

Acceptable outcome after laparoscopic appendectomy in children

Nicolaj M. Stilling, Claus Fristrup, Torben Gabers, Niels Qvist & Lars Rasmussen

ABSTRACT

INTRODUCTION: An increasing proportion of childhood appendicitis is being treated with laparoscopic appendectomy (LA). We wanted to elucidate the outcome of childhood appendicitis treated primarily by residents in a university hospital.

MATERIAL AND METHODS: All children (age < 16 years) with appendectomy treated surgically in our department between January 2006 and January 2011 were identified retrospectively. Readmission, reoperation or post-operative length of hospital stay (LOS) exceeding five days were considered non-satisfactory outcomes.

RESULTS: A total of 390 children had an appendectomy performed. The mean age was 9.8 years, and mortality was 0.0%. The surgeon was a resident in 92% of the cases. A total of 246 (63.1%) had an LA. The rate of LA increased over the five-year period from 45% to 88% ($p = 0.01$). The conversion rate decreased from 28% to 15% ($p = 0.02$). The median post-operative LOS was one and three days for simple and complicated appendicitis, respectively. A total of 45 patients (11.5%) had a complication, 40 patients (10.3%) were readmitted, and 56 patients (14.4%) had a non-satisfactory outcome. Logistic regression found open surgery and complicated appendicitis to be associated with an increased risk of complications ($p < 0.01$).

CONCLUSION: Increased use of LA did not increase the number of patients with a non-satisfactory outcome. Residents manage this treatment at a highly professional level. Readmission due to pain and discomfort was frequent and more targeted and systematic post-operative analgesic care of our children is called for.

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TRIAL REGISTRATION: The study was submitted to ClinicalTrials.gov (NCT01657565).

Appendectomy is the most common acute abdominal surgical procedure performed on children in the Western world [1]. A non-satisfactory outcome in almost one fifth of the cases has been reported in a nationwide Danish report covering the period 2006-2007 [2]. During the past decade, there has been a trend from open towards laparoscopic surgery in children with suspected appendicitis. This trend accelerated in the years after the aforementioned study [3-5]. We therefore found it interesting to investigate whether this change has had

an impact on the frequency of complications and non-satisfactory outcomes.

MATERIAL AND METHODS

The study was retrospective. The study included all children aged 0-16 years who had undergone appendectomy in the period in our department from 1 January 2006 to 31 December 2010. Patients were divided into three periods (2006-2007, 2008-2009 and 2010) according to year of operation and into three age groups (0-5, 6-10 and 11-15 years of age). The data were identified via the Funen Patient Administrative System (FPAS) using the procedure codes for appendectomy: KJEA00, KJEA01 and KJEA10 according to the Nordic Classification of Surgical Procedures and the diagnostic codes of appendicitis: DK35.0, DK35.1, DK35.9, DK36.9 and DK37.9 according to the International Classification of Diseases (ICD) 10. Patient charts were reviewed for: gender, age, type of operation, clinical assessment of the appendix, surgeon charge and length of hospital stay (LOS). We also recorded complications such as reoperation, wound infection or intraabdominal abscess requiring treatment and readmission within 30 days of the primary operation.

A non-satisfactory outcome was defined as the presence of one or more of the following events: readmission, reoperation (including drainage of abdominal abscesses) or LOS > 5 days. Children who had an appendectomy in conjunction with another operation than suspected appendicitis were excluded from the study.

Complicated appendicitis was defined as appendicitis with localized or diffuse peritonitis or abscess. Simple appendicitis was defined as a phlegmonous or gangrenous appendicitis without abscess or visible perforation. The standard treatment for complicated appendicitis was three days of post-operative intravenous antibiotics, while simple appendicitis generally received either one single dose of perioperative antibiotics or no antibiotics at all.

The choice of operation depended solely on the individual surgeon's skills/preferences, and there was no lower age or weight limit for diagnostic laparoscopy. The operating doctor was typically a resident in the 3rd or 4th educational year, or a younger doctor under the supervision of the aforementioned.

