The influence of age, duration of symptoms and duration of operation on outcome after appendicitis in children

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ABSTRACT

INTRODUCTION: The aim of the study was to evaluate the impact of any perioperative parameters on the outcome of treatment for appendicitis.

MATERIAL AND METHODS: The study included 108 consecutive children with appendicitis. Data were retrieved from files using the codes for appendectomy of the Nordic Classification of Surgical Procedures and the diagnosis codes for appendicitis from the International Classification of Diseases (ICD) 10. A non-satisfactory outcome was defined as a post-operative length of stay in hospital ≥ 5 days and/or readmission due to complications.

RESULTS: Significantly more patients with a non-satisfactory outcome had complicated appendicitis (73%) compared with those with a satisfactory outcome (25%). A total of 78% of children < 6 years and 44% of children > 10 years had a non-satisfactory outcome. The duration of symptoms before operation was mean 2.8 days for children with a non-satisfactory outcome and 2.7 days for those with complicated appendicitis compared with 1.5 days for children with a satisfactory outcome and 1.6 days for those with simple appendicitis. The median difference was two days in the younger patients. Surgical time was significantly shorter in the group of patients with a satisfactory outcome and in those with simple appendicitis than in the other groups.

CONCLUSION: Complicated appendicitis and a non-satisfactory outcome in children after operation are associated with a long preoperative duration of symptoms, young age and long surgical time. A cut-off age has not been established, but young children might benefit from direct referral and access to hospitalization in a regional or tertiary paediatric surgical centre.

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Appendectomy for appendicitis is one of the most common paediatric emergency surgical procedures. A Danish study showed that the incidence of appendicitis declined by 27% in the 1996–2004-period [1]. Several other studies also found a decline in acute appendicitis and appendectomy rates [2-4], while others reported constant levels [5, 6]. In the Danish study, the incidence of complicated appendicitis declined by only 10%. So, the relative fraction of patients having complicated appendicitis was increasing. Another study showed that almost 20% of Danish children had a non-satisfactory outcome after appendectomy in the 2006-2007 period [7]. The rate of complicated appendicitis was 27% in that study, but nearly half of the patients with a non-satisfactory outcome had simple appendicitis [7]. The reason for this high rate of non-satisfactory outcome is not fully understood. Young age is a well-known risk factor for complicated appendicitis [7-9]. The aim of this study was to evaluate if other parameters related to perioperative care have an impact on treatment outcomes.

MATERIAL AND METHODS

This was a retrospective study including children aged 0-16 years who were treated due to suspected appendicitis in the 2007–2011-period. Patient data were retrieved from their files using the Nordic classification procedure codes for appendectomy: KJEA00, KJEA01 and KJEA10 and the International Classification of Diseases (ICD) 10 diagnosis codes for appendicitis: DK35.0, DK35.1, DK35.9, DK36.9 and DK 37.9. Furthermore, records of all readmissions within 30 days of the primary operation were retrieved. A non-satisfactory outcome was defined as a post-operative length of stay in hospital (post-operative length of stay (LOS)) ≥ 5 days and/or readmission due to complications within the first post-operative month. Based on the conclusion of the surgeons' report, appendicitis was defined as complicated if the appendix was gangrenous, perforated or had a periappendicular abscess. The patients were stratified into three age groups (**Table 1** and **Table 2**). A single dose of prophylactic antibiotics (cefuroxime/metronidazol) was administered intravenously before surgery in simple appendicitis. Preoperative administration of cefuroxime/metronidazol was followed by daily intravenous administration for 3-5 days only in cases of complicated appendicitis according to the preference of the surgeon or microbiologist.

Non-parametric statistical analysis was conducted as appropriate (Mann-Whitney test, Spearman test and Fischer's exact test). Significance for all statistical tests was considered at 5%.

Trial registration: not relevant.

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TABLE 1

Satisfactory and non-satisfactory outcome after appendectomy in children.

