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Laparoscopic versus open appendectomy in pediatric patients: Operative and postoperative experience

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Abstract

Objective: Acute appendicitis is very frequently encountered in children. Despite many scientific controversies in supporting classical or laparoscopic appendectomy, there is still no official consensus on this issue. This study aimed to present our experience from the comparison of operative and postoperative effects of laparoscopic and open appendectomy in pediatric patients with acute appendicitis.

Materials and methods: The analytical cross-sectional study was conducted at the University Clinic for Pediatric Surgery, Ss. Cyril and Methodius University in Skopje, the Republic of N.Macedonia during the period 2015/2022. The study sample covered 184 hospitalized pediatric patients aged 4-14 years treated with laparoscopic (LA) or open appendectomy (OA). The data of interest included demographic characteristics, and selective operative and postoperative parameters.

Results: The average age of the children in LA vs. OA group was 9.63±2.70 with min/max of 4/14 vs. 9.16±2.91 with min/max 2/14 respectively. Postoperative complications were detected in 1 (0.90%) of LA patients and 3 (4.11%) of OA patients with no significant association. Analgesics' treatment received 57 (51.35%) of the children from LA group and all of the children from OA group. Conversion from LA to OA happen only in 1 (0.54%) child. The evaluation of parents/guardians related to the satisfaction from the cosmetic appearance of the scar the significantly higher level of satisfaction from the scare after LA compared to OA intervention.

Conclusions: Laparoscopic appendectomy was found to be feasible and comparable to open approach in terms of operative time and offers advantages over the latter in terms of postoperative pain, length of hospital stay and earlier return of bowel function to normal. It is a safe approach in all types of appendicitis, with an overall better complication profile than OA.

Keywords: Acute appendicitis, children, laparoscopic appendectomy, open appendectomy, postoperative effects

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Introduction

Acute appendicitis in developed countries is the most common acute surgical problem encountered in the pediatric population (1). Acute appendicitis is most common in children, adolescents, and young adults aged up to 25 years (2-4), A "Lifetime risk" of acute appendicitis is estimated to be 8.7% for boys vs. 6.7% for girls (3, 4). The incidence is the lowest in the neonatal period and the highest in the age group from 12 to 14 years (4). Perforated acute appendicitis can occur in 20-35% of patients. In children younger than 3 years this risk is estimated to be 80-100%, most often because of children's inability to communicate and because of numerous frequent benign gastrointestinal disorders (5, 6).

Acute appendicitis requires urgent surgical treatment, which is recommended to be done in the first 48 hours since the onset of symptoms. The gold standard in treating acute appendicitis is the appendectomy by Mc Burney (7).

The first appendectomy was performed by Claudius Amyand in 1735, whereas the first laparoscopic appendectomy was done over two centuries later in 1983 in adults, and even later in 1992 when the first pediatric laparoscopic appendectomy was done by Ure et al. (7).

Many authors have pointed out the wide acceptance of laparoscopic appendectomy in the management of all type of appendicitis in pediatric patients (8,9).

According to many studies, laparoscopic appendectomy in comparison with the open one applied in children results in less postoperative pain, shorter hospital stay, fewer postoperative complications, and a faster return to normal activities (10, 11). In laparoscopic appendectomy, the abdominal wall is exposed to smaller quantities of contaminated tissues and fluids, which results in a reduced risk of infection. This is particularly important for pediatric patients because of the high rate of perforated appendicitis (12, 13). In spite of the numerous scientific debates related to supporting classical or laparoscopic appendectomy, there is still no consensus about this issue (14-18).

The aim of this study was to present our experience from the comparison of operative and postoperative effects of laparoscopic and open appendectomy in pediatric patients with acute appendicitis.

Materials and methods

The analytical cross-sectional study was conducted at the University Clinic for Pediatric Surgery, Ss. Cyril and Methodius University in Skopje, the Republic of North Macedonia during the period 2015/2022.

This study was conducted in accordance with the principles of the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all parents/guardians prior to study enrolment. The Institutional Review Board of the University Clinic for Pediatric Surgery, Ss. Cyril and Methodius University in Skopje, Republic of North Macedonia approved the ethical of the study.

