

# Emergency appendicectomy during COVID-19 pandemic – a single UK centre experience

## Appendektomia wykonywana w trybie pilnym w okresie pandemii COVID-19 – doświadczenie pojedynczego ośrodka w Wielkiej Brytanii

### Authors' Contribution:

A – Study Design  
B – Data Collection  
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### ABSTRACT:

**Introduction:** In December 2019 following an outbreak of Novel coronavirus infection (COVID-19) in Wuhan, China, it spread rapidly overwhelming the healthcare systems globally. With little knowledge of COVID-19 virus, very few published reports on surgical outcomes; hospitals stopped elective surgery, whilst emergency surgery was offered only after exhausting all conservative treatment modalities.

**Aim:** This study presents our experience of outcomes of emergency appendectomies performed during the pandemic.

**Methods:** Prospectively we collected data on 132 patients in peak pandemic period from 1<sup>st</sup> March to 5<sup>th</sup> June 2020 and data compared with 206 patients operated in similar period in 2019. Patient demographics, presenting symptoms, pre-operative events, investigations, surgical management, postoperative outcomes and complications were analysed.

**Results:** Demographics and ASA grades of both cohorts were comparable. In study cohort 84.4% and 96.7% in control cohort had laparoscopic appendicectomy. Whilst the study cohort had 13.6% primary open operations, control cohort had 5.3%. Mean length of stay and early post-operative complications (<30 days) were similar in both cohorts apart from surgical site infections ( $p = 0.02$ ) and one mortality in study cohort.

**Conclusion:** In these overwhelming pandemic times, although conservative treatment of acute appendicitis is an option, a proportion of patients will need surgery. Our study shows that with careful planning and strict theatre protocols, emergency appendicectomy can be safely offered with minimal risk of spreading COVID-19 infection. These observations warrant further prospective randomised studies.

### KEYWORDS:

appendicectomy, COVID-19, coronavirus, emergency surgery, laparoscopy

### STRESZCZENIE:

**Wprowadzenie:** Po stwierdzeniu pierwszych przypadków zakażenia nowym koronawirusem (COVID-19) w Wuhan w Chinach w grudniu 2019 r., doszło do błyskawicznego rozprzestrzenienia się go i przeciążenia systemów ochrony zdrowia na całym świecie. Wobec braku wiedzy o wirusie odpowiedzialnym za COVID-19 i niewielkiej liczby doniesień na temat wyników operacji chirurgicznych przeprowadzanych w tym czasie, szpitale wstrzymały wykonywanie planowych zabiegów, natomiast zabiegi w trybie pilnym przeprowadzano jedynie po wyczerpaniu możliwości leczenia zachowawczego.

**Cel:** W niniejszej pracy przedstawiamy nasze doświadczenia w zakresie wyników chirurgii wyrostka robaczkowego w okresie pandemii.

**Metody:** Prospektywnie zgromadzono dane z leczenia 132 pacjentów w szczytowym okresie pandemii, tj. od 1 marca do 5 czerwca 2020 r. Następnie porównano je z danymi z leczenia 206 chorych w analogicznym czasie w 2019 r. Analizą objęto: dane demograficzne pacjentów, objawy przy przyjęciu, zdarzenia przedoperacyjne, rodzaj leczenia chirurgicznego oraz wyniki i powikłania pooperacyjne.

**Wyniki:** Zmienne demograficzne i stan ogólny wg ASA w obu kohortach były porównywalne. Appendektomię laparoskopową wykonano u 84,4% pacjentów w kohorcie badanej i 96,7% w kohorcie kontrolnej. Podczas gdy odsetek pierwotnych operacji techniką otwartą w kohorcie badanej to 13,6%, w grupie kontrolnej wynosił on 5,3%. Średnia długość hospitalizacji i odsetek wczesnych powikłań pooperacyjnych (<30 dni) były podobne w obu kohortach, z wyjątkiem zakażenia miejsca operowanego ( $P = 0.02$ ) oraz jednego zgonu w kohorcie badanej.

