ME, Schaefferbeke T. Implications of COVID-19 for the management of patients with inflammatory rheumatic diseases. *Joint Bone Spine* 2020;87(3):187–9.
- [2] Collard M, Lakkis Z, Loriau J, et al. Antibiotics alone as an alternative to appendectomy for uncomplicated acute appendicitis in adults: changes in treatment modalities related to the COVID-19 health crisis. *J Vis Surg* 2020;157(3S1):S33–42.
- [3] De Simone B, Chouillard E, Di Saverio S, et al. Emergency surgery during the COVID-19 pandemic: what you need to know for practice. *Ann R Coll Surg Engl* 2020;102(5):323–32.
- [4] Bozkurt H, Gur HU, Akinci M, Aslan H, Karakullukcu C, Yildirim D. Evaluation of patients undergoing emergency surgery in a COVID-19 pandemic hospital: a cross-sectional study. *Sao Paulo Med J* 2020;138(4):305–9.
- [5] Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol* 1990;132(5):910–25.
- [6] Hansson J, Korner U, Khorram-Manesh A, Solberg A, Lundholm K. Randomized clinical trial of antibiotic therapy versus appendectomy as primary treatment of acute appendicitis in unselected patients. *Br J Surg* 2009;96(5):473–81.
- [7] Charalampopoulos A, Dimopoulos I, Koliakos N, Kopanakis K, TL. Non-complicated acute appendicitis in adults treated successfully by conservative treatment without recurrences. *Chirurgia (Bucur)*. 2017;112(1):25–32.
- [8] Coccolini F, Fugazzola P, Sartelli M, et al. Conservative treatment of acute appendicitis. *Acta Biomed* 2018;89(9-5):119–34.
- [9] Steiner Z, Buklan G, Gutermaier M, Litmanovitz I, Landa T, Arnon S. Conservative antibiotic treatment for acute uncomplicated appendicitis is feasible. *Pediatr Surg Int* 2018;34(3):283–8.
- [10] Yang Z, Sun F, Ai S, Wang J, Guan W, Liu S. Meta-analysis of studies comparing conservative treatment with antibiotics and appendectomy for acute appendicitis in the adult. *BMC Surg* 2019;19(1):110.
- [11] Podda M, Di Saverio S, Cillara N, Gerardi C. Randomized clinical trial of antibiotic therapy for uncomplicated appendicitis: time to change the goal of our research? *Int J Surg* 2017;48:264–5.
- [12] Park HC, Kim MJ, Lee BH. Randomized clinical trial of antibiotic therapy for uncomplicated appendicitis. *Br J Surg* 2017;104(13):1785–90.
- [13] Sirikurnpiroon S, Amornpornchareon S. Factors associated with perforated appendicitis in elderly patients in a tertiary care hospital. *Surg Res Pract* 2015;2015:847681.

- [14] Romero J, Valencia S, Guerrero A. Acute appendicitis during coronavirus disease 2019 (COVID-19): changes in clinical presentation and CT findings. *J Am Coll Radiol* 2020;17(8):1011–3.
- [15] Suwanwongse K, Shabarek N. Successful conservative management of acute appendicitis in a coronavirus disease 2019 (COVID-19) patient. *Cureus* 1 2020;2(4):7834.
- [16] Agha R, Abdall-Razak A, Crossley E, et al. STROCCS 2019 Guideline: strengthening the reporting of cohort studies in surgery. *Int J Surg* 2019;72: 156–65.
- [17] Hashmi FYA, Zuabi AA, Hachim IY, Mannaerts GHH, Bekdache O. Conservative management of acute appendicitis in the era of COVID 19: a multicenter prospective observational study at the United Arab Emirates. *medRxiv* 2020. 2020.2009.2030.20204503.
- [18] Kelly ME, Murphy E, Bolger JC, Cahill RA. COVID-19 and the treatment of acute appendicitis in Ireland: a new era or short-term pivot? *Colorectal Dis* 2020;22(6):648–9.
- [19] Al-Jabir A, Kerwan A, Nicola M, et al. Impact of the Coronavirus (COVID-19) pandemic on surgical practice - Part 1. *Int J Surg* 2020;79:168–79.
- [20] Myles PS, Maswime S. Mitigating the risks of surgery during the COVID-19 pandemic. *Lancet* 2020;396(10243):2–3.
- [21] Sippola S, Gronroos J, Tuominen R, et al. Economic evaluation of antibiotic therapy versus appendectomy for the treatment of uncomplicated acute appendicitis from the APPAC randomized clinical trial. *Br J Surg* 2017;104(10): 1355–61.
- [22] Salminen P, Tuominen R, Paajanen H, et al. Five-year follow-up of antibiotic therapy for uncomplicated acute appendicitis in the APPAC randomized clinical trial. *JAMA* 2018;320(12):1259–65.
- [23] Di Saverio S, Podda M, De Simone B, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. *World J Emerg Surg* 2020;15(1):27.
- [24] Podda M, Gillara N, Di Saverio S, et al. Antibiotics-first strategy for uncomplicated acute appendicitis in adults is associated with increased rates of peritonitis at surgery. A systematic review with meta-analysis of randomized controlled trials comparing appendectomy and non-operative management with antibiotics. *Surgeon* 2017;15(5):303–14.
- [25] Prechal D, Damirov F, Grilli M, Ronellenfitsch U. Antibiotic therapy for acute uncomplicated appendicitis: a systematic review and meta-analysis. *Int J Colorectal Dis* 2019;34(6):963–71.
- [26] Rollins KE, Varadhan KK, Neal KR, Lobo DN. Antibiotics versus appendectomy for the treatment of uncomplicated acute appendicitis: an updated meta-analysis of randomised controlled trials. *World J Surg* 2016;40(10): 2305–18.
- [27] Javanmard-Emamghissi H, Boyd-Carson H, Hollyman M, et al. The management of adult appendicitis during the COVID-19 pandemic: an interim analysis of a UK cohort study. *Tech Coloproctol* 2020;25(4):401–11.