	Satisfactory (N = 60)	Non-satisfactory (N = 48)	p-value
Readmissions, n (% of total 108 patients)	0	18 (16.7)	
Age, years, median (range)	10 (3-15)	9.5 (0-16)	0.275
Age groups, n			
0-5 yrs	4	14	0.0035
6-10 yrs	29	13	0.0297
11-16 yrs	27	21	1
Total LOS, days, median (range)	2 (1-5)	7 (5-67)	< 0.001
Post-operative LOS, days, median (range)			
0-5 yrs	2 (1-4)	6 (2-11)	NA
6-10 yrs	2 (1-4)	6 (1-11)	NA
11-16 yrs	2 (1-4)	8 (1-67)	NA
Total	2 (1-4)	6 (5-67)	NA
Symptoms duration before surgery, days, median (range)			
0-5 yrs	1 (1-6)	3 (1-9)[a]	0.327
6-10 yrs	1 (0.5-3.5)	4 (0.5-7)[a]	0.0039
11-16 yrs	1 (0.5-4)	2 (0-7)[a]	0.373
Total	1 (0.5-6)	2 (0.5-7)	< 0.001
Contact before final hospitalization and treatment total, n (%)			
Unknown	6	1	
Paediatric emergency ward	23 (38)	25 (52)	0.176
Private physician on call	36 (60)	26 (54)	0.563
Hospitalised somewhere else	5 (8)	16 (33)	0.001
Hospitalised in own ward	0 (0)	5 (10)	0.015
Hospitalised in total	5 (8)	21 (44)	< 0.0001

LOS = length of stay; NA = not applicable.
a) Spearman test showed that preoperative duration of symptoms was negatively correlated with age at surgery ($p < 0.05$).

TABLE 2

Simple and complicated appendicitis.

	Simple (N = 58)	Complicated[a] (N = 50)	p-value
Age, years, median (range)	10 (0-16)	9.5 (1-15)	0.489
Age groups, n			
0-5 yrs	7	11	0.2[c]
6-10 yrs	23	19	
11-16 yrs	28	20	
Total LOS, days, median (range)	2 (1-14)	6 (1-67)	< 0.001
Post-operative LOS, days, median (range)			
0-5 yrs	4 (1-6)	7 (1-11)	0.035
6-10 yrs	2 (1-4)	5 (1-11)	0.0001
11-16 yrs	2 (1-14)	6 (1-67)	0.020
Total	2 (1-14)	6 (1-67)	< 0.001
Symptom duration, days, median (range)			
0-5 yrs	1 (1-5)	3 (1-9)[b]	0.085
6-10 yrs	1 (0.5-4)	1.75 (0.5-7)[b]	0.018
1-16 yrs	1 (0.5-4)	1.5 (0-7)[b]	0.376
Total	1 (0.5-4)	2 (0-7)	

LOS = length of stay.
a) Gangrenous/perforated/periappendicular abscess; b) Spearman test showed that preoperative duration of symptoms was negatively correlated with age at surgery ($p < 0.05$); c) 0-5 years versus 6-16 years.

RESULTS

We excluded 16 children whose primary operation was performed in another surgical department before the children were referred to our centre for treatment of complications. The evaluated material includes 108 children (51 boys and 57 girls) aged 0-16 years. For the total group of patients, the mean total LOS and the mean post-operative LOS were 5.1 and 4.8 days, respectively. Table 1 shows LOS in relation to the patient's age in cases with a satisfactory and a non-satisfactory outcome. A total of 50 (46.3%) of the children had complicated appendicitis including two patients with periappendicular abscess in whom primary ultrasound-guided percutaneous drainage was performed (Table 2).

None of the patients with a post-operative LOS ≥ 5 days but no re-admission had a post-operative abscess, deep wound infection or other serious complications. Fifty-eight children had open surgery and 45 children had a laparoscopic appendectomy, which was converted into open surgery in three cases. The mean surgical time from the first incision to the last suture was 57 minutes for all surgical procedures; the two cases with ultrasound-guided percutaneous drainage were excluded from this measure. The surgical time related to the type of outcome and the type of appendicitis is shown in **Table 3**. Significantly more patients had complicated appendicitis (73% (35/48)) in the group with a non-satisfactory outcome than in the group with a satisfactory outcome (25% (15/60)) ($p < 0.0001$).

Among the patients with complicated appendicitis, 31 had a gangrenous appendicitis, 17 patients had a perforated appendicitis and two had a periappendicular abscess. Among the 58 patients with simple appendicitis, five had a normal histology. Two of those patients were re-admitted and diagnosed with salpingitis and Meckel diverticulitis and were therefore included in the group with a non-satisfactory outcome. In all, 48 patients had a non-satisfactory outcome (Table 1). Five of these patients had a post-operative LOS = 5 days. Eighteen patients had re-admissions, eight of whom also had a post-operative LOS ≥ 5 days. The causes for re-admissions included fever, abdominal pain, vomiting, suspected abscess but only two verified (14 patients), pneumonia (two patients), change in prolonged antibiotic therapy (one patient) and deep wound infection (one patient).