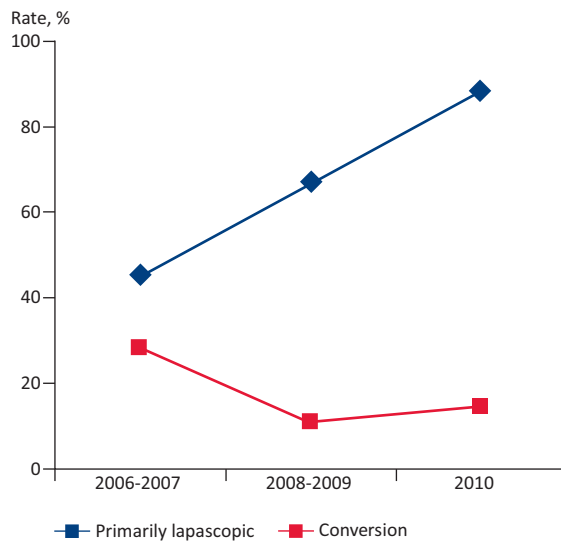
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Department of Surgery,
Odense University
Hospital

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FIGURE 1

Rate of laparoscopic appendectomy and conversion rate in three periods.



Statistical analysis

Data were analyzed using STATA v.12 and $p \leq 0.05$ was considered statistically significant. Categorical data were analyzed using χ^2 - and Fisher's exact test. Kruskal Wallis test was used for the analysis of LOS depending on categorical data. Regression or logistic regression was used for the analysis of outcomes.

Trial registration: The study was submitted to Clinical-Trials.gov (NCT01657565).

RESULTS

A total of 390 children had an appendectomy (49.5% boys and 50.5% girls). Their mean age was 9.8 years (1-15 years). Mortality was zero. A total of 144 patients were operated by means of open appendectomy (OA). Diagnostic laparoscopy (DL) with subsequent open operation (DL + OA) was performed in 42 and laparoscopic appendectomy (LA) in 204 patients.

The age distribution was as follows: 6% aged 0-5 years, 40% aged 6-10 years and 54% aged 11-15 years. A normal appendix was found in 33 (9%), simple appendicitis in 225 (58%) and complicated appendicitis in 132 (34%). Thus, there were overall 37% cases of complicated and 63% cases of simple appendicitis.

A non-specialist performed the operation in 92% and a surgical specialist performed the operation in 8% of the cases.

Type of operation

In the first period, 45% of the operations were initiated laparoscopically against 67% in the second period and 88% in the last period ($p = 0.01$). A significant decrease

($p = 0.02$) in the conversion rate from the first period to the second and third was observed. The percentages were 28%, 11% and 15%, respectively (**Figure 1**).

Age and type of operation

There was a significant difference in the choice of surgical access for the various age groups. OA was chosen in 80% of children aged 0-5 years, in 40% in children aged 6-10 years and in 15% in children aged 11-15 years ($p < 0.01$). The conversion rate from laparoscopic to OA was 27%, 21% and 15%, respectively. The difference was not significant ($p = 0.30$). The use of laparoscopic surgery increased significantly from the first to the last period in all three age-groups. The use of laparoscopic surgery increased over time for the 0-5-year group from 15% to 50% ($p = 0.02$), and from 21% to 89% ($p < 0.01$) and 73% to 100% ($p < 0.01$) for the 6-10 and 11-15-year groups, respectively.

Clinical assessment of the appendix and type of operation

A pathological appendix was removed in 82.6% of the open operations versus 97.1% in the laparoscopic group ($p < 0.01$). In general, the proportion of pathological appendix was 89.3%, 93.6% and 91.6% in the three periods, and this difference was insignificant ($p = 0.7$). The proportion of complicated appendicitis was unchanged during the three periods; 38.9%, 34.7% and 35.5%, respectively ($p = 0.75$).

OA had more perforated events than DL (40% versus 21%). A normal appendix was removed in 25 (17%) patients in the OA group; in the DL and DL + OA group, only eight (3%) normal appendixes were removed ($p < 0.01$).

