Efficacy and safety of the conservative management of appendiceal phlegmon during childhood

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ABSTRACT

Objective. To assess the efficacy and safety of conservative management with interval appendectomy vs. baseline surgery in the treatment of appendiceal phlegmon.

Materials and methods. A retrospective study of the 76 phlegmons treated from July 2016 to June 2024 was carried out. Two treatment groups were created –the baseline surgery (G1: 46 children) group and the conservative with interval appendectomy (G2: 30 children) group. Clinical and progression characteristics of both groups were collected and compared.

Results. No significant differences were found in terms of age, progression time, presence of appendicolith, or mean hospital stay. The number of intra-abdominal collections at diagnosis was greater in G2 (21.7% vs. 56.6%; p< 0.05), and the percentage of complications was significantly higher in G1 (54.34% vs. 20%; p< 0.002). In G2, 3 collection drainage procedures were carried out, and 4 children underwent surgery in an acute stage as a result of treatment failure. Following discharge, 2 patients from G2 underwent emergency surgery, 4 refused surgery, and 20 underwent surgery after 184 ± 55 days. Of the latter, 2 had complications. 89.47% of the appendices removed had histological disorders.

Conclusions. Conservative treatment of appendiceal phlegmon is safe and effective. It significantly reduces morbidity, and it is not contraindicated by age, presence of appendicolith, or intra-abdominal collections. However, large collection drainage procedures may be required. We believe interval appendectomy is indicated in a period of 3-6 months.

KEY WORDS: Appendicitis; Appendiceal phlegmon; Interval appendectomy; Child.

EFICACIA Y SEGURIDAD DEL MANEJO CONSERVADOR DE LOS PLASTRONES APENDICULARES EN LA INFANCIA

RESUMEN

Objetivo. Valorar la eficacia y seguridad del manejo conservador con apendicectomía diferida en comparación con la cirugía inicial en el tratamiento de los plastrones apendiculares.

Material y métodos. Estudio retrospectivo de los 76 plastrones tratados entre julio de 2016 y junio de 2024. Se dividieron en dos grupos de tratamiento: quirúrgico inicial (G1: 46 niños) y conservador con apendicectomía diferida (G2: 30 niños) y se recogieron y compararon las características clínicas y evolutivas de ambos grupos.

Resultados. No se hallaron diferencias significativas en la edad, tiempo de evolución, presencia de apendicolito ni estancia media. Se encontraron más colecciones intraabdominales al diagnóstico en el G2 (21,7% *vs* 56,6%; p< 0,05) y un porcentaje de complicaciones significativamente mayor en el G1 (54,34% *vs* 20%; p< 0,002). En G2 se realizaron tres procedimientos de drenaje de colecciones y cuatro niños fueron intervenidos en fase aguda por fracaso del tratamiento. Tras el alta dos pacientes del G2 fueron intervenidos de Urgencia, cuatro rechazaron la intervención y veinte fueron intervenidos tras 184 ± 55 días. De estos últimos, 2 presentaron complicaciones. El 89,47% de los apéndices extirpados presentaron alteraciones histológicas.

Conclusiones. El tratamiento conservador de los plastrones apendiculares es seguro y eficaz y disminuye de forma significativa la morbilidad. Ni la edad, ni la presencia de apendicolito o colecciones intraabdominales contraindica el manejo conservador, aunque pueden ser necesarios procedimientos para el drenaje de grandes colecciones. Consideramos indicada la apendicectomía diferida en un plazo de 3-6 meses.

PALABRAS CLAVE: Apendicitis evolucionada; Plastrón apendicular; Apendicectomía diferida; Niños.

INTRODUCTION

Even though acute appendicitis is the most frequent cause of emergency surgery in pediatrics, diagnosis can be challenging. Delayed identification translates into longer progression times and increases the incidence of appendiceal perforation up to 30% of the total appendicitis cases[1]. 30-50% of complicated appendicitis cases (10% of the total) develop an inflammatory mass or phlegmon as a result of adhesions emerging around the inflamed appendix and clogging the infection[2-4]. This makes surgical treatment more difficult and increases the likelihood of postoperative complications up to 50-60%, as reported in the literature[5].