Children belonging to the younger age group had a higher share of non-satisfactory outcomes (78% (14/18)) than the older age group (44% (21/48)) ($p < 0.05$) (Table 1). The duration of symptoms before admittance to the final hospitalisation with operation and diagnosis in our department was mean 2.8 days for children with a non-satisfactory outcome and mean 2.7 days for those with complicated appendicitis compared with 1.5 days for children with a satisfactory outcome and 1.6 days for

TABLE 3

Surgical circumstances for satisfactory/non-satisfactory and simple/complicated appendicitis.

	Outcome			Appendicitis		
	satisfactory (N = 60)	non-satisfactory (N = 48[a])	p-value	simple (N = 58)	complicated[c] (N = 50[a])	p-value
Operation, n			0.69			0.84
Open	36	25		34	27	
Laparoscopic	24	21		24	21	
Surgeon, n			0.01			0.42
Specialist	28	33		32	29	
Non-specialist	32	13		26	19	
Surgical time, min., median (range)						
Open	42 (19-136)	55.5 (20-112)	0.006	42 (19-136)	50 (20-112)	0.015
Laparoscopic	47.5 (31-113)	75 (35-125)	0.007	59 (34-103)	60 (36-125)	0.387
Total	45.5 (19-136	65 (20-125)	< 0.001	46 (19-136)	60 (20-125)	0.019
Surgical time, min., median (range)						
Specialist	39 (20-136)[b]	65 (20-112)	< 0.001	45.5 (19-136)	60 (20-125)	0.033
Non-specialist	50 (25-113)[b]	60.5 (42-93)	0.105	50 (25-113)	57 (36-102)	0.196

a) Two patients with ultrasound-guided percutaneous abscess drainage are not included in the calculations.
b) Mann-Whitney test showed that the surgical time for a specialist was significantly shorter than that of a non-specialist in this specific group (p = 0.048).
c) Gangrenous/perforated/periappendicaular abscess.

those with simple appendicitis (Table 1 and Table 2). A significantly larger proportion of children had been hospitalised but discharged prior to the final hospitalisation with surgery in the group with a non-satisfactory outcome than in the group with a satisfactory outcome ($p < 0.01$) (Table 1). When finally admitted to the ward for surgery, there was no difference in delay to surgery between the group with a satisfactory outcome (median: 6.5 hours) and the group with a non-satisfactory outcome (median: 7 hours) ($p = 0.701$). Surgical time was significantly shorter in the group of patients with a satisfactory outcome and those with simple appendicitis than in children with a non-satisfactory outcome and those with complicated appendicitis ($p < 0.05$) (Table 3). There was no difference between the patients who had open surgery and those in whom laparoscopic surgery was performed in respect of whether they had a satisfactory or a non-satisfactory outcome (Table 3). Data on whether the operation was performed by a fellow or specialist surgeon are presented in Table 3.

DISCUSSION

Our study showed that age younger than ten years, long duration of symptoms before admittance to the final hospitalisation with operation and a long surgical time increased the risk of a non-satisfactory outcome after operation for clinical appendicitis. These factors seem to be related. We believe that it is reasonable to aim for less than a five-day post-operative stay at the surgery ward in otherwise healthy children seeking the health care system with symptoms related to appendicitis, though it could be a high-set goal for satisfactory outcome. Our results showed that 44% of our patients had a non-satisfactory outcome, which is higher than the 18% recently published by Johansen et al [7]. In the latter study, the cut-off for a non-satisfactory outcome was set at six days; when corrected for this difference, 40% of our patients would still have a non-satisfactory outcome. Our patients were mean 1.5 years younger than the children in the study by Johansen et al [7], and this may partly explain the difference because young age seems to increase the risk of a longer post-operative LOS. No serious conditions explained the non-satisfactory outcome besides two cases with primary treatment for periappendicular abscess, two cases with post-operative abscesses, one case with post-operative deep wound infection, two cases with post-operative pneumonia and the two cases with overlooked salpingitis and Meckel diverticulitis.

In a study by Whisker et al from a British tertiary paediatric surgical centre, the patients' age and total LOS were very similar [10] to ours. In our study, 16.5% of the patients were readmitted which is in accordance with the 18% readmission rate presented by Johansen et al [7], but somewhat higher than British figures from tertiary paediatric surgical centres [10, 11]. Our concept with open post-operative access to the ward in case of any complaints may facilitate a higher readmission rate. Complicated appendicitis was seen more often among the patients in the group with a non-satisfactory outcome (76%) than in the group with a satisfactory outcome (25%). Perforated appendicitis is a well-known risk factor for complications and was seen in 16% of our patients. This is slightly less than the National perforation rate of 24% published by Johansen et al [7] and the perforation rate of 37% from British [9] and 39% from

A small organ with considerable impact on hospitalization of children.

