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Comparison of intraabdominal abscess formation after laparoscopic and open appendicectomies in children

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Abstract
Aim: Although laparoscopic appendicectomy (LA) is an accepted alternative to the open appendicectomy (OA) approach, it has been suggested that there is a higher incidence of intraabdominal abscesses (IAAs). Our aim was to determine the incidence of IAA in 3 pediatric surgical centers routinely practicing both techniques.
Methods: Data were collected retrospectively for pediatric patients undergoing LA or OA over an 8-year period. Analysis included IAA formation, appendicitis complexity, radiologic/histologic investigations, grade of surgeon, and wound infection.
Main Results: A total of 1267 appendicectomies were performed (514 LAs and 753 OAs). There was no difference between the incidences of IAA (LA, 3.9% [19/491] vs OA, 3.9% [28/714]; $P = 1.0$). The incidence of IAA was increased in those with complicated appendicitis (34/375 [9.1%] vs 13/830 [1.6%]; $P \leq .0001$). There was an increased proportion of those with complicated appendicitis in the LA group (182/491 [37.1%] vs 193/714 [27.0%]; $P = .0002$). Surgical trainees were more likely to be the primary surgeon in the OA group (79% vs 63%; $P = .0001$), although the incidence of IAA did not correlate with grade of surgeon. There was no significant difference in incidence of wound infection between groups (LA, 4.6% [8/173] vs OA, 2.5% [18/377]; $P = .93$).
Conclusion: This large retrospective study shows that the technique of appendicectomy does not appear to affect the incidence of IAAs. Patients with complicated appendicitis are more likely to develop an IAA regardless of technique.

Open appendicectomy (OA) has been successfully performed for acute appendicitis since the late 19th century [1]. However, the alternative, laparoscopic appendicectomy (LA), has now become popular in many pediatric surgical centers [2-7], although the relative risks and benefits are still the subject of ongoing debate. A recent Cochrane review

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comparing the 2 techniques found that although the incidence of wound infection is reduced with the laparoscopic technique, this was at the cost of an increased rate of intraabdominal abscess (IAA) formation [5].

One shortcoming of the Cochrane review was its reliance on the outcome of primarily adult patients. The question arises, therefore, whether a child-only study population would yield the same or different results. A previous study has been reported that showed no difference in the incidence of IAA or wound infection in a sample of 200 pediatric patients from one of our centers after OA or LA [8].

The aim of this study was to compare the outcome of LA and OA in a larger pediatric population to determine whether the incidence of postoperative complications is related to the modality of appendicectomy. The primary outcome measure was IAA formation. Wound infection was a secondary outcome.

1. Methods

A retrospective review was performed of consecutive pediatric patients (<18 years) undergoing operative treatment of appendicitis at 3 pediatric surgical institutions over a collective 8-year period. This occurred between January 2003 and July 2010 with the data collection period varying between centers (center 1, January 2005 to July 2010; center 2, August 2006 to February 2009; and center 3, January 2002 to June 2010). The 200 pediatric patients from center 1 who were included in an initial study between February 2006 and April 2008 were included in the current study [8].

Ethical approval was obtained for the study from the relevant research departments. Data were collected from medical records, operating theater records, and the hospital-coded database. All pediatric patients who underwent an appendicectomy in the center-specific period of the study were included. Patients who underwent either an interval or an incidental appendicectomy were excluded from final analysis.

The operative technique used was determined by the preferences of the surgical consultant responsible for the admission. A total of 10 consultants experienced in both OA and LA contributed patients to the study. The practices for both open and laparoscopic techniques were comparable in all 3 centers.

Patient data were analyzed primarily for the incidence of an IAA and the operative modality. Patients were analyzed using their initial intention-to-treat operative modality. Secondary variables included sex, age at operation, length of hospital stay, wound infection, presence of complicated appendicitis, conversion rates, the grade of the primary surgeon, and the histologic assessment.

Operative intervention occurred only once the patient had been appropriately resuscitated and a dose of preoperative intravenous antibiotics had been administered.

Laparoscopic appendicectomies were performed with a standard 3-trocar technique. The umbilical port was inserted using the open Hasson technique. Once a pneumoperitoneum was established, the additional ports were inserted under direct vision. Mesoappendix division was achieved with diathermy dissection; endoscopic snare ligatures (eg, Endoloops) were used for the appendicectomy, and care was taken to ensure no unrecognized release of a faecolith. Appendicectomies via the open technique were performed using a modified Lanz incision; the appendiceal base was transfixed and at times buried according to surgeon preference. All patients with intraabdominal pus received a thorough washout of warmed saline. Variable amounts were used depending on the age of the patient and the degree of peritoneal contamination, and the washout was continued until the returned irrigation fluid was clear.