Complications

A total of 45 (12%) children had one or more complications (**Table 1**). There was no difference in the number of complications over time. In the age group 0-5 years, 23.6% of the children experienced complications compared with 8.6% in the age group 6-10 years and 10.3% in the age group 11-15 years ($p < 0.01$). Overall, 40 (10%) children were readmitted and 56 (14%) had a non-satisfactory outcome. Pain or discomfort was the sole reason for readmission in 14 (35%) cases. Other causes of readmission were intraabdominal abscess ($n=10$), wound infection ($n = 9$), fever ($n = 4$) and ileus ($n = 4$) (one patient had a wound infection and an intraabdominal abscess). The proportion of patients with non-satisfactory outcome decreased over time in the three periods from 19% to 12% and to 10% (**Table 2**). The difference was insignificant ($p = 0.08$).

Complications occurred in 23% of the children with complicated appendicitis compared with only 6%, 6%



TABLE 1

Types of complication. The values are n (%).

Intraabdominal abscess	13 (3)
Wound infection	11 (2)
<i>Reoperation minus drainage</i>	
Mechanical ileus	2 (0.5)
Exploratory laparotomy without pathological findings	2 (0.5)
Total	4 (1)
Readmission	40 (10)
Patients with ≥ 1 complication	45 (12)

and 8% for normal, phlegmonous and gangrenous appendix, respectively ($p < 0.01$).

LA had a 5% risk of developing complications compared with 16% in OA and 29% in DL + OA ($p < 0.01$). The risk of complications was 9% in children who were offered laparoscopy including conversions (LA + (DL + OA) compared with 16% for the OA group ($p = 0.05$)),

Table 3.

Logistic regression analysis of complications depending on age, gender, type of surgery and clinical assessment of the appendix, revealed that OA and complicated appendicitis were associated with increased risk ($p < 0.01$). Age was not an independent risk factor.

Length of stay

The overall mean LOS was 3.2 days (1-27). For the OA 3.6 days (1-27), for the DL + OA 3.9 days (1-20) and for the LA 1.8 days (1-8). Simple and complicated appendicitis had a mean LOS of 1.5 and 4.1 days, respectively.

Linear regression analysis of LOS depending on age (in years), gender, type of surgery, clinical assessment of the appendix and complications, found complication, open surgery and the clinical assessment of the appendix to be associated with an increased LOS ($p < 0.01$).

DISCUSSION

This retrospective study represents the five past years of experience in a university hospital where the diagnostics and treatment of appendicitis is primarily handled by trainees.

The percentage of patients offered laparoscopic appendectomy rose from 45% to 88% over a five-year period. An intended laparoscopic appendectomy rate of 88% is rather high compared with other international studies in which the rate ranged from 8.4% to 70% [3, 4, 6, 7]. The conversion rate fell significantly in the same period from 28% in the first period to 11% and 15% in the two subsequent periods, respectively. Consequently, our patient material is significantly different from the former Danish nationwide register study covering the 2006-2007-period, where only 34% were operated lapa-



TABLE 2

Post-operative outcome. The values are n (%).

	Total	2006-2007	2008-2009	2010
Patients with a non-satisfactory outcome ^a	56 (14)	29 (19)	19 (12)	8 (10)
Patients with ≥ 1 complication	45 (12)	22 (15)	16 (10)	7 (8)
LOS > 5 days	19 (5)	14 (9)	4 (3)	1 (1)

LOS = post-operative length of stay.

a) Either readmission, LOS > 5 days or reoperation. None of the three outcomes changed significantly over the three periods.



TABLE 3

Complication rates. The values are n (%).

Complications	LA + (DL + OA)	OA	Total
No	224 (91.1)	121 (84)	345 (88.5)
Yes	22 (8.9)*	23 (16)*	45 (11.5)
Total	246	144	390

DL + OA = diagnostic laparoscopy with conversion to open appendectomy; LA = laparoscopic appendectomy; OA = open appendectomy.

*) $p = 0.05$.

