Original Article

Predictive Factors of Post-laparoscopic Appendectomy Peritoneal Collection in Children and Adolescents with Complicated Appendicitis

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Abstract

Introduction: Intra-peritoneal collection (IPC) following laparoscopic appendectomy (LA) of complicated appendicitis in children is a serious complication. This is associated with a longer duration of hospital stay, more costs, and psychological upsets of both children and their parents. The aim of this study is to evaluate different factors that may affect the development of IPC following LA of complicated appendicitis. **Patients and Methods:** Seventy-five children were admitted with acute complicated appendicitis. All of them had LA between January 2016 and October 2020. The following variables were studied: patients' demographics, clinical findings, laboratory and imaging studies and operative parameters. Patients were divided according to their post-operative course into two groups; Group (A): patients with IPC (n = 19), Group (B): patients without IPC (n = 56). Potential risk factors for the development of post-operative IPC were identified by univariate and multivariate logistic regression analysis. **Results:** Nineteen cases (25.3%), out of 75 patients, presented with post-operative collection. Forty-seven (62.7%) patients were males, the overall median age was 11 (inter-quartile range [IQR] 10–13). The most significant operative variable was the operative time, which was significantly longer in Group A, 78 min (IQR 75–88) versus 56 (50–66), P = 0.001. The following variables were associated with an elevated incidence of post-operative IPC; age, body mass index, total leucocytic count (TLC), duration of symptoms, pediatric appendicitis score, pre-operative morbidity, being on medications, operative time, suction and irrigation or suction only and drain duration. In the multivariate model, TLC (odds ratios [OR]: 1.358, P 0.006), symptoms duration (OR: 2.051, P 0.012), morbidity (OR: 2.064, P 0.041) and operative time (OR: 2.631, P 0.039) were statistically significant and confirmed as being predictors of IPC post-LA in complicated appendicitis. **Conclusion:** Post-operative IPC is quite common after LA for complicated appendicitis. Increased TLC, prolonged symptoms duration, associated co-morbidity and operative time could be predictors of its occurrence. Improving general condition, surgical technique and reducing operative time help to reduce its incidence.

Keywords: Acute appendicitis, children, intraperitoneal collection, laparoscopic

Introduction

The most common childhood condition that necessitates surgical management is acute appendicitis. During the last years, laparoscopic appendectomy (LA) has been widely accepted worldwide and has become the preferred choice in centers with comprehensive laparoscopy experience.[1,2]

Recently, LA in children with complicated appendicitis gained popularity and represented the mainline of management by many surgeons.[3]

When LA is performed for the management of complicated appendicitis, there is a higher incidence of the intra-peritoneal collection (IPC). It is estimated that IPC developed in 4.2% of cases of acute simple appendicitis and up to 6.7%–28% of cases of acute complicated appendicitis.[2,4]

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This complication was associated with increased morbidity, longer hospital stay, more costs and psychological upsets among affected children.[5-7]

The aim of this study is to predict potential risk factors related to the development of IPC post-LA of complicated appendicitis in children.

Patients and Methods

This study included 75 children presented with acute complicated appendicitis during the period from January 2017 to October 2020. Ethical Board Review was obtained with Approval code 33871/6/20.

They were evaluated according to our institutional protocol. All children were subjected to evaluation using clinical, laboratory and radiological imaging. Children were operated by laparoscopy using three ports. Data of patients were collected. Recorded variables included: patients' demographics; age, sex, body mass index (BMI), pre-operative ultrasound findings, morbidity, and medications, duration of symptoms, paediatric appendicitis score (PAS), total leucocytic count (TLC), C-reactive protein level (CRP), operative parameters (operative time, gross pathological appearance of the appendix, methods of securing the base, use of suction/irrigation and whether a drain was inserted by the end of the procedure.

Patients were divided according to their post-operative course into two groups; Group (A): included patients with IAC (n = 19), Group (B): patients without IAC (n = 56).