All patients with macroscopic appendicitis, irrespective of operative technique, received postoperative antibiotic therapy. Patients with mild appendiceal inflammation received 24 hours of single intravenous antibiotic therapy. Patients with complicated appendicitis received 3 to 5 days of broad-spectrum intravenous antibiotic therapy. The antibiotics used depended on the individual center's microbiological protocol. Discharge criteria were identical for LA and OA patients, for example, reestablishment of enteral feeds, comfort with mobilization, and apyrexia for more than 24 hours. All wounds were examined before discharge. Investigation of persisting postoperative pyrexia included an abdominal ultrasound. An *IAA* was defined as recorded pyrexia, raised inflammatory marker, and a positive radiologic or operative confirmation of an intraabdominal collection after a minimum of 5 days postoperatively. A *wound infection* was defined as purulent wound discharge associated with localized pain and swelling, with or without positive microbiological analysis. Subset analyses were performed for patients with complicated appendicitis. Complicated appendicitis was defined by the presence of necrosis or perforation on histology with correlation of intraoperative findings such as free intraperitoneal pus or an inflammatory mass. Data analysis used a Fisher's Exact, χ^2, or Mann-Whitney U test, as appropriate. $P < .05$ was considered significant.

2. Results

During the periods of study, 1267 children underwent an appendectomy at the 3 institutions. Those with incidental or interval appendicectomy (n = 62) were excluded from further analysis, leaving 1205 operations for acute appendicitis (LA, n = 491; OA, n = 714). There was no significant difference between the demographic details of the other 2 groups, except for a lower mean age at time of operation in the OA (10.9 vs 11.6; $P = .002$) (Table 1). Primary surgeon data were available for 855 (71%) of 1205 of the cohort,

Table 1 Preoperative demographics (n = 1205)

Demographic	Laparoscopic (%) (n = 491)	Open (%) (n = 714)	*P*
Male	271	430	.09
Female	220	284	
Age (y)	11.6 (1-18) [a]	10.9 (1-18)	.002
Hospital stay (d)	3 (1-31) [b]	3 (1-48)	.73

[a] Mean (range).
[b] Median (range).

and a surgical trainee was more likely to be the primary surgeon in the OA group (79% vs 63%; *P* = .0001).

Conversion to an open procedure occurred in 8 (1.6%) of the LA group, with most (n = 7) having complicated appendicitis. One occurred where there was concern over a possible cecal perforation, and the remainder was owing to technical difficulties.

An IAA developed in 47 children (3.9%). There was no significant difference between the groups overall (LA, 19/491 [3.9%] vs 28/714 [3.9%]; *P* = 1.0) or when analyzed by a center (Table 2). Significantly more children were investigated for a potential IAA in the OA group (53 [8.2%] vs 22 [4.7%]; *P* = .04). The median time from operation to the diagnosis of IAA was 9 days (5-13 days). Thirty-four (72%) of the IAAs resolved with conservative management and the use of broad-spectrum intravenous antibiotics. Intervention was required in 13 (28%) of children with IAA: laparoscopic drainage (n = 3), open drainage (n = 7), transrectal drainage (n = 1), and ultrasound-guided drain placement (n = 2). There was no difference in the proportion of IAAs requiring intervention between the groups (LA, 4/19 [21.1%] vs OA 9/28 [32.1%]; *P* = .5). There was no association between grade of surgeon and development of IAA (6/247 [consultant] vs 15/608 [surgical trainee]; *P* = .97).

Complicated appendicitis at time of surgery (n = 375) was more common in children undergoing LA than OA (182 [37.1%] vs 193 [27%]; *P* = .0002). They were more likely to develop an IAA compared with those presenting with uncomplicated appendicitis (34 [9.1%] vs 13 [1.6%]; *P* < .0001). This relationship was observed in both operative groups (LA: 8.2% vs 1.3%, *P* = .0003; and OA: 9.8% vs 1.7%, *P* = .0001) (Fig. 1).

