Pediatric appendectomy in developing countries: How does it differ from international experience?

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1. Introduction

Acute appendicitis is one of the most common causes for hospitalization in pediatrics and adolescents [1]. Approximately 30% of appendicitis cases in the pediatric population are complicated [2]. Open appendectomy (OA) was originally described by McBurney [3]. Since the introduction of laparoscopy, this appendectomy was progressively increasingly carried out by the minimal invasive approach, which was first introduced by Semm in 1983 [4].

In the adult population, it was demonstrated that there is a benefit of laparoscopic appendectomy (LA) compared to OA in reducing the incidence of surgical site infection (SSI) and length of hospital stay (LOS). However, LA was associated with higher rates of intra-abdominal abscesses (IAA), longer operative timing, and higher costs than OA [5].

In the pediatric population, it was found that in complicated appendicitis (CA), LA was superior to OA in reducing postoperative complications, wound infections, and LOS, but it was associated with an increased risk of IAA and increased operative timing (OT). No evidence of statistically significant difference was seen between the two approaches [5].

In this article, we present our experience in appendectomy in Lebanon, a developing low-to-middle-income country. We analyzed the differences between OA and LA approaches according to our experience, and we compared our results with those of international ones.

2. Material and method

A single-center, retrospective study was carried out. The medical charts of patients below the age of 15 years who underwent appendectomy during the 7-year period (2010–2016) in one...
With a re-evaluation appointment reserved after 12 h patients were either admitted for close monitoring or discharged. In cases of persistence of doubt, attenuated-dose abdomino-pelvic CT scan with intravenous contrast injection was performed. In cases when the diagnosis was still questionable, an experience. Abdominal ultrasound was a choice of surgical approach depended only on the on-call surgeon's experience. Abdominal ultrasound was a first-line imaging modality. In cases when the diagnosis was still questionable, an attenuated-dose abdomino-pelvic CT scan with intravenous contrast injection was performed. In cases of persistence of doubt, patients were either admitted for close monitoring or discharged with a re-evaluation appointment reserved after 12 h – the choice depended on the ease of access to the hospital. Once the diagnosis of acute appendicitis was made, all patients were started on IV antibiotics. In the absence of signs and symptoms of peritonitis, and in patients who were diagnosed after midnight, the operation would be performed the next day; otherwise, the case was labeled as urgent. Operative time (OT) was calculated from the induction of anesthesia until closure of the wound.

In the OA approach, a rocky Davis incision was made with the muscle-sparing approach. Cultures were taken from peritoneal fluid. The cecum was delivered outside the wound, and double ligation of appendicular base was done. Appendectomy was routinely followed by coagulation of the appendicular stump mucosa. Peritoneal toileting was always done. The abdominal wall was closed in layers with profuse wound irrigation. The subcutaneous tissue was closed by 2–3 separate sutures, and the skin was closed by either several separate sutures over an antibiotic-impregnated mesh – bactigras – in cases of gross contamination or by subcuticular running suture, otherwise. Bactigras usage is an off-label usage, and not supported by research evidence. Daily dressing changing started on the second operative day if indicated. In cases where a mesh was used, it was progressively retrieved to allow for secondary healing to take place.

In the LA, after insertion of a Foley catheter in the bladder, a trans-umbilical 10 mm trocar was inserted by the OA technique and one 5 mm trocar by the LLQ. After inspection of the peritoneal cavity. It drains the cul-de-sac de Douglas along with/without the right paracolic gutter and exiting through an RLQ stab incision. If another one is needed – in cases of generalized peritonitis – it usually drains the left paracolic gutter and exists through an LLQ stab wound. All patients resumed feeding and started ambulation 24 h postoperatively.

All patients underwent our hospital’s antibiotics protocol, which involves administering intravenous antibiotics for 3 days. In simple nCA, no more antibiotics were given. In complicated cases, however, administration of antibiotics for a total of 5 days was prescribed. Patients with generalized peritonitis were given antibiotics for 7 days. In cases of nCA, the choice was augmentin. In cases of CA, the choice was ceftriaxone/gentamicin, and metronidazole. An antibiotic regimen was adapted according to each patient’s evolution and with regard to peritoneal culture results. A switch toward antibiotics perOS was made as soon as the patient resumed his/her peristalsism.

