


Laparoscopic Transumbilical Appendectomy in Nonperforated Appendicitis in Pediatric Age Group

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Abstract

Introduction: Laparoscopic appendectomy has recently been trended to be performed by using a less trocar technique. In children, appendectomy is performed more by open approach; so this study was designed to compare benefits of non-invasive laparoscopic appendectomy with usual open technique.

Materials and Methods: After obtaining institutional review board approval, from 2015 to 2018, 73 children with acute, nonperforated appendicitis were treated by single-incision laparoscopic or open approach. The patients were randomized to two treatment groups: 36 patients underwent open operation, and 37 by laparoscopic approach via single-incision in umbilicus. 3 cases of laparoscopic approach were converted to open surgery and removed from the study. In patient selection, cases of complicated appendicitis confirmed by imaging modalities were excluded. The outcomes were investigated in both groups by length of operation, duration of hospital stay, presence of postoperative fever, wound infection, ileus after operation, and pelvic abscess after surgery.

Results: 73 appendectomies were carried out totally by single surgeon, 37 were single-incision laparoscopy and 36 underwent open procedure. Total anesthesia time and duration of operation showed significantly longer in the laparoscopic group. On the other hand, time to tolerate liquid diet was significantly shorter in the laparoscopic group. The

Keywords

- Appendectomy
- Nonperforated Appendicitis
- Laparoscopy

duration of hospital stay showed similar duration in both groups. No mortality occurred in the study. Overall complications demonstrated no significant difference between two groups. Also there was no difference in infectious complications between the laparoscopic group and the open group.

Conclusion: Our study suggests that Assisted Transumbilical laparoscopic appendectomy is a reasonable alternative to open surgery for appendicitis in acute none ruptured condition. All analyzed complications were similar between the groups, suggesting that Assisted Transumbilical laparoscopic appendectomy is a suitable ingrained method in pediatric cases with appendicitis.

Introduction

Laparoscopic appendectomy (LA) has introduced as an ideal approach for the management of appendicitis in adults in most centers. However, there are minor reports regarding the results of this technique in pediatric age group. Nowadays trend to Assisted Transumbilical Laparoscopic Appendectomy has become accounted in the literatures as a substitute to multiple-ports laparoscopic appendectomy.¹ In this study we evaluate the results of open appendectomy and the single-incision transumbilical technique for cases of pediatric none perforated appendicitis. This study will compare advantages and disadvantages of the two techniques.

Materials and Methods

Inclusion Criteria

Patients with appendicitis admitted in Mofid Children Hospital Department of Pediatric Surgery from 2015 to 2018 were included in the study. All cases were 14 years of age or younger.

The diagnosis of appendicitis was carried by subsequent criteria: presence of acute pain in right lower quadrant (RLQ) or periumbilical with shifting to the right lower quadrant, with nausea and/or vomiting, and leukocytosis above 10,000 cells per mL, and restricted tenderness in RLQ on examination.

Exclusion Criteria

Cases were excluded if the diagnosis was complicated appendicitis. In this study complicated appendicitis was described as acute appendicitis associated with perforation or an abscess formation. Perforated appendicitis was characterized by intra-peritoneal purulent fluid, or presence of free fecalith in the pelvic cavity, and restricted abscess.

Another exclusion criteria included those cases of appendicitis which were not clinically diagnosed in time, and the presence of symptoms for the duration of longer than 5 days and/or occurrence of palpable mass in RLQ suggestive of a phlegmon or abscess formation.

Surgery

After obtaining institutional review board approval, 73 children with acute nonperforated appendicitis from 2015 to 2018 were treated by single-incision laparoscopic or open surgery. The diagnosis of none perforated appendicitis was based on clinical presentation, physical examination, laboratory and ultrasonography in some cases. The patients randomly were divided into two treatment groups; 36 had open surgery and 37 had single-incision laparoscopy. A single surgeon with their assistants performed both types of operations. Chart review for all patients was carried out. In contrast to commonly used multi-port in multiple-incision laparoscopic surgery, single incision in umbilicus was carried out.