The study sample covered 184 hospitalized pediatric patients aged 4-14 years with clinically diagnosed acute appendicitis and treated at our clinic either with laparoscopic (LA) or open appendectomy (OA) regardless of gender and other demographic characteristics. The allocation of patients into the LA or OA group depended on the decision of the parents/guardians. Excluded criteria understood signs for the existence of inter-intestinal abscesses, the existence of abscess in the small pelvis; previous surgery in the abdominal region; suspicion of a malignant process in the ileocecal region, or comorbidities such as muscular dystrophies, hematological diseases, lymphoproliferative diseases, or respiratory/ other infection.

The data of interest included demographic characteristics, and selective operative and postoperative parameters. For parents/guardians' satisfaction related to the cosmetic appearance of the scar, the 5-point Likert Scale was used where "0" was the lowest and "5" was the highest satisfaction.

Statistical Analysis

The data obtained with the research were processed in SPSS for Windows, v22.0 (IBM Corp.; Armonk, NY, USA). Qualitative and quantitative series were analyzed with measures of central tendency (mean, median, range), as well as by dispersion measures (standard deviation). The Shapiro-Wilk W test was used to determine the normality of frequency distribution of age, BMI, temperature, CRP, time from onset of symptoms to hospitalization, duration of operation, time to first stool, hospital stay, days of antibiotic treatment, etc. For analysis of the

association between qualitative variables, the Pearson Chi-square test and Fisher exact test were used. Mann Whitney U test was used to compare differences between two independent groups when the dependent parameters were either ordinal or continuous, but not normally distributed. A two-sided analysis with a significance level of $p<0.05$ was used to determine the statistical significance.

children were younger than 10 years and 9 years, respectively. No significant differences were found between groups related to the age of the patients (Mann Whitney U test: Z=1.093; p=0.274). Male were 64 (57.66%) in LA and 49 (67.12%) in OA with no association of the gender with the groups (Pearson Chi-square test:X^2=1.665, df=1, p=0.197).

Table 1: Comparison of LA /OA according to selected operative and postoperative parameters

Parameters	N	Mean± SD	Min/Max	Median (IQR)	p
Time from onset of symptoms to hospitalization (hours)					
LA	111	24.92±9.53	12/48	24 (24-28)	Z=-5.065; p=0.000001*
OA	73	38.34±18.69	12/96	30 (24-48)	
Duration of intervention (minutes)					
LA	111	34.19±6.13	25/50	32 (30-38)	Z=-10.860; p=0.000001*
OA	73	69.16±22.39	30/126	63 (56-75)	
Time to first stool (hours)					
LA	111	11.06±2.00	7/16	12 (10-12)	Z=-11.463; p=0.000001*
OA	73	46.97±17.45	24/96	48 (36-48)	
Time to oral intake of drink and food (hours)					
LA	111	10.15±1.52	8/15	10 (15-10)	Z=-11.480; p=0.000001*
OA	73	37.94±21.24	12/96	24 (96-24)	
Hospital stay (days)					
LA	111	4.23±1.49	2/10	4 (3-5)	Z=-4.906; p=0.000001*
OA	73	5.18±1.43	3/11	5 (4-6)	
Treatment with analgesics' (days)					
LA	111	0.67±0.75	0/3	1 (0-1)	Z=-10.553; p=0.000001*
OA	73	3.43±1.61	1/8	3 (2-5)	
Treatment with antibiotics (doses)					
LA	111	4.13±1.43	0/8	4 (3-5)	Z=-4.435; p=0.000001*
OA	73	5.16±1.58	2/9	5 (4-6)	
Time to complete activities (doses)					
LA	111	13.04±2.64	10/25	12 (12-14)	Z=-9.859; p=0.000001*
OA	73	21.41±5.27	14/35	21 (18-25)	
Cosmetic appearance of the scar (satisfaction on 1-5 scale)					
LA	111	4.99±0.09	4/5	5 (5-5)	Z=5.108; p=0.000001*
OA	73	4.10±0.99	1/5	5 (3-5)	