**Wniosek:** Choć w okresie pandemicznego przeciążenia jedną z opcji terapeutycznych w przypadkach ostrego zapalenia wyrostka robaczkowego stanowi leczenie zachowawcze, u pewnego odsetka pacjentów nadal wymagana jest operacja chirurgiczna. Wyniki naszego badania wskazują, że przy starannym planowaniu i ścisłych protokołach obowiązujących na bloku operacyjnym możliwe jest bezpieczne wykonywanie zabiegów pilnej appendektomii przy minimalnym ryzyku transmisji COVID-19. Obserwacje te uzasadniają przeprowadzenie dalszych, randomizowanych badań.

**SŁOWA KLUCZOWE:** appendektomia, COVID-19, koronawirus, laparoscopia, operacje pilne

## ABBREVIATIONS

**ASGBI** – Association of Surgeons of Great Britain and Ireland  
**CC** – control cohort  
**CT** – computed tomography  
**LOS** – length of stay  
**NAR** – negative appendicectomy rate  
**PPE** – personal protective equipment  
**RT-PCR** – reverse transcriptase polymerase chain reaction  
**SAU** – surgical assessment unit  
**SC** – study cohort  
**SSI** – surgical site infections  
**VTE** – thromboembolic prophylaxis  
**WHO** – World Health Organization

## INTRODUCTION

The COVID-19 pandemic which started from Wuhan, China, soon spread across the globe and no continent was spared. The World Health Organization (WHO) on 11<sup>th</sup> March 2020 declared COVID-19 a global pandemic [1]. As the virus swept across the world, healthcare systems were overwhelmed and faced grave challenges, including decisions about the continuation of elective and emergency surgical procedures. The massive influx of critically ill patients requiring isolation care, respiratory and intensive care support resulted in congestion of hospitals, lack of capacity of beds and medical personnel. This raised significant safety concerns for healthcare staff and patients suffering from other ailments. Although the first case of COVID-19 in the United Kingdom (UK) was reported on 29<sup>th</sup> January 2020, it was not until early March 2020 that hospitals across UK were overwhelmed. In this national crisis with the lack of clear guidelines, fear of spread of infection in the hospitals, all elective operations, including cancer were cancelled and this had a huge impact even on emergency surgeries. While it was easy to defer elective surgery for health planners, decisions to defer semi-emergent or emergency operations were difficult. Internationally, there was additional confusion over the safety of laparoscopy due to the reported risk of transmission of the virus with air leak or smoke extraction [2].

Acute appendicitis is a common abdominal pathology requiring emergency surgery in the majority of cases and it is one of the most common procedures performed by any surgeon or trainee. While open appendicectomy was considered the gold standard, ever since Kurt Semm [3] performed the first laparoscopic appendicectomy in 1983, it has widely been accepted as the standard of care. The laparoscopic approach offers all the established benefits of minimally invasive surgery including reduced post-operative pain, early recovery, reduced length of stay (LOS), reduced risk of wound infection and analgesic requirements over the open approach. The reduced tissue handling with less associated injuries, reduces the incidence of post-operative adhesions. Reduced pain, early mobilisation and shorter LOS facilitate early return to routine activities and work. Laparoscopy has the added advantage of allowing easy assessment of other abdominal or pelvic disease. The smaller incisions are also connected with better cosmesis and improved patient satisfaction [4–6].

As per NICE guidelines, appendicitis is a medical emergency warranting immediate hospital assessment and management [7].

It is well recognised that the longer the duration of symptoms, the higher the reported complications. Hence, a prompt diagnosis and treatment are essential to improve outcomes [8, 9]. There should be a low threshold for admitting high-risk patients, namely those at the extremes of age, pregnant women and patients with complications e.g. perforation, abscess formation etc. A perforated appendix is recognised as a single most important factor leading to increased complications. An overall mortality rate of 0.2–0.8% is attributed to complications of appendicitis, rather than the operation [9].

There was a significant anxiety in patient population and similarly, medical professionals had concerns due to the absence of clear guidelines and paucity of data about the ideal management of surgical emergencies in COVID-19 pandemic. In addition, concerns were high about the possible risk of aerosol generation during laparoscopy. In March 2020, the Intercollegiate General Surgery Guidance document was published which suggested avoidance of laparoscopy if possible. Laparoscopy was only to be undertaken in individual cases where the clinical benefit to the patient far outweighed the risk of potential viral transmission to the theatre team. The same guidance document also suggested considering non-operative management for early acute appendicitis [2]. However, there will be a significant cohort of patients who will still need an operation.