The surgical technique described below was performed in all laparoscopic cases: patients with localized abdominal tenderness in RLQ and no evidence of perforation were given intravenous antibiotics preoperatively and after transfer to the operating room, general anesthesia was induced and in supine position stomach was decompressed by NG tube. Patients were asked to go to the toilet before entering the operating room, however if bladder is palpated after general anesthesia it was also decompressed. The supra-umbilical skin is incised with a 10 millimeter transverse incision and then by veress needle, the peritoneal space insufflated with carbon dioxide up to a pressure of 10 to 12 mmHg. 3-5 mm primary trocar was inserted at the umbilicus and 3-5 millimeter, 30-degree camera was introduced.

After visualization of whole intraperitoneal

cavity via a telescope, a 5-mm trocar is inserted 2 millimeters away from previous trocar site in umbilicus **Figure 1**. At first exploration of the entire abdominal cavity was performed to find the appendix and evaluation for other probable diagnoses. A non-traumatic grasper employed to discover the appendix. Retroperitoneal bands around the cecum and ascending colon was dissected and lysed with a 5-mm blunt grasper and after complete mobilization of appendix from surrounding tissues, the tip of the appendix was exteriorized through the umbilicus and the base and meso-appendix was double ligated with absorbable suture **Figure 2** and appendectomy was performed extracorporeally. Then stump of the appendix returned to peritoneal cavity. In patients with considerable swollen appendix the wound was enlarged as necessary **Figure 3**.

Open appendectomy performed with transverse incision in the right lower quadrant. The stump was ligated with absorbable suture.

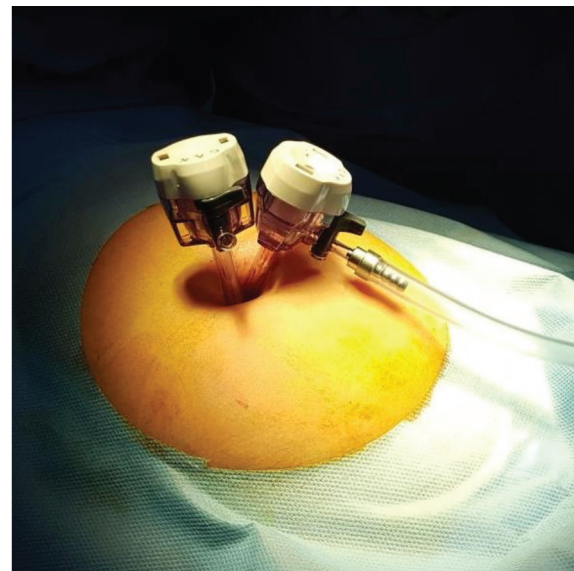


Figure 1: Laparoscopic single site trocars

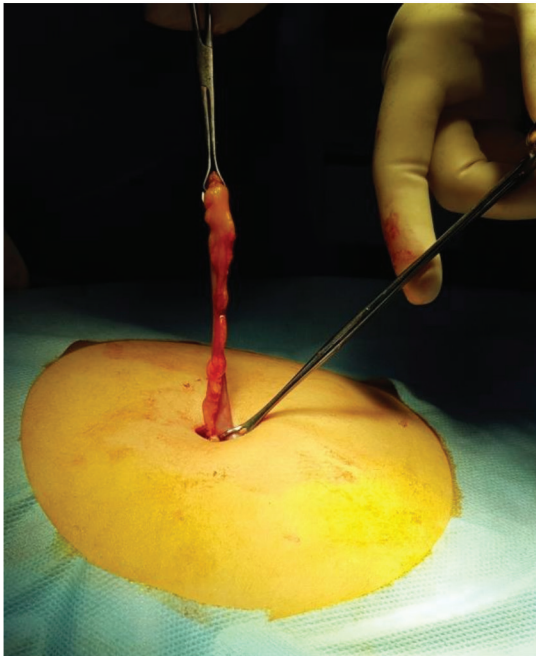


Figure 2: extracted appendix from the umbilicus

Outcomes

- The subsequent parameters reported:

Demographic information included age at operation, gender of cases, physical examination and laboratory data.