American paediatric surgical series [10]. In another British paediatric surgical unit, the rate of gangrenous and perforated appendicitis was 42% compared to 44% in our series [11]. Several studies of paediatric materials have found that perforated appendicitis is seen more often in the younger children [8, 9]. Duration of symptoms may be a major factor in the high perforation rate seen in young children, as signs and symptoms may be less specific [12, 13]. Although it is generally understood that appendicitis in very young children follows a different course than that of older children, the exact age cut-off is less clear.

Narsule et al [8] found clearly that a longer delay between onset of symptoms and surgical intervention was associated with increased rates of perforation in children. No child with symptoms for less than 12 hours had a perforated appendicitis. The perforation rate rose in a linear fashion from 10% at 18 hours to 44% at 36 hours. If symptoms were present for more than two days, the risk of perforation was greater than 40% [8]. They also found that perforation correlated more with pre-hospital delay than with in-hospital stay [8]. In our study, a long duration of symptoms before admittance to the final hospitalisation with diagnosis and operation was clearly associated with complicated appendicitis and a non-satisfactory outcome. This finding was even more significant in the younger children (Table 1 and Table 2). In a retrospective study, such information may include uncertainty. However, among those with a non-satisfactory outcome, 33% (16/48) of our patients had been hospitalised somewhere else but discharged, and 10% (5/48) had been admitted to our ward but discharged before re-admittance for surgery. Our paediatric surgical guidelines were modified late in the study period, so all patients with suspicion of acute appendicitis who were not immediately operated were admitted for a 12-24-hour observation period and evaluated by a senior paediatric surgeon with the support of ultrasound diagnostics when appropriate. Besides such changes, the use of the clinical scoring system designed by Alvarado combined with increased frequency of computed tomography in selected cases for acute appendicitis may lower the risk of overlooking the disease and discharging patients without surgery [14, 15]. The perforation rate may be a quality indicator for the public health-care system or the referral pattern, but recognizing the disease at an early stage and getting the patient to the right place are the factors that would make a difference. Normal histology in 4% of the patients is in accordance with the figures from other paediatric surgical centres [10]. In our study, there was no difference between the patients who had open surgery and those with a laparoscopic operation in respect of whether they had a satisfactory or a non-satisfactory outcome (Table 3). But irrespective of operative method, a longer surgical time was associated with a non-satisfactory outcome (Table 3).

Operating complicated appendicitis takes longer time than operating simple appendicitis (Table 3). This is in agreement with other studies that have presented a long surgical time for complicated appendicitis which is in line with our figures [16]. However, we cannot exclude that other factors are involved and a long surgical time may therefore be an independent factor associated with a non-satisfactory outcome. The data on the surgeons performing the operation are difficult to interpret. The rather long surgical time for the specialist surgeon performing operations with a non-satisfactory outcome may be due to the fact that sometimes the specialist has to take over an operation where the fellow had already operated too long (Table 3). Other studies have shown longer surgical times when fellows are involved. The reason may be that the specialist uses time for instruction of the fellow during surgery [17]. It may influence the flow and the speed of surgery positively for an operating fellow if a scrubbed specialist surgeon is present from the start of the session .We found that the surgical time for laparoscopic operation exceeded that of open appendectomy. The mean surgical time for laparoscopic operations in two other paediatric studies was 60 and 62 minutes, respectively, and for the open appendectomy it was 57 and 42 minutes, respectively [18, 19].

In a meta-analysis of 2,633 operations in children based on another 11 studies, the mean surgical time used for laparoscopic operation was 54 minutes, and for open appendectomy it was 47 minutes [20]. This study also found a shorter post-operative LOS and fewer complications with respect to wound infections and ileus

after laparoscopic operation than after open appendectomy, so a laparoscopic approach as the first choice seems well indicated [20]. In order to improve the treatment results in young children of this common serious emergency surgical disease, it may be necessary to educate the public and first-line health care providers about the risk of delay in appendicitis in children. National guidelines on the subject may be helpful. Furthermore, though a cut-off age has not been established, young children may benefit from direct referral and access to hospitalisation in a regional or tertiary paediatric surgical centre.

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