The aim of this study was to review the presenting features, investigations, surgical approach and surgical outcomes of patients who presented with acute appendicitis and who were managed with appendicectomy during the peak period of the COVID-19 pandemic in a UK teaching hospital.

## MATERIALS AND METHODS

This was a prospective observational study with informed consent obtained from all patients. The operative consent process included the risk of hospital-acquired COVID-19 infection during the admission. All patients who underwent open or laparoscopic appendicectomy between March 1, 2020 and June 5, 2020 were included in the study.

### Inclusion criteria

- Patients with a clinical or radiological diagnosis of acute appendicitis who underwent appendicectomy;
- Patients of all age groups;
- Patients with a minimum of 30 days of follow-up.

### Exclusion criteria

Patients with early acute appendicitis managed non-operatively.

### Parameters

The study parameters were patient demographics, presenting features, investigations, COVID-19 testing, operative details and post-operative outcomes. This data was then compared with similar parameters collected from patients who underwent appendicectomy during the period March 1, 2019 to June 30, 2019.

## STATISTICAL ANALYSIS

We utilised IBM SPSS statistics 23 for analysis. For the purpose of simplicity, we chose to summarise the distributions of variables using the mean. Continuous variables were compared using an independent sample T-test. The Chi-square test was used to analyse dichotomous variables. Results were presented as 2-tailed values with a statistical significance if the P value was < 0.05.

## FOLLOW-UP PROTOCOL

Although we do not routinely follow up emergency appendicectomies in our hospital, in view of the COVID-19 pandemic, all patients were discharged with an “open access letter” to our surgical assessment unit (SAU) for a period of 2 weeks. Patients were informed to have a very low threshold to contact the department for clinical concerns such as fever, breathing difficulty, persistent or new-onset abdominal pain, diarrhoea, wound redness or discharge, generalised weakness and any suspected COVID-19 symptoms.

## COVID-19 TESTING PROTOCOL

In the initial period of the pandemic, in March 2020 and first half of April 2020, not all patients were tested for COVID-19 due to the absence of specific guidelines and test availability. Asymptomatic patients were not tested and only patients with suspicious symptoms for COVID-19, or history of contact or international travel were tested for COVID-19 using the reverse transcriptase polymerase chain reaction (RT-PCR) to detect the virus RNA with both nasal and oro-pharyngeal swabs. A computed tomography (CT) of the thorax was added if a patient was having an abdominal CT for diagnostic purposes.

In the latter half of the study from mid-April 2020, all patients were tested for COVID-19. As a universal precaution, all patients were assumed to be positive, irrespective of the test result, and full precautions (PPE) were taken to protect the theatre staff and patients.

## PERI-OPERATIVE MANAGEMENT

All patients underwent detailed physical examination and routine blood tests prior to surgery. As per our hospital guidelines, a single dose of prophylactic antibiotic was given in all cases apart from patients who were already on antibiotics. Thromboembolic prophylaxis (VTE) was given in selected cases based upon the venous thromboembolism risk assessment.

## THEATRE SAFETY PROTOCOLS

Staffing levels were kept to a minimum during anaesthetic intubation and extubation manoeuvres avoiding positive pressure ventilation. All theatres' staff was mandated to use full PPE, with separate donning and doffing areas. Universal precautions were implemented in the care of every patient, irrespective of their admission to a COVID or a non-COVID ward.

## SURGICAL APPROACH AND TECHNIQUE

In the first half of March 2020, some patients were subjected to open appendicectomy as a default to reduce the suspected risk of aerosol generation associated with laparoscopy. Later with the availability of air seal systems in our hospital, laparoscopy was the preferred approach. Open appendicectomy was preferred in very young paediatric age group patients or when the disease mandated open surgery due to complications of acute appendicitis utilizing a Lanz incision. In all laparoscopic appendicectomies, an open entry technique (Hasson's) was used for creation of a pneumoperitoneum. A standard 3-port technique was used. The first step was to perform a diagnostic laparoscopy and rule out any associated pathology. At the end of the operation, a specimen was extracted in an endobag.