Statistical analysis

Data were analysed using SPSS ™ statistical package v. 21 (IBMSPSS, NY,USA). Quantitative data were expressed as median and inter-quartile range (IQR). Qualitative data were expressed as frequency and percentage.

The following tests were used:

- Mann–Whitney test of significance was used when comparing in quantitative data
- Chi-square test of significance was used to compare in qualitative data.

Finally, to determine risk factors for post-operative IPC, univariate and multivariate logistic regression models were developed. Results were considered statistically significant when $P < 0.05$.

Results

Nineteen cases (25.3%) presented with post-operative (IPC), the other 56 (74.7%) had a smooth post-operative course. Forty-seven (62.7%) children were male. Both groups were compared regarding age and sex. Median age for the whole cohort of patients was 11 years (IQR: 10–13). Groups varied through most of the parameters analysed, where 5 (26.3%) patients in Group A had BMI >25 kg/m^2 versus only 3 (5.4%) in Group B. Similarly, the duration of symptoms from the onset of presentation till surgical intervention was significantly longer in Group A; 4 days (IQR 2.2–4.5) versus 2 days (1–2.95) in Group B (P = 0.001). Inflammatory markers, including leucocytic count and CRP were significantly higher in Group A, with P = 0.001, 0.013, respectively. Fifteen children had a pre-operative co-morbidity (six children had diabetes mellitus, 7 children on corticosteroid therapy and two children was malnourished) [Table 1].

As regards operative data, differences between such findings within both groups were not statistically significant, apart from the operative time. It was significantly longer in Group A, 78 min (75–88) versus 56 (50–66) in Group B and P = 0.001. In 40 (53.3%) children, clipping was the favoured modality of handling the base of the inflamed appendix using Hem-O-Lok, while ligature of the base was used in 35 (46.7%) patients. During laparoscopy, 27 patients (36%) found to have suppurative appendicitis, 18 (24%) had gangrenous appendicitis, 19 cases (25.3%) had perforated appendix and 11 cases (14.7%) had the pelvic collection, with no significant difference between both groups [Table 2].

Suction and peritoneal toilet were used in 9 cases (47.4%) in Group A and 21 cases (37.5%) in Group B. Suction only was performed in 10 cases (52.6%) in Group A and in 35 cases (62.5%) in Group B.

Peritoneal drains were inserted in 8 cases (42.1%) in Group A versus 18 cases (32.1%) in Group B.

The results of the univariate analysis of post-operative IAC potential risk factors employing pre-and perioperative parameters are shown in Table 3. The following variables were associated with an elevated incidence of post-operative IAA; age, BMI, TLC, duration of symptoms, PAS, having pre-operative morbidity (six children had diabetes mellitus, 7 children were on corticosteroids therapy and two children were malnourished), and operative time. In the multivariate model, TLC, symptoms duration, morbidity and operative time were statistically significant and confirmed as being predictors of IPC post-LA [Table 4].

Discussion

LA has become the standard option of management of acute appendicitis in children at our institution. In recent years, authors preferred this option also for children with complicated appendicitis.

However, LA for complicated appendicitis has been reported to be associated with a higher incidence of post-operative IPC. In some reports, it was estimated to be 18%–26% of all cases when compared to simple appendicitis. This is considered one of the most important complications that may preclude the decision of LA in complicated cases.[8,9]

There is a strong need to study different variables that may have effect on the development of IAC in complicated appendicitis cases that will be managed by laparoscopy.

In the current study, nineteen cases (25.3%) presented with post-operative IPC. Authors reported the occurrence