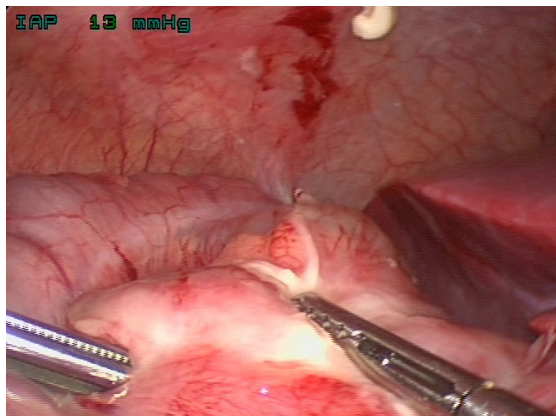
roscopically. The conversion rate was not estimated [2]. The reason for the increasing use of laparoscopy over open surgery, and the declining conversion rate is presumably rooted in a higher level of proficiency of laparoscopic surgery among the trainees on ever younger children.

Despite this increase in laparoscopic surgery on children, there was a significantly higher proportion of children in the younger age-groups who were primarily operated with OA. However, this rate seems to change over time, as the rate of OA for the 0-5-year-old children decreased to 50% in 2010. Overall, 37% had a complicated appendicitis. This is slightly higher than in a previous Danish study [2] which found complicated appendicitis in 27% of the cases, while Whisker [7] and Newman [8] found comparable rates of 37% and 36.5%, respectively. A previous Danish study also found that the proportion with complicated appendicitis increased by 22.5% for all age groups (0-19 years) in the period from 1996 to 2004, while the incidence of appendicitis in all age groups declined by 27.1% over the same period [9]. We demonstrated no significant development in the rate of complicated appendicitis over this five-year period.

The observed difference in healthy appendixes between the age groups is probably due to the increased frequency of laparoscopic appendectomy among children in the older groups.

It is unclear why more than half of the children in the youngest group had a complicated appendicitis.

Three-year-old with perforated appendicitis. 5 mm optics.



The mean LOS was among the lowest reported [2, 10, 11] for both simple (1.5 days) and complicated appendicitis (4.1 days). The standard antibiotic regimen for complicated appendicitis is three days of intravenous antibiotics. This in itself contributes to an increased LOS in this group.

The proportion of patients in this study with a non-satisfactory outcome (readmissions, reoperation or LOS > 5 days) was 14%. This is relatively high compared with other studies, especially in terms of complications, where others have found a complication rate below 5% [12]. However, the non-satisfactory outcome rate is slightly lower than the 18% rate reported in the previous Danish study [2].

We observed a decrease in the number of patients with non-satisfactory outcome over the period from 19% to 10%, although this decline was insignificant. This might be owed to an increased use of LA, since we found OA to be associated with a non-satisfactory outcome.

A readmission rate of 10% is relatively high compared with the 0-10% reported in other studies [8, 12]. The latter study included only those aged 6-15 years, which in itself contributes to fewer complications because of the higher incidence of perforated appendicitis among the 0-5 year-olds. The somewhat higher readmission rate may be due to our general practice about discharging children with simple appendicitis after one day and complicated appendicitis after three days. Pain and malaise were the most frequent reasons for a non-satisfactory outcome.

There was, however, a huge difference, since a non-satisfactory outcome was seen in almost every third child with complicated appendicitis, but only in every 14th child with simple appendicitis. Thus, pain and discomfort were the direct and sole cause of 35% of the readmissions. Almond [13] showed that the readmission rate could be reduced from 10% to 4.2% simply by standardizing pre- and post-operative treatment (especially analgesic treatment) in children with appendicitis.

The retrospective design of the present study is a limitation. Especially the missing data regarding the choice of operative access and the decision on length of antibiotics treatment could give rise to bias.

CONCLUSION

This retrospective study shows that the change in the treatment of children with appendicitis from open to laparoscopic operation did not increase the number of patients with a non-satisfactory outcome. Trainee doctors manage this treatment at a highly professional level.

Readmission due to pain and discomfort was frequent and more targeted and systematic post-operative analgesic care of our children is called for.

CORRESPONDENCE: Nicolaj M. Stilling, Gastrokirurgisk Afdeling, Odense University Hospital, 5000 Odense, Denmark. E-mail: nicolajstilling@gmail.com

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