LA=Laparoscopic; OA=Open appendectomy
Z=Mann-Whitney U Test; *Significant for p<0.05

Results

The sample of the study covered 184 children diagnosed with acute appendicitis and treated either with LA – 111 or with OA - 73. The average age of the children in the LA vs. OA group was 9.63±2.70 with a min/max of 4/14 vs. 9.16±2.91 with a min/max of 2/14 respectively. In LA and OA groups, 50% of the

Average BMI was 17.81±3.58 with a min/max of 11.8/33.3 and median IQR=16.96 (15.4-19.2) in the LA group and 19.24±5.12 with a min/max of 10.9/38.8 and median IQR=18.9 (15.6-21.5) in OA group. No significant differences between the groups were found related to BMI (Mann-Whitney U test: Z=-1.922; p=0.054). Echotomography was

significantly associated with the LA group (Pearson Chi-square test: X^2=17.583, df=2, p=0.0001). It was not applied to 49 (44.14%) of the children from LA and 48 (65.75%) from the OA group. Positive echotomographic findings had 53 (47.75%) vs. 13 (17.81%) of the children in the LA vs. OA group respectively.

Temperature above 37.5^{o}C at admission was significantly associated with patients from the LA group (Pearson Chi-square test: X^2=11.963, df=1, p=0.0005). It was registered in 45 (40.54%) vs. 12 (16.44%) of the patients in the LA vs. OA group respectively. The level of CRP at admission was not significantly associated with the group to which the patient belong (Mann-Whitney U test: Z=-0.145; p=0.884) with an average of 59.13±64.94 and median IQR=34.4 (21-74) in LA vs. 50.71±40.93 and median IQR=39 (22-68) in OA.

Conversion from LA to OA happens only in 1 (0,54%) child. The distribution of histopathological finding in LA and OA group were as follow: catarrhal – 5 (4.50%) vs. 4 (5.48%), phlegmonous – 60 (54.05%) vs. 32 (43.84%) vs. emphysematous – 12 (10.81%) vs. 14 (19.18%); gangrenous without perforation – 15 (13.51%) vs. 14 (19.18%) and gangrenous with perforation – 19 (17.12%) vs. 9 (12.33%). There was no significant association between the type of operative intervention with the histopathological' finding (Pearson Chi-square test: X^2=4.747, df=4, p=0.314).

Postoperative complications were detected in 1 (0, 90%) of the LA patients and 3 (4.11%) of the OA patients with no significant association (Fisher exact test: p=0.302). Infection of the wound during hospital stay had 3 (2.70%) of children treated with the LA and 4 (5.48%) of one with OA (Fisher exact test: p=0.438).

Analgesics treatment received 57 (51.35%) of the children from the LA group and all of the children from the OA group.

A comparison of the pediatric patients treated with LA or OA, because of clinically diagnosed acute appendicitis, shows that there were significant differences related to the selected parameters as the time from the onset of symptoms, duration of intervention, time to first stool, time to oral intake of drink and food, hospital stay, treatment with analgesics and antibiotics, and time to complete activities. All identified significant differences were in favor of better results achieved in the group of patients with acute appendicitis treated with LA compared to OA (Table 1).

Also, the evaluation of parents/ guardians related to the satisfaction from the cosmetic appearance of the scar a significantly higher level of satisfaction from the scare after LA compared to OA intervention (Table 1).

Discussion

Appendicitis is the most common acute abdominal emergency in children (19). In recent years a large number of pediatric surgeons have started practicing laparoscopic appendectomy, which is mainly due to achieving excellent results. Still, the treatment of acute appendicitis with the open surgical method does not lag much behind that of the laparoscopic method, first of all, because it is a minimally invasive procedure with a small and cosmetically acceptable scar. Numerous studies that compare LA with OA agree with the fact that it is very difficult to give an unequivocal advantage to any of these two methods. Both methods have their own advantages and disadvantages, but without any substantial difference (20, 21).