Table 1: Patients demographics and preoperative findings

Variables	Group A	Group B	*P*
	n=19 (25.3%), *n* (%)	*n*=56 (74.7%), *n* (%)	
Age (years) Median (IQR)	9 (7.5-13)	12 (10-13)	0.014* 11 (10-13)
Sex			
Males	13 (68.4)	34 (60.7)	0.546
Females	6 (31.6)	22 (39.3)	
Body mass index (kg/m^2)			
Median (IQR)	23 (22-25)	22 (21-23)	0.001*
>25	5 (26.3)	3 (5.4)	0.011*
Duration of symptoms (days)			
Median (IQR)	4 (2.2-4.5)	2 (1-2.95)	0.001*
>2 days	16 (84.2)	23 (41.1)	0.001*
Preoperative ultrasonography			0.148
Collection	10 (52.6)	19 (33.9)	
Total leucocyte count (×10^3)			
Median (IQR)	15.5 (14-18)	12.33 (11.58-13.46)	0.001*
>13	17 (89.5)	18 (32.1)	0.001*
CRP (mg/L)			
Median (IQR)	85 (56-90)	56 (34-80)	0.013*
>35	17 (89.5)	41 (73.2)	0.144
Pediatric appendicitis score			
Median (IQR)	9 (8-10)	8 (7-8)	0.003*
>8	11 (57.9)	13 (23.2)	0.005*
Preoperative medication	7 (63.2)	40 (71.4)	0.007*
Preoperative morbidity	10 (52.6)	5 (8.9)	0.001*

IQR: Inter-quartile range, CRP: C-reactive protein, *Significant

Table 2: Operative and postoperative variables in both groups

Variables	Group A	Group B	*P*
	n=19 (25.3%), *n* (%)	*n*=56 (74.7%), *n* (%)	
Operative time (min)	78 (75-88)	56 (50-66)	0.001*
Median (IQR)			
>60	17 (89.5)	17 (30.4)	0.001*
Gross pathological appearance			
Suppurative	3 (15.8)	24 (42.9)	0.067
Gangrenous	7 (36.8)	11 (19.6)	
Perforated	4 (21.1)	15 (26.8)	
Any of the above plus collection	5 (26.3)	6 (10.7)	
Base securing			0.943
Clip	10 (52.6)	30 (53.6)	
Ligature	9 (47.4)	26 (46.4)	
Suction/irrigation	9 (47.4)	21 (37.5)	0.448
Suction alone	10 (52.6)	35 (62.5)	0.253
Postoperative drain use	8 (42.1)	18 (32.1)	0.430
Hospital stay (mean in days)	7 (3-12)	3 (2-5)	0.052*

*Significant. IQR: Inter-quartile range

of IPC in children with TLC >14,000 c/mm^3, duration of symptoms >2 days, BMI >23 and PAS >8. On the other hand, there was a lower incidence of IPC to occur when pre-operative antibiotics were prescribed. The study of operative variables showed that IPC was associated more with perforated appendicitis and longer operative time. The authors documented that the use of suction alone or suction and irrigation was found to have no effect on postoperative prognosis. Controlling the base of the appendix by either ligature or Hem-O-Lok did not contribute to the development of IPC. Insertion of an intra-peritoneal drain or not by the end pf the procedure was not associated with IPC development.

Schlottmann noticed that LA in obese patients, leucocytosis (20.000/mm^3), perforated appendicitis or long

Table 3: Univariate regression analysis of predictors of postoperative collection

Variable	OR	95% CI	*P*
Age	1.369	1.041-1.801	0.029*
Sex	1.402	0.464-4.237	0.377
BMI	2.109	1.855-5.204	0.022*
Duration	1.554	1.175-2.056	0.001*
TLC	1.847	1.328-2.569	0.001*
CRP	1.248	0.982-1.587	0.124
PAS	1.557	1.057-2.291	0.007*
Medication	1.489	1.058-2.097	0.008*
Morbidity	2.550	1.237-5.257	0.001*
Operative time	1.902	1.350-2.681	0.001*
Base	0.963	0.775-1.315	0.576
Suction/irrigation	1.111	0.838-1.472	0.311
Postoperative drainage	1.120	0.832-1.508	0.302
US	1.228	0.909-1.657	0.121

*Significant. OR: Odds ratio, CI: Confidence interval, BMI: Body mass index, TLC: Total leucocytic count, CRP: C-reactive protein level, PAS: Pediatric appendicitis score

Table 4: Multivariate regression analysis of predictors of postoperative collection

