Have acute appendicitis complications increased in children as a result of SARS-CoV-2?

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ABSTRACT

Introduction. The impact of the SARS-CoV-2 pandemic on healthcare has already been described, since it has caused an increase in diagnostic delay and morbidity. Our objective was to assess its influence on the development of complications in children with acute appendicitis.

Materials and methods. A retrospective cohort study was carried out. It included acute appendicitis patients under 15 years of age treated from January 1, 2019 to December 31, 2020. They were classified according to diagnosis date as before the pandemic (B) (January 2019-February 2020) and during the pandemic (D) (March 2020-December 2020). According to operative findings, they were classified as complicated appendicitis (perforated/abscess/plastron/peritonitis) and non-complicated appendicitis (catarrhal/phlegmonous/gangrenous). Demographic data, progression time, and postoperative complications were analyzed.

Results. A total of 309 patients were included, 193 (62.5%) in Group B, and 116 (37.5%) in Group D, with an age of 9.2 ± 0.4 and 9.4 ± 0.6 years, respectively (CI = 95%). Diagnostic time was 1.35 and 1.43 days (p > 0.05) in Groups B and D, respectively, with ≥ 3 days representing 15.5% of cases in Group B, and 16.4% of cases in Group D (p = 0.84). The proportion of complicated appendicitis was 23.3% in Group B vs. 21.6% in Group D (p > 0.05). Postoperative complications were observed in 11.4% of patients in Group B, and in 13.8% of patients in Group D (p > 0.05), with intra-abdominal abscess being the most frequent complication in both groups (54.5% of the total complications in Group B vs. 65.5% in Group D; p > 0.05).

Conclusions. The management of acute appendicitis and its complications in pediatric patients has not been impacted by the SARS-CoV-2 pandemic or the safety measures enforced.

KEY WORDS: Appendicitis; Pediatrics; Children; COVID-19; SARS-CoV-2; Appendectomy.

INTRODUCTION

Although acute appendicitis is the most frequent surgical emergency in pediatric patients(1-5), its etiology is unclear. Various hypotheses related to the development of appendicitis, such as the presence of fecaliths, appendic-
ular lymphoid hyperplasia, parasites at the lumen, enteric or systemic viral infections, and genetic factors, among other variables, have been described\(^{5,6}\). The standard treatment of acute appendicitis is appendectomy, either open or laparoscopic, and with or without antibiotic treatment according to progression time at diagnosis\(^{5,6}\).

Disease progression – from an early stage to a more advanced or complicated one – is impacted by clinical, environmental, social, and economic factors. Early diagnosis and treatment reduce the risk of complications\(^{3,7}\).

Since the SARS-CoV-2 was declared a pandemic by the WHO on March 11, 2020\(^{8,9}\), multiple studies have described its impact on healthcare. In Spain, the state of emergency was declared on March 13, 2020, and it was published in the Spanish Official Gazette on March 14, with precautionary and hygiene measures, as well as mobility and capacity restrictions, being enforced to prevent contagion\(^8\).

**OBJECTIVE**

Our objective was to assess the pandemic’s impact on the development of complications in children with acute appendicitis, considering that SARS-CoV-2 control measures caused diagnostic delays, and therefore, greater morbidity.

**MATERIALS AND METHODS**

A retrospective cohort study of pediatric patients diagnosed with acute appendicitis from January 1, 2019 to December 31, 2020 was carried out.

Acute appendicitis patients under 15 years of age, either diagnosed and managed at our healthcare facility, or diagnosed at other institutions and referred to ours for the surgical treatment of appendicitis or its complications, were included. Patients over 15 years old were excluded.

Individuals were divided into two groups according to diagnosis date. Patients diagnosed before the pandemic – from January 2019 to February 2020 – were allocated to Group B, whereas patients diagnosed during the pandemic – from March 2020 to December 2020 – were allocated to Group D.

Appendicitis was classified according to operative findings as complicated appendicitis (perforated, abscess, inflammatory piastron, and peritonitis) and non-complicated or simple appendicitis (catarrhal, phlegmonous, and gangrenous).

Demographic data, clinical manifestations, and blood and imaging test results were collected from electronic medical records. Demographic data, progression time from symptom onset to diagnosis, and postoperative complications were analyzed.

Statistical analysis was conducted using the IBM SPSS Statistics software, version 28.0. Qualitative variables were compared using the Chi-squared test or Fisher’s test, whereas quantitative variables were compared using Student’s t-test. Statistical significance was established at p ≤ 0.05.