- Time from induction to reversal of the anesthesia considered as “anesthesia time” and recorded in minutes; and “surgical procedure time” calculated from skin incision to skin closure in minutes.
- Indications of conversion from laparoscopic to open surgery.
- Complications such as intra-abdominal abscesses, wound infections, intestinal obstruction, incisional hernias.
- Pathology reports for the type of appendicitis.



Figure 3: Final surgical scar

- Time until recommencement of diet (clear liquid) in hours and hospital stay in days.

After 2 weeks, patients visited in clinic and complications investigated (wound infection, abscess formation, and other complications).

Statistical Methods

All converted cases analyzed in laparoscopic group. Data collected and analyzed using SPSS 17 for Windows. Discrete variables are reported as number and percentages. Chi-square test was used for comparison of means. Fischer’s two-tailed exact test was used to calculate P value.

All continuous variables are as mean and standard deviation.

P values reported are 2-sided, and p-value less than 0.05 denotes statistical significance.

Results

A total of 73 appendectomies achieved. 37 children underwent LA, and 36 cases experienced open surgery. In 3 patients, laparoscopic operation

changed to open surgery (8%). The indications for conversion were inability to identify anatomy, and difficult dissection in an unexpected appendiceal phlegmon. In 2 patients one additional trocar added. Causes for additional trocars were helplessness in observing intra-abdominal organs due to inflammation and dense adhesions.

The 2 groups were similar with respect to age, sex, and preoperative white cell count, duration of symptoms before surgery and pathology report **Table 1 and 2**. **Table 2** shows pathology reports verified by the pathologist.

Table 1. Patients Characteristics*

Characteristics	Open Appendectomy	Laparoscopic Appendectomy	P value
Number	36	37	
Age (month)	100 ± 34	90 ± 37	0.53
Sex (female)	18	23	0.62
preoperation WBC count.	13822 ± 5943	13544 ± 4671	0.45
Duration of Symptoms (day) .	2.08 ± 1.4	2.74 ± 1.8	0.91
*Results as mean			

Table 2. Postoperative Diagnosis

		Open appendectomy	Laparoscopy converted to open	Laparoscopic appendectomy	
Postoperative Diagnosis	Simple appendicitis	26	0	32	57
	Appendiceal mass	0	1	0	1
	Gangrenous appendicitis	2	2	0	4
	Simple suppurative appendicitis	6	0	1	7
	Acute suppurative appendicitis	2	0	1	3
Total	36	3	34	73	

The operative duration and the length of anesthesia were significantly more in the laparoscopic group **Table 3**. Time to resumption of liquid food was significantly shorter in laparoscopic group. The length of hospitalization was the same for both groups. Ninety percent (66/73) of patients were discharged after 3 days or earlier.

No mortality occurred in this study. No significant difference in the overall complication rates showed between two groups (2% in LA group and OA

group) (Table 4). Only one major complication due to intestinal obstruction in the laparoscopic group led to reoperation. There was no difference in infectious complications between the laparoscopic and the open group (one wound infection in open group).

Mean duration of follow up was about 36 ± 5 month. There were no readmissions due to small bowel obstruction after open or laparoscopic surgery performed for acute appendicitis.

Table 3. Clinical Outcomes

	Open Appendectomy (N=36)	Laparoscopic Appendectomy (N=37)	p
Operative time	25 (15–45)	42 (35–60)	0.004
Anesthesia time (min)	60 (55–80)	75 (65–120)	0.001
Time to start liquids (day)	1.83 ± 0.50	1.15 ± 0.35	0.04
Length of stay (days)	2.7 ± 1.8	2.11 ± 0.84	0.31

		open appendectomy (transverse)	Laparoscopic Appendectomy	Total
Complications	Wound infection	1	0	1
	postoperative intestinal obstruction	0	1	1
	None	35	36	71
Total		36	37	73

Discussion

Appendectomy is still the most frequent emergent abdominal surgical procedure for pediatric patients. In adult population, laparoscopic surgery has been considered the chosen method of treating appendicitis in most studies; but there has been few reports from results of laparoscopic appendectomy

in pediatric age group.¹ Additionally, in 2014 our center previously accounted that laparoscopic removal of the appendix is practicable and secure in all stages of pediatric appendicitis.²