DOI: 10.54847/cp.2025.03.14

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Date of submission: March 2025 *Date of acceptance:* July 2025

The introduction of a conservative approach for the management of appendiceal phlegmon without baseline appendectomy is aimed at reducing hospital stay, morbidity rates, and baseline-surgery-related costs. Even though this approach has demonstrated to be safe[6], it has not been fully accepted yet[7,8], giving rise to new questions regarding treatment duration, optimal time from baseline diagnosis to appendectomy, and real need for such surgery.

The objective of our study was to review the appendiceal phlegmon cases treated in our institution and to assess the efficacy of the two therapeutic approaches –baseline surgery and conservative treatment– in terms of complications, morbidity, and hospital stay. Additionally, an attempt was made to identify progression patterns in conservatively managed cases to improve treatment protocols.

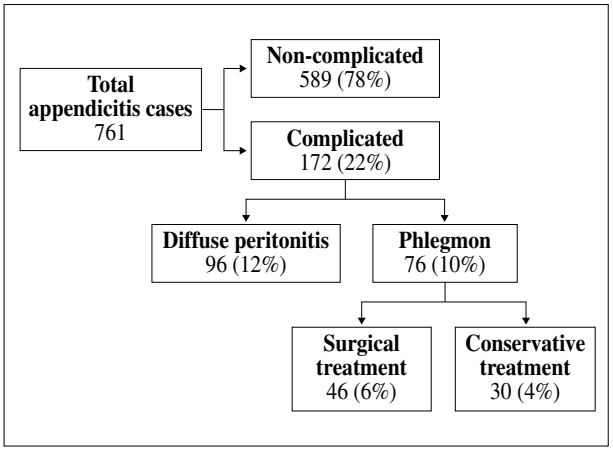

Figure 1. Characteristics of the appendicitis cases treated from July 2016 to June 2024.

MATERIALS AND METHODS

A retrospective study of the appendiceal phlegmon cases managed in our institution over an 8-year period was carried out. Two treatment groups were created –baseline appendectomy + antibiotic therapy (G1), and baseline conservative management + interval appendectomy (G2).

Appendiceal phlegmon cases managed with baseline appendectomy were included in G1, with the presence of inflammatory phlegmon being checked for at surgery. In this group, treatment was completed with intravenous amoxicillin-clavulanic acid + gentamicin (occasionally piperacillin tazobactam) antibiotic therapy for at least 5 days according to our hospital's complicated appendicitis protocol.

Children diagnosed with appendiceal phlegmon without signs of sepsis, diffuse peritonitis, or intestinal obstruction at diagnosis were eligible for G2. Neither age nor the presence of appendicolith were regarded as contraindications. The final decision whether to conduct surgery or not was made by the main surgeon on a case-by-case basis. The diagnosis of appendiceal phlegmon was based on the combination of medical history, physical exploration, complementary laboratory tests (hemogram, C-reactive protein), and imaging studies (ultrasonography and/or abdominal CT-scan) to radiologically confirm the inflammatory mass and the potential presence of appendicolith and collection within it. Drainage of collections > 6 cm at diagnosis was considered as part of conservative management.

The conservative management protocol included intravenous antibiotics for 7 days (meropenem or piperacillin-tazobactam, along with an aminoglycoside), followed by 7 days with oral antibiotics (ciprofloxacin or amoxicillin-clavulanic acid) after discharge.

Conservative treatment was maintained beyond 72 hours provided that clinical (reduced pain, absence of fever, and progressive digestive tolerance) and laboratory (decreased C-reactive protein and leukocyte levels) improvement was observed. In case of clinical, laboratory, or radiological worsening, immediate surgery was carried out, and the case was recorded as conservative treatment failure.

Ultrasound controls were conducted prior to discharge in all cases, and clinical follow-up at outpatient consultation was maintained until scheduled surgery.

Conservative management was completed with interval appendectomy 3-6 months following diagnosis.

Clinical and progression characteristics (mean hospital stay, incidence of complications, conservative treatment failure rates, and additional procedures required) of either conservatively or surgically managed phlegmon patients were assessed. Interval appendectomy results (complications, second hospital stay, and histopathological findings) were also analyzed.