## RESULTS

The study cohort (SC) comprised of 132 patients who underwent appendicectomy during the 2020 pandemic whilst the control cohort (CC) had 206 patients operated on in 2019. Patient demographics, presenting symptoms and biochemical investigations are summarised in Tab. I. The mean age was more or less similar, i.e. 32.9 years (range 4 to 83 years) and 32 years (range 7–87 years) in SC and CC respectively ( $P = 0.7$ ). There was a slight female preponderance in both groups, with 72 (54.5%) in SC and 119 (57.7%) in CC respectively. The median ASA score of 2 (range: 1–4) was comparable in both groups ( $P = 0.74$ ).

Most patient presented with pain (97.7% in SC and 99.5% in CC), anorexia (20.4% in SC and 5.3% in CC), fever (9% in SC and 10.6% in CC) and vomiting (32.5% in SC and 8.2% in CC).

In the study cohort, 18 (13.6%) patients underwent primary open appendicectomy, whilst 114 (86.3%) patients were subjected to a laparoscopic operation, of which 5 had to be converted to open appendicectomy. In the control cohort, 11 patients (5.3%) had open appendicectomy, whilst 195 (94.6%) underwent laparoscopic appendicectomy, of which 2 patients were converted to open. The open conversions were due to dense adhesions, perforated appendicitis and non-progression.

The most common intra-operative findings were an acutely inflamed appendix (82 in SC and 119 in CC); this was followed by necrotic or gangrenous appendix, perforated appendix, abscess/pus formation and peritonitis. Appendicular mass formation was observed in 2 and 6 patients in SC and CC respectively. These findings were comparable in both groups without any significant differences ( $P > 0.05$ ). A single case each of mucocele and worms was seen in an inflamed appendix in CC. The only significant difference in these two groups was an intra-operative finding of a normal appendix: 6 in SC and 29 in CC ( $P = 0.004$ ). Intra-operative findings have been detailed in Tab. II.

The mean LOS was 5.2 days (range 1–34) in SC and 4.2 days (range 1–33) in CC ( $P = 0.31$ ). The incidence of post-operative intra-abdominal collections (4.5% in SC and 4.3% in CC) was comparable in both groups ( $P = 0.76$ ). Most collections were managed conservatively with antibiotics, except for 1 patient in both groups who needed radiological drainage. Despite a low threshold for re-admission, the 30-day

Tab. I. Characteristics of study population.

		2020 COVID APPENDECTOMY STUDY COHORT (SC)	2019 APPENDECTOMY CONTROL COHORT (CC)	P VALUE
<b>Age (Years)</b>	Mean	32.9	32	p = 0.66
	Range	4–83	7–87	
<b>American society of anaesthesiologists (ASA) score</b>	Median	2	2	p = 0.74
	Range	1–4	1–3	
<b>Presentation (numbers)</b>	Pain	129 (97.7%)	205 (99.5%)	p = 0.13
	Anorexia	27 (20.4%)	11 (5.3%)	p > 1
	Fever	12 (9%)	22 (10.6%)	p = 0.49
	Vomiting	43 (32.5%)	17 (8.2%)	p = 1.05
	Jaundice	3 (2.2%)	0	p = 0.7
<b>White cell count</b>	Mean	142	140	p = 0.63
<b>Neutrophils</b>	Mean	12	10.6	p = 0.7
<b>Haemoglobin</b>	Mean	142	140	p = 0.67
<b>CRP</b>	Mean	87	73	p = 0.22

Tab. II. Intra-operative findings and histopathological results.