In contrast to traditional method of surgery, such as laparotomy, minimally invasive surgery leads to fewer pains and scarring and needs fewer

amounts of analgesics. As a result, it ends up with early ambulation; quick return to regular diet and lesser hospitalization days. Furthermore, minimal manipulation of operation site and other intra-abdominal organs diminishes the incidence of postoperative adhesions. In recent years, laparoscopic surgery has highly evolved into lesser invasive methods, such as performing laparoscopic surgery with a single-incision,³ which yield in smaller amount of scarring and less postoperative pain. Yet, it has a number of disadvantages. One important problem is the mobility limitation of the equipments owing to the limited number of ports, and inability to use more instruments and other technical challenges during surgery.⁴ In this study, transumbilical laparoscopic appendectomy resulted in early healing and more appreciated cosmetic results in comparison to open surgery.

However, the mean operative time in laparoscopy group was 12 minutes longer than in open group. Nowadays with lazy lifestyle of most children, the majority of them are overweight; so pain, wound infection and other complications are more possible after open procedure.

Some studies showed umbilical wound infection due to transport of inflamed appendix straightly through it, but in this study, no wound infection was found in laparoscopic group. One disadvantage of laparoscopic appendectomy is higher cost due to the usage of Endoloops, stapling instruments, and disposable laparoscopic trocars; but in this study, we used less disposable laparoscopic trocars than traditional laparoscopic appendectomy.⁵

Laparoscopy is a perfect option in those cases of

acute abdomen with diagnostic doubt, especially among children that do not explain the exact location of pain.

Most studies reported that minimally invasive operations allowed more rapid recovery and earlier return to work. In this study, the length of hospitalization was the same for both groups. Ninety percent (66/73) of patients were discharged on or before 3 days after surgery.

The diminished chance of adhesion formation following laparoscopic appendectomy influences the long-term frequency of small-bowel obstructions following operation. It needs long standing follows ups. In our study, mean duration of follow up was about 36 ± 5 month. There were no readmissions due to small bowel obstruction after open or laparoscopic surgery performed for nonperforated appendicitis.

In 2016, Tashiro et al⁶ evaluated pediatric (<20 years of age) cases of complicated and uncomplicated appendicitis undergoing laparoscopic appendectomy or open appendectomy. They found that operation time is significantly longer for laparoscopic appendectomy group but the duration of hospitalization is shorter in this patients (2.11 ± 0.84 days in LA vs. 2.7 ± 1.8 days in OA) but blood transfusion rates are higher in LA groups.

In 2015, Noviello et al⁷ had included 300 children patients aged between 2 and 14, who had diagnosis of the possible uncomplicated appendicitis according to the clinical and paraclinical findings in their study. 352 (84 %) patients had Transumbilical Laparoscopic assisted appendectomy, and the remaining 49 patients underwent open surgery.

Conversion to open surgery was because of problems related to not finding the appendix in 47 patients and development of bleeding in one patient. The mean duration of operation for TULAA was 42 minutes and the mean time for hospital admission for TULAA was about 4 days. Cosmetic consequences measured good or outstanding by parents in all cases, even those with wound infection.

Marker et al⁸ recruited 73150 patients who had diagnosis of uncomplicated appendicitis in their study. 27249 patients underwent laparoscopic appendectomy and 45901 patients had open surgery. Post operative complications in laparoscopic appendectomy group vs. open appendectomy group were not significantly different (2.62 % vs. 5.74 %) (P=0.83) but the hospital stay was significantly higher in open appendectomy group.

Li Hsia Alicia Cheong et al⁹ conducted a similar study in 2014 in Canada. They randomly enrolled the children with diagnosis of uncomplicated appendicitis to laparoscopic surgery and open surgery groups. The length of hospital stay was shorter in laparoscopic assisted appendectomy group (1 day vs. 2 days) (P < 0.01).

The duration of hospital stay in our study was small, and there was no significant difference between the two groups. This finding is similar to other investigations.