The data achieved was collected in a dedicated database. Statistical study was subsequently carried out using the SPSS software, version 26, for Windows. Qualitative variables were expressed as absolute frequency and percentage, whereas quantitative variables were reported as mean with standard deviation and range. Student's t-test was used to compare quantitative variables, whereas the χ^2 test was employed to compare qualitative ones. Statistical significance was established at $p< 0.05$.

RESULTS

From July 2016 to June 2024, 761 acute appendicitis cases in pediatric patients aged 18 months-16 years were diagnosed in our institution. 172 of them were complicated acute appendicitis cases –96 with diffuse peritonitis and 76 with inflammatory phlegmon (Fig. 1).

Phlegmon patients were divided into two groups according to the treatment used –**G1** (baseline appendec-

Table 1. Characteristics of the phlegmon cases treated from July 2016 to June 2024.

	Baseline surgery treatment	*Conservative treatment*	*p*
No. of cases	46	30	
Sex-based distribution	16 F / 31 M (35% / 65%)	13 F /17 M (43% / 57%)	0.218
Mean age (years)	9.1 ± 3.6	10.24 ± 4.4	0.227
Mean progression time (days)	3.8 ± 2.3	5.8 ± 2.7	0.001
Laboratory tests			
Total leukocytes/μL	16,651 ± 4,939	17,742 ± 5,837	0.384
Neutrophils (%)	80.37 ± 8.4	78.28 ± 9	0.401
CRP (mg/dl)	16.67 ± 16.6	22.55 ± 12.8	0.105
Imaging tests			
Radiological diagnosis	27 cases	28 cases	
Radiological technique used	Conducted (diagnostic)	Conducted (diagnostic)	
Ultrasonography alone	38 (23)	13 (13)	
CT-scan alone	7 (4)	2 (2)	
Ultrasonography + CT-scan	0	15 (13)	
Intra-abdominal collection	10 (21.7%)	17 (56.6%)	0.002
Mean collection size (cm)	3.8 ± 2	4.54 ± 2	0.378
Presence of appendicolith	22 (47.8%)	10 (33.3%)	0.211

F: females; M: males.

tomy + antibiotic therapy): 46 patients; **G2** (conservative treatment + interval appendectomy): 30 patients.

General epidemiological characteristics of both groups, as well as the results from diagnostic laboratory and imaging tests, are featured in Table 1. Even though at least one imaging test was carried out in 75 patients (98.68%), radiological diagnostic confirmation of appendiceal phlegmon was achieved in only 55 (27/46 G1; 28/30 G2). In 19 G1 children, diagnosis was surgical, and in 2 G2 patients, diagnosis was clinical.

In G1, antibiotic treatment consisted of gentamicin (49/49) + amoxicillin-clavulanic acid (29/46), piperacillin tazobactam (12/46), or metronidazole (5/49). Hospital stay was 10 ± 4.1 days, and mean time to full nutrition was 3.2 ± 2.1 days following diagnosis. 54.34% of the patients (25/46) had at least one complication. There were a total of 36 complications, including 20 intra-abdominal collections, 10 wall abscesses, 3 prolonged ileus cases, 2 intestinal obstructions, and 1 pleural effusion. 3 children required a second surgery, and 1 needed intestinal resection.

In G2, gentamicin (30/30) + meropenem (28/30) or piperacillin tazobactam (2/30) were employed. Hospital stay was 8.5 ± 2.5 days in the first hospitalization, which was not a statistically significant difference vs. G1 (p= 0.096). Time to full nutrition was 1.5 ± 0.8 days, significantly shorter than in G1 (p< 0.001). Invasive procedures for draining collections > 7 cm were required in 3 cases (1 ultrasonography-guided and 2 laparoscopically). 4 children (Table 2) had to undergo surgery during treatment as a result of treatment failure (2 cases due to clinical, laboratory, and radiological worsening, 1 case due to reoccurrence of fever, and 1 case due to intestinal obstruction). 4 patients refused interval appendectomy (mean follow-up after diagnosis: 172 days), 2 underwent surgery in other institutions 30 and 120 days following discharge, respectively, and 20 children underwent scheduled laparoscopic surgery after 184 ± 55 days, with a mean hospital stay of 1.6 days in this hospitalization. 2 children had postoperative complications (1 abscess in the umbilical port and 1 omental infarction). The 4 treatment failures and the 2 postoperative complications represent a total complication percentage of 20% in this group, significantly lower than in G1 (p< 0.002). The histopathological diagnosis of the 19 appendices removed (in 1 case the appendix was digested) was normal appendix in 2 cases, acute appendicitis in 10 cases, chronic appendicitis with/without acute inflammatory infiltration foci in 5 cases, and appendiceal fibrosis in 2 cases.