**RESULTS**

During the study period, from January 1, 2019 to December 31, 2020, 309 patients were admitted at our institution for the treatment of acute appendicitis or its complications. 193 patients were admitted from January 2019 to February 2020 (62.5%) (Group B), and 116 patients were admitted from March 2020 to December 2020 (37.5%) (Group D). Of the 309 patients, 115 were female and 194 were male. No significant differences were found in terms of age. Mean age of children treated during the pandemic was 9.2 ± 0.4 (CI 95%) years, and mean age of children treated before the pandemic was 9.4 ± 0.6 (CI 95%) years. Table I features a descriptive analysis of the study sample.

3 patients in Group B had previously undergone surgery at another institution, and they had been referred to our healthcare facility for various reasons – 2 of them as a result of clinical worsening (1 had undergone re-intervention at the corresponding reference hospital), and 1 of them at the parents’ request (he was referred from a hospital in another province where he was on vacation).

In terms of postoperative complications, complication rate was 13.8% in Group D vs. 10.4% in Group B (p > 0.05). 5.7% of patients in Group B had intra-abdominal abscess vs. 8.6% in Group D. This was the most frequent postoperative complication in both groups (55% of complications in Group B vs. 62.5% in Group D; p > 0.05) (Table II). Other complications found in Groups B and D included surgical wound infection in 20% and 25% of patients with complications, respectively, and adynamic ileus in 20% and 6.3% of patients with complications, respectively – statistically significant differences were not detected in any case. Of the 3 patients who had previously undergone surgery at other institutions, 2 had intra-abdominal abscess – both were percutaneously drained –, and 1 had no complications.

Mean time from symptom onset to diagnosis of acute appendicitis was a little longer in Group D (1.43 ± 0.3; CI = 95%) than in Group B (1.35 ± 0.2; CI = 95%) (p > 0.05). Diagnosis was achieved after more than 3 days in 15.5% of children in Group B vs. 16.4% of children in Group D (p = 0.84).

Surgical treatment was carried out in all patients in Group B, and in 114 patients in Group D (98.3%). Surgical diagnosis of complicated acute appendicitis was similar in both groups (23.3% in Group B vs. 21.6% in Group D; p > 0.05).
None of the patients with acute appendicitis or complications of acute appendicitis PCR-tested positive for COVID-19.

**DISCUSSION**

Since the emergence of SARS-CoV-2, many studies have analyzed its impact on various populations, whether in social, economic, cultural, or healthcare terms. In the medical field, direct and indirect patient care have been assessed following the healthcare changes occurred as a result of pandemic restrictions.

We supposed the declaration of COVID-19 as a pandemic and the multiple precautionary and hygiene measures enforced in Spain to prevent contagion could impact acute appendicitis progression in the pediatric population.

At our institution, the number of patients diagnosed was similar in both groups (about 14 monthly patients in the 14 months included in Group B, and about 12 monthly patients in Group D). No significant differences were found in terms of demographic data between groups.

According to official reports, in the healthcare area our institution belongs to, there were 4 incidence peaks of SARS-CoV-2 – in epidemiological weeks 13, 37, 45, and 53 –, with an incidence slightly above 200 infections per 100,000 inhabitants in the first peak, about 275 in the second peak, 450 in the third peak, and 850 in the fourth peak. These peaks occurred in March, September, November, and late December, respectively. This data demonstrates COVID-19 incidence in our healthcare area during the first wave (March 2020-June 2020) was much lower than in other Spanish regions. This could explain why COVID-19 had such a small impact on appendicitis at our institution, and it could also account for the fact none of the acute appendicitis patients had SARS-CoV-2.

Some authors claim the number of patients undergoing acute appendicitis treatment decreased during the pandemic. Zvizdic and Vranic\(^{(10)}\) reported a significant reduction in the number of pediatric emergencies – including

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**Table I. Descriptive analysis of the sample.**

<table>
<thead>
<tr>
<th></th>
<th>Group B (Jan 19-Feb 20)</th>
<th>Group D (Mar 20-Dec 20)</th>
<th>P</th>
<th>Total patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>193</td>
<td>116</td>
<td>0.38</td>
<td>309</td>
</tr>
<tr>
<td>Age</td>
<td>9.2 ± 0.4*</td>
<td>9.4 ± 0.6*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>F: 37.8% (n = 73)</td>
<td>F: 36.2% (n = 42)</td>
<td>0.35</td>
<td>F: 115</td>
</tr>
<tr>
<td></td>
<td>M: 62.2% (n = 120)</td>
<td>M: 63.8% (n = 74)</td>
<td></td>
<td>M: 194</td>
</tr>
<tr>
<td>Diagnostic delay &gt;3 days</td>
<td>15.5% (n = 30)</td>
<td>16.4% (n = 19)</td>
<td>0.84</td>
<td>49</td>
</tr>
</tbody>
</table>