Minutolo et al¹⁰ were investigating a retrospective analysis of 230 patients who underwent appendectomy between 2008 and 2012. Laparoscopic appendectomy established in 139 patients, open surgery in 91. There was

no significant difference in the operation time (median, 52.2 minutes in laparoscopic surgery versus 49.3 minutes in open surgery) (P= 0.476). The incidences of post operative complications were lower in laparoscopic approach (2.9 % vs. 13.2 %); but intra-abdominal post operative abscess were equal in both LA and OP groups.

Scire et al¹¹ in a retrospective study in 2014 evaluated differences between open appendectomy, laparoscopic appendectomy, and transumbilical laparoscopic assisted appendectomy (TULAA) in 196 patients who had diagnosis of the appendicitis. 46 patients underwent laparoscopic appendectomy, 62 patients had TULAA and remaining 88 patients underwent open appendectomy. The surgery duration was significantly shorter in open approach but hospital stay was shorter in TULAA group. They realized that surgical site infection rates were significantly higher in laparoscopic appendectomy group.

In 2014, Zampieri et al¹² assessed the surgical diagrams of all cases of appendicitis less than 14 years old managed by transumbilical laparoscopic-assisted appendectomy from 2009 to 2013. According to their study, TULAA is a safe, minimally invasive way in children suffering from acute appendicitis due to less post-operative complications in comparison to open approach.

In 2014 in Italy, Montalto et al¹³ compared the surgical stress responses between TULAA and open appendectomy surgery by measuring levels of IL-6, IL-10 and IL-18 at the beginning of surgery, and at the ending time of operation, and 24 hours after surgery. An increase in IL-6 levels at the end

of surgery and increases in both IL-6 and IL-18, 24 hours after the surgery were observed after open appendectomy. A significant increase in amount of both IL-6 and IL-18 reported 24 hours after laparoscopic surgery but these values were less compared to open appendectomy ($p = 0.0006$). A significant decline in the amount of postoperative cytokines in TULAA group proposed that this management would lead to less surgical trauma in children.

In a prospective study in 2332 children with suspected appendicitis, Esposito et al found out that length of hospital stay is significantly shorter in laparoscopic appendectomy group than open appendectomy group.¹⁴

Ikeda et al¹⁵ in Japan investigated 100 cases who managed with appendectomy, either laparoscopic or open. 53 cases were operated in the laparoscopic approach and 47 patients in the open method. As our study, the duration of operation was significantly longer in laparoscopic method than open technique (80 minutes vs. 50 minutes) ($P = .001$), but the span of hospital stay in patients with uncomplicated appendicitis was significantly less in laparoscopic approach (6 days vs. 9 days) ($P = .001$). The costs for laparoscopic group were significantly more than for open group ($P < .001$). There was no significant difference between complications in both groups.

Pappalepore et al¹⁶ in 2002 compared 58 transumbilical laparoscopic-assisted appendectomy (TULAA) and 65 OA patients with preoperative judgment of acute none perforated appendicitis. No complications observed in the TULAA group and cosmetic consequences were outstanding.

They supposed that TULAA is the best approach in non perforated appendicitis, particularly in fatty patients and in cases of ectopic appendicitis.

Finally, there is no doubt regarding cosmetic benefit of minimally invasive surgery over open procedure. This is significant in children, whose body presentation turns into a vital part of their psychosocial growth. This technique provides a surgery with minimal proof of scar to a nearly scarless procedure by creating a single incision in the umbilicus. As actually benefits of laparoscopic surgery, we consider this method may be an imperative surgical technique. Using a single incision method in particular would gain more widespread acceptance.

Conclusion

Our study suggests that Transumbilical laparoscopically Assisted Appendectomy is a reasonable alternative to the open surgery for children with acute non perforated appendicitis. For enhancement of the mentioned boundaries to this study, a randomized prospective study with a larger amount of cases is required in the future. This research did not include any cases of complicated appendicitis. In order to do a more widespread research about all cases, more information related to the cases of complicated appendicitis should be collected.

Ethical Consideration

This study was approved by Organizational Committee of Ethics in Biomedical Research of Shahid Beheshti University of Medical Sciences with code number IR.SBMU.RAM.REC.1394.532.

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Conflict of interests

There is no conflict of interests

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