DISCUSSION

Conservative treatment of acute appendicitis has been known since the mid-1900s[9,10]. However, it was not fully applied to all appendicitis types until the 1990s, first in

Table 2. Progression characteristics of conservatively managed phlegmon cases.

	Failure (N= 4)	*Success (N= 26)*	*p*
Clinical and epidemiological characteristics			
Age (years)	6 ± 3.5	10.89 ± 4.2	0.038
Sex	2 M/2 V	11 M/15 V	0.351
Progression time (days)	5.5 ± 2.3	5.88 ± 2.3	0.802
Laboratory tests			
Total leukocytes/µL	21.090 ± 5.791	17.227 ± 5.778	0.224
Neutrophils (%)	80.42 ± 3.6	77.25 ± 9.58	0.619
CRP (mg/dl)	29.9 ± 13.3	21.43 ± 12	0.227
Imaging tests			
Radiological diagnosis	4 (100%)	24 (92.3%)	
Technique used	Conducted (diagnostic)	Conducted (diagnostic)	
Ultrasonography alone	0	13 cases (13)	
CT-scan alone	0	2 cases (2)	
UltrasonograpHY + CT-scan	4 (4)	11 cases (9)	
Collection (cases)	4 (100%)	13 (50%)	0.06
Collection size (diameter, cm)	3.25 ± 0.86	4.9 ± 2.1	0.151
Presence of appendicolith	3 (75%)	7 (26.9%)	0.058

F: females; M: males.

adults[11] and subsequently in children[12]. In complicated appendicitis cases with clogged infection, it has demonstrated to be safe[13], but not in diffuse peritonitis cases, where baseline appendectomy remains the best treatment option[15,16].

The primary interest of conservative management in inflammatory phlegmon cases is to avoid the high morbidity rates, long hospital stay, and significant costs of baseline surgery. In our review, even when considering the limitations resulting from its retrospective nature, conservative management significantly reduced complications vs. surgical treatment (20% vs. 54%), consistent with the literature[7,13,18]. Regarding complications, the most frequent one in G2 was treatment failure (13.3%), with 75% of therapeutic failures occurring in the first 3 years of protocol application. This was possibly a result of overestimating symptoms and fearing the occurrence of complications due to the absence of surgery, out of experience/learning curve reasons. Such assumption, based on speculation, is to be confirmed in the upcoming years.

It would be interesting to assess "quality of life" during hospitalization, but this is uneasy in a retrospective study. Time from diagnosis to full digestive tolerance, which may be a good indirect indicator, was significantly lower in the conservative management group. This is clearly a result of the absence of prolonged ileus following interval appendectomy, contrary to what may occur in the postoperative period of baseline appendectomy.

However, the lower morbidity rates of conservative treatment are seemingly not associated with a significant reduction in mean hospital stay. In our experience, hospital stay was shorter in G2 (G1: 10 days; G2: 8.5 days), in spite of the initial treatment protocol being longer. Nevertheless, this occurs when considering the first hospitalization only, since hospital stay is compensated when adding interval appendectomy hospitalization (1.6 days), consistent with other series.