		2020 COVID APPENDECTOMY STUDY COHORT (SC)	2019 APPENDECTOMY CONTROL COHORT (CC)	P VALUE
<b>Operative findings</b>	Acute appendicitis	82	119	p = 0.4
	Necrotic or gangrenous appendix	15	27	p = 0.6
	Perforated appendix	17	19	p = 0.2
	Peritonitis	2	2	p = 0.6
	Pus or abscess formation	8	12	p = 0.9
	Appendicular mass	2	6	p = 0.4
	Mucocele	0	1	p = 0.42
	Worms	0	1	p = 0.42
	Normal-looking appendix	6	29	p = 0.004
<b>Histology</b>	Histologically normal appendix	9 (6.81%)	37 (17.09%)	p = 0.003

re-admission rates (5.8% in SC and 10.6% in CC) were comparable ( $P = 0.93$ ) and the most common cause for readmission in both groups was abdominal pain which was managed with simple analgesics. The 30-day re-operation rates was not statistically significant ( $P = 0.25$ ). Port-site bleeding was seen in 1 patient in SC ( $P = 0.93$ ) which led to rectus sheath hematoma and this was managed conservatively (Tab. III.).

The proportion of patients with a histologically normal appendix (negative appendicectomy rate) was significantly lower ( $P = 0.003$ ) in SC (6.81% in SC and 17.09% in CC). Surgical site infections (SSI) were significantly more frequent ( $P = 0.02$ ) in SC (6.9% for SC and 1.9% for CC). One octogenarian patient with significant comorbidities and a negative COVID-19 swab test, who presented with peritonitis secondary to a perforated appendix, died post-operatively in the study cohort ( $P = 0.21$ ). The cause of death was decompensated heart failure with a background history of atrial fibrillation, congestive cardiac failure with low ejection fraction and pulmonary hypertension.

In the study cohort, only 64 out of the 132 patients were swab-tested for COVID-19 and all were reported negative. Despite the negative swab results, 54 patients were considered to be indeterminate or suspicious for COVID-19 based upon chest CT findings.

## DISCUSSION

In March, WHO declared COVID-19 a pandemic [1], affecting millions across the world with the United Kingdom (UK) being one of the most severely affected European nation [10]. Surgical societies all over the world issued guidelines to defer elective surgery and advised non-operative management of certain routine emergency surgical conditions [2, 11]. The Association of Surgeons of Great Britain and Ireland (ASGBI) guidance document specifically advocated teams to implement emergency operations based upon local circumstances, resources and exceptional circumstances for patient care [2]. ASGBI proposed non-operative management for early appendicitis if deemed possible and reasonable. In patients requiring



**Tab. III.** Post-operative complications and findings.

		2020 COVID APPENDECTOMY STUDY COHORT (SC)	2019 APPENDECTOMY CONTROL COHORT (CC)	P VALUE
<b>Intra-abdominal collection</b>	% (No.)	4.5 % (6)	4.3 % (9)	p = 0.76
<b>Bleeding</b>	% (No.)	0.7 % (1)	0	p = 0.93
<b>Surgical site infections</b>	% (No.)	6.9 % (9)	1.9 % (4)	p = 0.02
<b>Mortality</b>	% (No.)	0.7 % (1)	0	p = 0.21
<b>Length of stay (days)</b>	Mean	(Range 1–34)	4.2 (Range 1–33)	p = 0.31
<b>30-day readmission</b>	% (No.)	5.8 % (12)	10.6 % (22)	p = 0.93
<b>30-day re-operation</b>	% (No.)	0.7 % (1)	2.91 % (6)	p = 0.25

an appendicectomy, an open approach was proposed as an alternative to laparoscopy due to the perceived risk of aerosol spread of infection. Laparoscopy was advised to be used selectively in individual cases where clinical benefit to the patient substantially exceeded the potential risk of transmission. In cases where laparoscopic approach was undertaken, use of safety mechanisms like filters, traps and careful deflating methods were advocated [2]. As healthcare systems were overwhelmed by the sheer magnitude of the pandemic, these safety mechanisms were considered necessary [12].

Appendicectomy is one of the most common abdominal surgical procedures performed in most hospitals worldwide. Only a couple of reports on appendectomies performed during the COVID-19 pandemic were available [13, 14]. Our study shows that most complications such as intra-abdominal collections, re-admission, re-operations and bleeding were comparable in both groups without any significant differences. As such, both laparoscopic and open appendectomies appear to be safe and feasible when sufficient precautions are taken. It was interesting to find that the SSI rate in our study was significantly higher in the appendectomies performed during the pandemic as compared to the control group from 2019. This is possibly due to the slightly higher proportion of open appendectomies performed in 2020 during the pandemic (13.6% vs 5.3%). The rates of complicated appendicitis which is defined as perforation, gangrene, empyema and abscess formation in our study were similar in both groups, contrary to the findings of the study by Dreifuss et al. from Argentina [13]. They found significantly higher rates of severe peritonitis, complicated appendicitis in their cohort of 15 patients when compared to a control group from previous years. They suggested this was possibly due to delay in patient consultation owing to the lockdown measures and population fear of the hospital environment. Although the Argentinian study reported no significant differences in post-operative outcomes, which is similar to our study results, they did not mention the incidence of SSI in their paper.