**Type of management**

<table>
<thead>
<tr>
<th></th>
<th>Group B (Jan 19-Feb 20)</th>
<th>Group D (Mar 20-Dec 20)</th>
<th>P</th>
<th>Total patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical management</td>
<td>100% (n = 193)</td>
<td>98.3% (n = 114)</td>
<td>0.14</td>
<td>307</td>
</tr>
<tr>
<td>Conservative management</td>
<td>0% (n = 0)</td>
<td>1.7% (n = 2)</td>
<td>0.14</td>
<td>2</td>
</tr>
</tbody>
</table>

**Surgical diagnosis**

<table>
<thead>
<tr>
<th></th>
<th>Group B (Jan 19-Feb 20)</th>
<th>Group D (Mar 20-Dec 20)</th>
<th>P</th>
<th>Total patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-complicated appendicitis</td>
<td>75.7% (n = 146)</td>
<td>78.4% (n = 91)</td>
<td>0.57</td>
<td>237</td>
</tr>
<tr>
<td>Complicated appendicitis</td>
<td>23.3% (n = 45)</td>
<td>21.6% (n = 25)</td>
<td>0.71</td>
<td>70</td>
</tr>
<tr>
<td>Unspecific</td>
<td>1% (n = 2)</td>
<td>0% (n = 0)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

*Confidence interval for p ≤ 0.05.

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**Table II. Descriptive analysis of postoperative complications.**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Group B (Jan 19-Feb 20)</th>
<th>Group D (Mar 20-Dec 20)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall rate</td>
<td>10.4%</td>
<td>13.8%</td>
<td>0.36</td>
</tr>
<tr>
<td>Surgical wound infection*</td>
<td>20%</td>
<td>25%</td>
<td>1</td>
</tr>
<tr>
<td>Postoperative adynamic ileus*</td>
<td>20%</td>
<td>6.3%</td>
<td>0.35</td>
</tr>
<tr>
<td>Intra-abdominal abscess*</td>
<td>55%</td>
<td>62.5%</td>
<td>0.74</td>
</tr>
<tr>
<td>Other*</td>
<td>5%</td>
<td>6.2%</td>
<td></td>
</tr>
</tbody>
</table>

*Percentage of total complications.
acute appendicitis – at the pediatric surgery department during the lockdown period from March 15, 2020 to May 25, 2020 in Sarajevo, Bosnia and Herzegovina. However, Montalva et al.\(^\text{(11)}\) described a 77% increase in appendicitis cases during confinement in France. In addition, various studies have found no significant differences regarding the number of acute appendicitis patients – and their demographic characteristics – undergoing treatment during the pandemic vs. previous periods\(^\text{(1,12)}\).

In our study, the percentage of patients where diagnosis was achieved after 3 or more days was 16.4% in Group D vs. 15.5% in Group B (p > 0.05), which is associated with an increase in complications according to some studies\(^\text{(13)}\). The fact parents and/or guardians were afraid of exposing their children to patients diagnosed with COVID-19 and present at the same healthcare facility could account for this. The increase in phone medical consultations – with no physical exploration – as a result of pandemic restrictions could be another reason\(^\text{(3,4,7,8,12)}\).

Regarding acute appendicitis treatment during the pandemic, various studies reveal how management changed in some institutions, with conservatively managed cases increasing\(^\text{(1,12)}\). At our healthcare facility, management remained the same, and the pathology was surgically treated. During the study period, conservative management was decided upon only in 2 clinically stable, advanced stage cases with radiological evidence of appendicular plastron – these criteria were already used before the pandemic\(^\text{(5,6)}\). The 2 patients belonged to Group D.

In terms of surgical diagnosis, differences were not significant between groups, with complicated appendicitis being slightly more frequent in patients undergoing surgery before the pandemic was declared (23.3% vs. 21.6%), contrary to the findings reported in multiple studies\(^\text{(3-8)}\). The proportion of postoperative complications was a bit higher – about 3% more (p = 0.36) – in patients undergoing surgery during the pandemic, with intra-abdominal abscess being the most frequent complication (5.7% in Group B vs. 8.6% in Group D; p > 0.05).

The main study limitation lies in the fact it was a retrospective study. The fact data was collected by various researchers could be another one.

**CONCLUSIONS**

In spite of the multiple changes occurred as a result of the SARS-CoV-2 pandemic, both socially and in healthcare terms – increased hygiene measures, mobility and interpersonal contact restrictions, rise in phone medical consultations and decrease in physical explorations, recommendation of avoiding hospitals unless absolutely necessary, etc. –, our study reveals there were no significant differences in acute appendicitis progression once the pandemic had been declared. The number of pediatric patients diagnosed with acute appendicitis at our institution has not significantly changed as compared to the months before the pandemic broke out. Acute appendicitis care and/or complications have not changed either.

**REFERENCES**