



# MANAGEMENT OF ACUTE APPENDICITIS DURING COVID-19 PANDEMIC IN CROATIA: A SINGLE-CENTER STUDY

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**SUMMARY** – The aim of the study was to evaluate the impact of the COVID-19 pandemic on the number of patients presenting to the emergency room with acute appendicitis and subsequent results of surgical treatment. Our single center retrospective study was conducted in Sestre milosrdnice University Hospital Center, Zagreb, Croatia. We analyzed data on the patients diagnosed with acute appendicitis, their duration of symptoms, length of hospital stay, histopathologic diagnosis, and operative techniques, recorded from September 1, 2019 to October 17, 2020. The results showed a statistically significant increase in the ratio of open laparotomies ( $p=0.006$ ) and ratio of perforated appendicitis ( $p=0.047$ ) during the COVID-19 pandemic in relation to the pre-pandemic period. The time between symptom onset and hospitalization, measured in days, did not demonstrate a statistically significant increase ( $p=0.379$ ), and minor increase in the postoperative length of stay was not statistically significant either ( $p=0.879$ ).

*Key words: Appendicitis; Emergency surgery; COVID-19; Pandemic*

## Introduction

The coronavirus SARS-CoV-2 emerged as a novel virus strain causing unusual cases of pneumonia in China during late December 2019<sup>1</sup>. On March 11, 2020, the World Health Organization declared a pandemic after rapid spread of the disease caused by the virus. The same day, the Ministry of Health of

the Republic of Croatia proclaimed the COVID-19 epidemic for our country<sup>2</sup>. Since then, the healthcare systems worldwide have encountered organizational challenges to ensure adequate distribution of hospital resources. Many countries, including ours, introduced quarantine and social distancing orders. Fear of hospitals perceived as a place of a high risk of exposure to COVID-19 infection and recommendations for postponement of non-oncologic elective surgeries resulted in fewer people presenting to the hospitals and especially the emergency room (ER)<sup>3</sup>.

Acute appendicitis is the most common surgical emergency, with over 250 000 appendectomies per-

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formed each year in the USA<sup>4</sup> and 5156 performed in our country in 2019<sup>5</sup>. The potential impact of COVID-19 quarantine on the outcome of treatment of patients who developed appendicitis is yet to be investigated. Several studies to date indicate a decrease in the overall number of patients admitted with the diagnosis of acute appendicitis but an increase of those with complicated appendicitis<sup>6-8</sup>. However, these studies were done on a small sample of patients, and further research is required to validate the conclusions drawn from currently published papers.

Due to COVID-19 restrictions and 'stay at home' policy governed in our country, we expect similar results. The prehospital delay caused by fear of the viral infection and complying with the pleas to reduce non-emergency hospital visits is likely to result in a reduced number of patients with acute appendicitis and, at the same time, an increased rate of perforated appendicitis.

Thus, our study aimed to evaluate the impact of the COVID-19 pandemic on the number of patients presenting to ER with acute appendicitis and the severity of disease, the technique of operation (open *vs.* laparoscopic), and length of stay in the hospital. The findings could lead to modulation of the response of emergency services during this and potential future epidemics or similar events.

## Materials and Methods

We retrospectively collected data on the number of hospital admissions for the diagnosis of acute appendicitis, duration of symptoms, length of hospital stay, histopathologic diagnosis, and operative techniques from September 1, 2019 to October 17, 2020. We chose these dates based on patient record availability and using roughly the same period before and after the pandemic was proclaimed.

Inference statistics were performed using the Statistica software package (TIBCO Software Inc., 2018; Statistica data analysis software system, version 13; <http://tibco.com>). The level of statistical significance was set at 0.05. The normality of distribution for the variables measured by the ratio scale was examined by the Kolmogorov-Smirnov test. Differences between the observed groups were examined by the  $\chi^2$ -test for nominal variables, Mann-Whitney U test for ordinal variables and proportional variables that did not follow normal distribution, and Student's t-test for proportional variables that followed normal distribution.

## Results

During the study period, there were 169 emergency appendectomies performed in the Sestre milosrdnice University Hospital Center in Zagreb, Croatia (72 before *vs.* 97 after the pandemic was proclaimed). The patient mean age was 43.2 years. The mean duration of symptoms before admission was 1.8 days (median 1 day). The mean period was 1.61 days in the pre-COVID period and 1.98 days in the post-COVID period (both median values were 1 day). The mean postoperative stay was 4.75 days pre-COVID and 5.46 days post-COVID (both median values were 4 days). The share of perforated appendicitis was 16.7% pre-COVID and 29.9% post-COVID. Most appendectomies were performed laparoscopically, but there was considerable divergence in the periods before and after the epidemic was proclaimed, i.e., 91.6% *vs.* 71.4% laparoscopic appendectomies.