Variable	OR	95% CI	*P*
Age	0.857	0.597-5.631	0.328
BMI	1.931	0.297-4.392	0.219
Duration	2.051	1.965-7.256	0.012*
TLC	1.358	1.036-3.627	0.006*
PAS	0.625	0.237-2.638	0.105
Medication	0.931	0.267-4.209	0.095
Morbidity	2.064	1.259-3.637	0.041*
Operative time	2.631	1.157-8.254	0.039*

BMI: Body mass index, TLC: Total leucocytic count, PAS: Pediatric appendicitis score, OR: Odds ratio, CI: Confidence interval, *Significant

operative time >90 min led to the development of IPC. His series of patients included both simple and complex appendicitis.[10]

Several authors had highlighted the duration of symptoms before surgical intervention as a leading risk factor of both prolonged hospital stay and the development of IPC. They depended on that long history of disease would predispose to more complex pathology of appendix.[11,12]

Both TLC and CRP helped to predict complicated appendicitis in children if they were unusually shooting. As a sequence, the more elevation of both may be associated with an increased incidence of IPC. Emil reported a lower pre-operative TLC in children that did not develop post-operative collection to those that did (17.3 ± 5.3) versus (19.9 ± 6.8).[13]

On the other hand, Guy and Wysocki found that even elevated TLC when associated with post-operative IPC, should not be considered as a risk factor.[14]

During the LA series of Tartaglia, it was reported that control of mesoappendix with clipping is an important risk factor for the development of IPC. He did not explain why that happened.[15]

During the current study, the mesoappendix was controlled by monopolar cautery in all LA cases.

Lee Lee and Hong studied three different methods of controlling mesoappendix, ultrasonic energy, clipping and the use of monopolar cautery. They did not find significant differences of the incidence of IPC development.[16]

The role of operative suction or suction/irrigation is still a field of debate. In the current study, we did not find a significant relation between suction or suction/irrigation and the development of post-operative IPC. However, we recommend adequate suction before termination of the procedure.

Furthermore, Hartwich reported that there was no clinically significant correlation between suction alone and irrigation as regard wound infection or IPC development.[17]

St Peter had performed a prospective randomised trial that compared the use of at least 500 mL irrigation with normal saline versus suction alone in 220 children with complicated mainly perforated appendicitis. The study reported no difference in the rate or location of IPC.[18]

Furthermore, the current results are near to that of Snow and his team. They tailored a randomised controlled trial to study the effect of suction and irrigation on the development IPC and found that its rate was equivalent between groups treated with peritoneal irrigation and suction-only techniques.[19]

These studies explained that irrigation had a negative effect on the defense mechanism of the peritoneal cavity. This may be caused by the removal of opsonins and impairing the function of present macrophages. In addition, irrigation and suction increased the overall operative time.[18]

This study reported that children with pre-operative co-morbidity were associated with high incidence of post-operative IPC.

According to the American Society of Anesthesiologists (ASA) stated that class III or greater was associated with increased 30-day post-operative morbidity following appendicectomy.[20]

However, on the other hand, according to Guy and Wysocki, ASA was not associated with increased risk of peritoneal abscess in their study.[14]

The routine use of a surgical drain post-operatively has not been proven to improve outcomes and the exact impact on the risk of post-operative remains unclear. Studies by Allemann and Narci reported that the use of drains at operation increased abscess formation and therefore were not recommended.[21,22]

The results of the current study showed that peritoneal drains were inserted in 8/19 in Group A and in 18/56 in Group B patients with no remarkable difference and no significant advantage as well.

The main limitation of this study was the need to expand it among different tertiary centres and increase the number of children subjected to LA due to complex appendicitis.

Conclusion

Post-operative IPC is quite common after LA for complicated appendicitis. Increased TLC, prolonged symptoms duration, associated co-morbidity and operative time could be predictors of its occurrence. Improving general condition, surgical technique and reducing operative time help to reduce its incidence.

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Conflicts of interest

There are no conflicts of interest.

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