Our study reports a lower negative appendicectomy rate (NAR), i.e. of 6.81%, in patients who underwent emergency appendicectomy in COVID pandemic compared to 17.1% in the control cohort of 2019. This is partly due to the stringent management policy and implementation of antibiotics for early appendicitis, as well as surgery only for those with unresolving symptoms and complications.

Three studies reported high peri-operative morbidity and mortality in patients undergoing various surgical operations in COVID-19-positive patients. A publication by Gangakhedkar et al. suggested a mortality rate of 27.5% with a high proportion of severe

pulmonary complications [15]. A study by Lei S. et al. reported a 20% mortality rate and 44% ICU admission rate. In the same series, they reported a 100% risk of post-operative pneumonia in asymptomatic COVID-19 patients who underwent elective surgery [16]. Another series, by Li et al., documenting outcomes of thoracic surgery reported a post-operative fatality rate of 38.5% [17].

However, case reports by Kim et al. [18] and Ngaserin et al. [19] demonstrated laparoscopic appendicectomy to be safe in COVID-19-positive patients. A large series of 520 elective cancer surgeries from Tata Memorial Hospital, India, demonstrated elective cancer surgery to be safe when proper case selection and precautions are taken [20].

Our observations suggest that patients with acute appendicitis may be safely treated surgically if indicated as per the NICE guidelines and other studies [7–9]. As opposed to the initial fear of the high risk of viral transmission during laparoscopic approach, our study clearly demonstrates that with the use of full PPE gear, the risk can be minimised. Ngaserin et al. [19] and Flemming et al. [21] did not detect viral RNA in the peritoneal fluid or bile samples in COVID-19-positive patients subjected to appendicectomy and cholecystectomy respectively, although Coccolini et al. did isolate the viral RNA from the peritoneal fluid in a patient with small bowel obstruction [22]. Hence, if resources are available, laparoscopic appendicectomy can be safely offered to patients in pandemic periods.

We advise that laparoscopic appendicectomy should be preferred over open appendicectomy where possible, as to date there has been no definitive evidence of spread of COVID-19 virus during laparoscopy [11, 23]. With the use of airseal systems, smoke extraction devices with filters or suction, the insufflated CO<sub>2</sub> and smoke can be easily removed in a controlled manner [23]. As a precautionary measure, we keep low insufflation pressures and advocate small port site incisions to avoid leakage of pneumoperitoneum while accruing all the benefits of the laparoscopic approach. Definitive appendicectomy during index admission reduces the risk of complications of acute appendicitis – namely perforation, abscess formation, and peritonitis, in addition to reducing the risk of multiple re-admissions and higher resource consumption of expensive resources.

Our study in the COVID pandemic peak period demonstrates that timely assessment, stringent policy of case selection, adoption of best medical and surgical practices by senior experienced surgical teams result in good outcomes and low complication rates. Although our study presents the largest series of emergency appendectomies

during the on-going pandemic, we do recognise the limitations which are: around 50% of the patients in the study were not tested for COVID-19. This leaves a concern of asymptomatic carriers transmitting the disease. However, till date none of the post-operative patients represented with COVID symptoms or its complication. Hence, the outcome measures so far have been encouraging.

## CONCLUSION

The current unprecedented COVID-19 pandemic is likely to have a long-haul effect with second waves seen in most countries,

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until a definitive protective measure is invented and implemented. The results of our study serve to re-enforce our belief that the best surgical practice, aided by stringent patient evaluation by senior surgeons and implementation of rigorous theatre protocols with PPE can result in provision of safe laparoscopic appendectomy service during COVID pandemic times.

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