The number of patients with acute appendicitis did not show significant change during the COVID-19 lockdown period and followed the usual pattern of monthly variation. The postoperative length of stay and time between symptom onset and hospitalization measured in days did not demonstrate a statistically significant increase ( $p=0.879$  and  $p=0.379$ , respectively). However, we noticed a statistically significant increase in the number of open appendectomies and the rate of perforated appendicitis ( $p=0.006$  and  $p=0.047$ , respectively).

## Discussion

The COVID-19 virus pandemic imposed a change of organizational paradigm to health care systems worldwide. While most aspects of preoperative and postoperative care functioned normally, some aspects could be improved through better organization and cooperation among various specialties in the system (emergency doctors, surgeons, anesthesiologists, radiologists, etc.). As testing for COVID-19 became more routine and available, the waiting times were reduced, and special operating rooms for the yet untested patients were organized. Unfortunately, this also led to delays in elective surgeries because of the lack of space and staff needed to conduct them.

Restrictions introduced by the government encouraged people to stay at home and avoid non-emergency hospital visits.

However, there was no significant impact of COVID-19 lockdown on the number of patients with

acute appendicitis in our institution. Possibly it was due to the usual monthly variation in the incidence of acute appendicitis<sup>9</sup>. The other reason might be a relatively short period of lockdown combined with latency in accepting the pandemic restrictive measures, which would also explain the absence of increased prehospital delay.

We found an increase in the number of gangrenous and perforated appendicitis and a higher rate of open appendectomies during the lockdown, resulting in a slightly increased postoperative length of stay. The reasons for this difference probably were multifactorial and could not be solely attributed to the pandemic. While there was a slight delay before the patients reported to the ER, there was also an issue of preoperative COVID-19 testing required for all patients who did not have immediately life-threatening conditions. This delay depended on the biochemical laboratory and its capacities and sometimes took up to 12 hours.

As one of the Zagreb hospitals became a COVID-19 center (Dubrava University Hospital), their ER was closed, which caused an increase in emergency patient admissions to other hospitals. This led to an increase in the number of operative procedures, and our department capacities were reduced because of the need for isolation of certain patients and sometimes the staff. All of this often led to overcapacity of our hospital, which caused delay between admission to the ER and the operation.

The prolonged recovery time after open appendectomy and increased postoperative length of stay posed additional financial burden on our health care system, which was already strained by the pandemic.

The limitations of our study were the relatively small number of patients and single-center data. Additional studies that would include data from other Croatian and European hospitals are required to make a more in-depth analysis.

## Conclusion

The COVID-19 pandemic caused some disruption in the functioning of emergency surgery based on our experiences with acute appendicitis. We noticed a statistically significant increase in the number of open appendectomies and rate of perforated appendicitis. These problems can be mitigated by appropriate organization and analysis of other center experiences.

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## Sažetak

ZBRINJAVANJE AKUTNOG APENDICITISA TIJEKOM PANDEMIJE COVID-19 U HRVATSKOJ:  
ISKUSTVO JEDNE USTANOVE

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Cilj ove studije bio je procijeniti utjecaj pandemije COVID-19 na broj bolesnika koji su dolazili u hitnu službu s akutnim apendicitisom te na rezultate daljnjeg kirurškog liječenja. Studija je provedena u KBC „Sestre milosrdnice“, Zagreb, Hrvatska. Retrospektivno smo analizirali podatke bolesnika uključujući trajanje simptoma, duljinu hospitalizacije, patohistološku dijagnozu i operativni pristup u razdoblju od 1. rujna 2019. do 17. listopada 2020. godine. Naša studija je zabilježila statistički značajan porast udjela otvorenih laparotomija ( $p=0,006$ ) te udjela perforirajućih apendicitisa ( $p=0,047$ ) za vrijeme pandemije COVID-19 u odnosu na razdoblje prije pandemije. Nije bilo statistički značajnog odstupanja u vremenu od nastupa simptoma do hospitalizacije ( $p=0,379$ ), kao ni statistički značajne promjene duljine hospitalizacije nakon operacije ( $p=0,879$ ).

Ključne riječi: *Apendicitis; Hitna kirurgija; COVID-19; Pandemija*