There was no significant difference between the incidences of wound infections in either group; however, because of different follow-up practices from the individual centers, this subset analysis only included 550 (45.6%) of 1205 of patients (LA, 8/173 [4.6%] vs OA, 18/377 [2.5%]; *P* = .93). This difference did not influence the IAA detection. Other postoperative complications observed included small bowel obstruction (n = 10, or 0.8%), hydrosalpinx (n = 1, or 0.1%), chest infection (n = 1, or 0.1%), urinary retention requiring catheterization (n = 2, or 0.2%), and urinary tract infections (n = 1, or 0.1%).

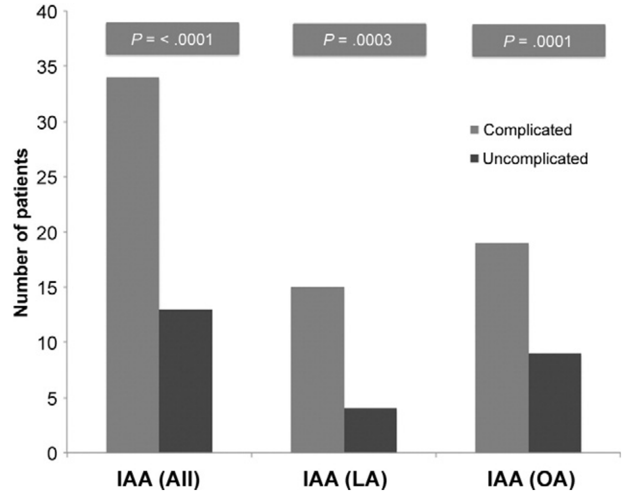

Fig. 1 Incidence of IAA by operation (LA and OA) and grade of appendicitis (complicated and uncomplicated).

3. Discussion

There has been persistent concern over an apparent increase in the incidence of IAA after an LA [3,5,9]. A recent Cochrane systematic review on this issue in 2010 primarily included adult randomized, controlled trials, with only 7 of the 67 studies including children [5]. An initial study from one of our centers showed no difference in the incidence of IAA, although this conclusion was limited by a small sample size and with no IAAs occurring at all in the LA group [8]. The current study addresses this shortcoming by analyzing a much larger cohort.

We found no difference in incidence of IAA in either group, and this appeared because of a lower incidence of

Table 2 Comparison of IAA after LA and OA in individual centers

	Total no. of patients	Total IAA	LA IAA	OA IAA	LA vs OA *P* value
All centers	1205	47	19	28	1.0
Center 1	431	22	5	17	1.0
Center 2	655	19	10	9	.8
Center 3	119	6	4	2	1.0

IAA after LA compared with other published studies [10-15] and greatly decreased after OA [12-19]. This was not a randomized trial, so surgeon preference could have lead toward the use of LA in less complicated cases. However, this appeared unlikely because there was a greater proportion of complicated appendicitis in the LA group. The main factor for the development of IAA was the condition of the appendix rather than the method of its extraction. This finding was conserved on subset analysis; therefore, we conclude that the risk of IAA is not increased by treatment with LA and that complicated appendicitis may be safely treated by LA in a pediatric population [6,20,21]. We did find that more children underwent investigation for an IAA after an OA. This difference may be secondary to the benefit of increased intraperitoneal visualization with the LA technique and, therefore, increased confidence of a thorough washout.

Our previous study had shown that a surgical consultant was more likely to be the primary operator in LA compared with an OA [8]. This appears to have changed because there was an increase in surgical trainees being the primary operator, unaccompanied by an increase in the incidence of IAA. However, it is likely that consultant supervision of trainees performing laparoscopic cases is likely to be greater than that for open surgery.

The operative approach also did not influence whether an identified IAA was treated surgically; indeed, most settled with conservative management. There was also no significant difference in the incidence of postoperative wound infection between the 2 groups, although this was limited by the subset analysis. In our pediatric population, we were not able to demonstrate a difference in median hospital stay between the open or laparoscopic group. Our findings are consistent with other published studies [8,22,23]. The laparoscopic technique in an adult population has repeatedly demonstrated an earlier discharge and return to activities after LA. This may not be the case in pediatric postoperative management for appendicitis for several reasons. Postoperative antibiotics regimens and standardized analgesic regimens are 2 potential explanations and robust conclusions only possible from prospective randomized data.

This is a retrospective 3-center multinational study and is potentially subject to bias as a result. However, our data show striking consistency in outcome between the 3 centers, strengthening the validity of the conclusions drawn.

This study with its large cohort of pediatric patients shows that LA is comparable with the open technique even in the presence of complicated appendicitis. Because there was no increase in IAA formation after an LA, this technique is a safe and viable alternative to the open technique.

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