OT, LOS, SSI (adjusted to BMI), IAA, and reoperation rate were compared in both groups. BMI was not matched to patient age. Our results were compared to those reported in the literature. Descriptive and bivariate analyses were carried out using SPSS® version 20. P values of less than 0.05 were considered statistically significant. P values for categorical data were calculated using chi-square or Fisher’s exact test, and those for continuous data were calculated with Student’s t-test or one-way ANOVA in case of more than 2 categories.

### Table 1
Patients’ characteristics in the laparoscopic appendectomy and open appendectomy groups.

| Characteristic       | LAP (32 patients) | Open (52 patients) | P value |
|----------------------|--------------------|---------------------|---------|
| Gender               | Male               | Female              |         |
|                      | 18                 | 14                  | .11     |
|                      | 56.3%              | 43.8%               |         |
|                      | 38                 | 14                  |         |
|                      | 73.1%              | 26.9%               |         |
| Age (year)           | Mean (SD)          | 18                  | 56.3%   | .49     |
|                      | 10.1 (3.2)         | 9.5 (3.7)           |         |
|                      | Mean (SD)          | 20 (5.8)            | 18.5 (3.1) | .19     |
|                      | 0.5 (0.8)          | 0.5 (0.8)           |         |
| Duration of symptoms (days) Mean (SD) | 01 | 0 | .15 |
|                      | 3.1%               | 0                   |         |
| Intraoperative grading | nCA                | 19                  | 24      | .15     |
|                      | 59.4%              | 46.2%               |         |
|                      | CA                 | 12                  | 28      | .69     |
|                      | 37.5%              | 53.9%               |         |

University hospital were reviewed. We divided the patients into two groups: group 1 included all the patients who underwent OA, and group 2 included all the patients who underwent LA. No interval appendectomies were performed. Three surgeons were involved. All the OAs were performed by one surgeon (A). All the LAs were carried out by one of the other two surgeons (B, C). The choice of surgical approach depended only on the on-call surgeon’s experience. Abdominal ultrasound was a first-line imaging modality. In cases when the diagnosis was still questionable, an attenuated-dose abdomino-pelvic CT scan with intravenous contrast injection was performed. In cases of persistence of doubt, patients were either admitted for close monitoring or discharged with a re-evaluation appointment reserved after 12 h – the choice depended on the ease of access to the hospital. Once the diagnosis of acute appendicitis was made, all patients were started on IV antibiotics. In the absence of signs and symptoms of peritonitis, and in patients who were diagnosed after midnight, the operation would be performed the next day; otherwise, the case was labeled as urgent. Operative time (OT) was calculated from the induction of anesthesia until closure of the wound.

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### 3. Results

Eighty-four patients were included. All patients were operated within 24 h of surgical consultation.

### Table 2
Comparison of the two groups regarding LOS, OT, incidence of IAA, and re-intervention rate.

| Criterion       | Group 1 | Group 2 | P value |
|-----------------|---------|---------|---------|
| LOS (days)      | 4.6±2.6 | 4.4±2.51 | 0.74    |
| OT (minutes)    | 75.1±31.99 | 85±29.58 | 0.16    |
| OT in CA        | 75±36.79 | 85.91±32.77 | 0.39    |
| OT in nCA       | 79.2±26.35 | 85.79±28.73 | 0.21    |
| IAA             | 1       | 3       | 0.15    |
| Re-intervention rate | 1   | 1       | 1       |
We found that both groups were similar with regard to gender, age, duration of symptoms, and BMI. Moreover, the distribution of CA and nCA cases between the two groups was similar as shown in Table 1.

OT in both groups was similar. Even when adjusting for CA and nCA, there was no difference between the groups. The same was applied to LOS.

Out the 84 patients studied, 4 (4.8%) developed deep intra-abdominal abscesses postoperatively. The incidence of deep abscess formation was 3 times higher after LA versus OA; however, this was not statistically significant.

The re-intervention rate (re-operation or by interventional radiology) was also found to be similar; however, the etiology differed. In the OA group, the reason was small bowel obstruction due to adhesions, while it was IAA in the LA group as summarized in Table 2.

OA was associated with statistically significant higher rate of SSI compared to LA. However, higher BMI was not a risk factor. The results are summarized in Table 3.