Our study has shown a significantly shorter hospital stay in the group treated with LA, because of the smaller incisions, less postoperative pain, and early mobilization. This has also been confirmed in other studies, some of which were published at the beginning of the 1990ties (22, 23). Contrary to this, Milewczyk et al. pointed out a longer hospital stay of children treated with LA compared to those treated with OA (24). According to some authors, the difference between the two procedures regarding hospital stay might be due to the difference in the healthcare system, which opens up the question of the advantage of LA versus OA (25, 26).

The duration of the LA and OA intervention is one of the most frequently discussed questions among experts. Most of the studies recorded a longer duration of surgery with a laparoscopic approach than with open appendectomy (2, 26-29) whereas few studies reported similar or even shorter operating times with a laparoscopic approach (30, 31). Other studies have reported a longer duration of LA, but at the same time, they debate the indisputable influence of the surgeon's skills on the procedure duration (32).

Our study showed that the operating time of the laparoscopic procedure was significantly shorter than that of open appendectomy. Better visualization during the laparoscopic approach and the expertise of the operating surgeon are possible explanations for the shorter length of the laparoscopic procedure.

We notice a significant difference between LA and OA with regard to the postoperative antibiotic treatment applied in case of infection or complication. This is similar to the results of Guller et al., who presented a significant difference in the total morbidity between the two procedures (33).

An important intraoperative complication of appendectomy is the rate of conversion from laparoscopic to open surgery. In our study, we had only 1 (0.54%) conversion, due to technical reasons (34). Gosemann et al. in their nationwide cohort analysis found that they had a conversion rate of 1.2% which was associated with an increased risk of complications compared to individual laparoscopic or open surgery groups (35).

Markus Schäfer et al. in their study reported a 6.8% and a 25.5% conversion rate in overall and perforated appendicitis cases, and they also reported an overall reoperation rate of 3% (36).

The postoperative complication in our study was detected in 1 (0.90%) of LA patients and 3 (4.11%) of OA patients with no significant association. Infection of wounds during hospital stay had 3 (2.70%) of children treated with LA and 4 (5.48%) of the ones with OA. Similar results have been observed in other published studies (2, 27-29).

Appendicitis may sometimes be confused with covid-19 disease (37-43) and colitis (44, 45), or appendicitis can occur as a complication of these two. In our study, analgesics treatment was received by 57 (51.35%) of the children from the LA group and all of the children from the OA group. Children's treated with LA received significantly fewer doses of analgetics than those treated with OA, which coincides with the results reported in other studies in patients who underwent laparoscopic appendectomy (21, 28).

Postoperatively all patients were evaluated for wound infection at four weeks and a similar rate was found. All patients were managed conservatively. Many studies have found a significant reduction in wound infection rate with the laparoscopic approach, though this was not the case in this study (46-51).

In our study satisfaction from the cosmetic appearance of the scar after evaluation of parents/ guardians has a significantly higher level of satisfaction from the scar after LA compared to OA intervention. This is in agreement with a number of investigations and raises the question of the opposing attitudes of a group of researchers regarding the primary attitude that LA shows better esthetic results than OA (52-56).

Conclusions

Laparoscopic appendectomy was found to be feasible and comparable to the open approach in terms of operative time and offers advantages over the latter in terms of postoperative pain, length of hospital stay, and earlier return of bowel function to normal. It is a safe approach in all types of appendicitis, with an overall better complication profile than OA. With good training, and improved surgical technique, laparoscopic appendectomy will increasingly become the surgical procedure of choice for the treatment of acute appendicitis in children.

Conflict of interest:

The authors report no conflict of interest.

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Ethical approval:

The Institutional Review Board of the University Clinic for Pediatric Surgery, Ss. Cyril and Methodius University in Skopje, Republic of North Macedonia

Contributions

Research concept and design: **TR, RS, SM**
Data analysis and interpretation: **TR, RS, RS**
Collection and/or assembly of data: **RS, RS, SM**
Writing the article: **TR, RS, RS**
Critical revision of the article: **TR, RS, SM**
Final approval of the article: **TR, RS**

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