The preoperative diagnosis of appendiceal phlegmon remains challenging and requires a high degree of clinical suspicion. Diagnostic confirmation is essentially based on imaging tests, with ultrasonography + CT-scan combined allowing for the greatest diagnostic accuracy[19]. In our series, radiological diagnosis was achieved in 86.6% of the children when both tests were combined, vs. 70.6% with ultrasonography alone and 66.6% with CT-scan alone. Even though 19 G1 children in whom the phlegmon had been detected as an operative finding (41.3%) had undergone a diagnostic imaging test (ultrasonography or CT-scan), none of them had undergone both tests combined. Although identifying the phlegmon is not mandatory –albeit recommended– in the case of baseline surgery and does not impact subsequent progression, it is key when decision is made not to proceed with surgery in the acute stage, with clinical suspicion being essential to seek and reach diagnosis.

Even though there is no consensus regarding which antibiotics should be employed in the pursuit of an ideal

conservative treatment and for how long[20], the use of powerful antibiotics making up for the loss of baseline surgery benefits (removal of the infection focus and reduction of the bacterial inoculum through aspiration with/without purulent exudate lavage) is indicated. Both single wide-spectrum antibiotic therapy (piperacillin-tazobactam, carbapenems) and combined narrow-spectrum antibiotics (metronidazole + ceftriaxone) –which were not used in these patients– for at least 5 days followed by oral antibiotic therapy have been demonstrated to have similar efficacy.

The comparative study of conservative treatment and therapeutic failure (TF) children vs. treatment success (TS) children (Table 2) is aimed at finding factors associated with greater likelihood of conservative treatment failure, to the point they could even contraindicate it, as some authors posit[18,20-22]. In our series, mean age was lower and the presence of appendicoliths and intra-abdominal collections at diagnosis was greater in the children where conservative management had failed. Leukocyte and CRP levels were also higher, with none of the differences being significant. When analyzing each factor in our series separately, none of them was an absolute contraindication for conservative management, since the latter was successful in 67% of the children under 5 years of age (n= 6), in 70% of the children with appendicolith (n= 10), and in 77% of the children with intra-abdominal collection at diagnosis (n= 17).

In our experience –albeit limited due to the small sample size–, collections > 6 cm require a specific drainage procedure, preferably through interventional radiology. However, laparoscopy is a good option when the latter is not feasible, either because there is no safe access route, or as a result of any other reason[23]. In our series, the laparoscopic drainage of 2 large (8 and 9.5 cm) collections allowed for resolution, with no postoperative complications or morbidity increases.

The favorable mid- and long-term progression observed in conservatively managed patients has raised doubts regarding the need for systematically conducting interval appendectomy. Arguments in favor of surgery include the risk of a potential appendiceal carcinoid tumor –which is a rare condition in children, with a prevalence of 0.2-0.9%[24,25]– going undiagnosed, and potential appendicitis recurrence[25,26], with an overall reported incidence of 8-20.5% –according to some authors, of up to 72% in the presence of appendicolith[27]. In our series, only 2 children required emergency surgery before the scheduled interval appendectomy, which represents an incidence of 7.69% in the first 6 months following diagnosis. Arguments against systematically performing interval appendectomy include the increase in healthcare costs and hospital stay, as well as the risk of exposing healthy children to potential postoperative complications, which may occur in up to 12.4% of the cases[25,28] (10% in our series). Some authors[26,29] conclude that at least 80% of the patients will benefit from not undergoing surgery.

However, in our review, the histological study of the appendices removed at scheduled surgery in a mean time of 24.5 weeks following diagnosis demonstrates that 78.9% (15 out of 19 specimens) still had inflammatory infiltration, which was acute in 10 cases (52.6%) and chronic in 5 cases (26.3%). This finding, similar to those previously reported by other authors[24,30,31], has an uncertain meaning, but suggests appendices do not fully recover following the acute stage, thus supporting interval appendectomy. Patients who would benefit from not undergoing surgery are those in whom the appendix has disappeared in the process, and those with appendiceal fibrosis (3/20 children, 15%), but preoperative identification is not feasible.

The optimal timing of scheduled appendectomy also poses significant doubts. If performed too early, it will increase difficulty, operating time, and the likelihood of complications as a result of persistent inflammatory adhesions. From week 12 post-diagnosis, inflammatory changes virtually disappear[24]. Therefore, in our experience, appendectomy between weeks 12 and 24 is easier, faster, and safer.

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