No per-/postoperative bleeding was encountered; no bowel injury and no conversion occurred.

4. Discussion

Appendicitis is one of the most common causes of abdominal pain, with lifetime risk of approximately 8% [6]. It was first approached by McBurney’s incision; then with the advent of laparoscopy, the minimally invasive approach in the early 1980s started to be utilized. Currently, with more experience and advancement in minimally invasive surgeries, single trocar appendectomy is also being performed [7].

When studying the OT, Aziz et al. found no difference between OA and LA, although they did not differentiate between CA and nCA cases [12]. Others had found that a longer OT was associated with the LA approach [15], especially in CA cases [5]. In our setting, OT was similar between the groups even when considering the complication level. This is possibly because the OAs were performed frequently by surgeons during training, while in laparoscopy cases, less tolerance was noted and a senior surgeon rapidly interfered taking into consideration the training curve.

Regarding LOS, international results are contradictory. While some studies that demonstrated LA have a significantly shorter LOS than OA, for both CA and nCA [5,9–11], other studies showed no difference [15] as in our series. The reason underlying the shorter LOS in laparoscopic surgery is that it has a faster recovery, faster mobilization, less ileus, and less pain [12]. Although this is evident in prolonged and complex surgeries, in appendectomies, patients have a very fast recovery regardless of the approach, and their stay is determined by the duration of intravenous antibiotics needed [13]. In our series, the prolonged and probably excessive antibiotic protocols that we use might be a reason for similar LOS in the two groups. Another factor for a long LOS in both groups was the presence of drainage, which might delay patient mobilization, delay the peristalsism, and prolong the duration of pain and the need for painkillers.

In a Cochrane review of LA versus OA surgery for suspected appendicitis, a higher incidence of intra-abdominal abscess was described following laparoscopy, with OR = 2.48 (95% CI 1.45–4.21) [16]. Although, in our practice, the rate of IAA was higher in LA, it was not statistically significant. This might be due to our aggressive lavage in cases of peritonitis.

When studying the rate of SSI post-appendectomy, one meta-analysis showed that LA is associated with a statistically significant less incidence of SSI than OA [12,15]. However, this advantage was later proven to be only in cases of CA [5]. In our series, there was a significantly less incidence of SSI in LA that in OA, with no influence of severity degree. This is most likely related to the degree of wound contamination during the surgery.

BMI is not an independent factor for the development of SSI post-appendectomy. This finding is contradictory to those reported in many studies in the adult population, where elevated BMI was a bad prognostic factor [17], knowing that in the adult population this might be associated with comorbidities – such as hypertension, insulin resistance, diabetes, and dyslipidemia – that could contribute to higher infectious complications.

An important limitation to our study is the small patient number. Because of the subtle differences in the outcome and complications between all the approaches, the gold standard technique and the superiority are not established yet [8], spotlighting the importance of studying a large population [12].

5. Conclusion

In a low-to-middle-income country, in the pediatric age group, LA seems to be superior to OA only in terms of reducing SSI. This is similar to the findings concluded in other international studies. Despite this and because of the absence of large randomized clinical trials, it is difficult to define the gold standard technique to manage appendicitis.

4.2.1 Table 3

| Approach | SSI | Total | P value | SSI prevalence in each group according to BMI | SSI prevalence in each group according to disease severity, irrespective of BMI |
|----------|-----|-------|---------|---------------------------------------------|--------------------------------------------------------------------------------|
|          | No  | Yes   |         |                                             |                                                                                 |
| Open     | 24  | 14    | 38      | 0.05                                        |                                                                                 |
| LAP      | 23  | 4     | 27      |                                             |                                                                                 |
|          |     |       |         |                                             |                                                                                 |
|          |     |       |         |                                             |                                                                                 |

Abbreviations

OA: open appendectomy; LA: laparoscopic appendectomy; CA: complicated appendicitis; nCA: noncomplicated appendicitis; IAA: intra-abdominal abscess; SSI: surgical site infection; LOS: length of hospital stay, OT: operative time.

Conflicts of interest

There is no conflict of interest to be declared by any of the authors.
Ethical approval

This is a retrospective study. No informed consent was needed. No unethical actions were undertaken. The variable techniques is dependent on surgeon experience.

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