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Transumbilical single-incision laparoscopic appendectomy in pediatric appendicitis: A single-surgeon experience

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ABSTRACT

Introduction: Appendicitis is the most frequent emergency in children. In recent years, transumbilical single-incision laparoscopic appendectomy (TULA), a single-incision procedure exteriorizing the appendix from inside the umbilicus, has shown shorter operation duration and almost invisible scars. In this study, we present our single-surgeon experience on TULA in the treatment of appendicitis in children and guide young surgeons who have started learning laparoscopy.

Materials and Methods: Between January 2017 and December 2022, 79 patients with acute appendicitis who underwent TULA were retrospectively analyzed. The operation was performed as an emergency appendectomy. Data including demographic, laboratory, preoperative, and postoperative data were recorded.

Results: Of the patients, 55 were boys and 24 were girls. The mean age was 10.4±2 (range, 5–17) years. The main symptoms were abdominal pain in 89.8% (n=71), anorexia in 31.6% (n=25), nausea in 36.7% (n=29), vomiting in 52.1% (n=65), and fever 13.9% (n=10). In the laboratory examinations, leukocytosis was identified in 62 (78.4%) patients and C-reactive protein value was elevated in 10 (87.3%) patients. Significant ultrasonographic findings were observed in 58 (73.4%) patients. The diagnosis was made in 21 (26.5%) patients using computed tomography.

Conclusion: TULA is a less invasive procedure which can be performed in children and adolescents by a young surgeon easily and safely. It has a short operation time and hospital stay, and the rate of conversion to open surgery is also very low. This technique is a good start to learn laparoscopic surgery.

Keywords: Appendectomy, appendicitis, children, laparoscopy training, single-port laparoscopic appendectomy

Introduction

Appendicitis is the most frequent emergency in children. There are still many controversies for the management of appendicitis. The overall incidence of appendicitis is approximately 1/1,000 individuals with an increasing trend in recent years. The overall lifetime risk is about 8% and it peaks during the teens. It is more predominant in males (55–60%). Its lifetime risk is 9% for males and 7% for females with a peak incidence occurring between the ages of 11 and 12.[1,2]

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Although the exact etiology of acute appendicitis is still needed to be elucidated, it is thought to be caused by luminal obstruction. In most cases, luminal obstruction and subsequent infection cause appendicitis. Luminal obstruction may cause appendicitis; however, the exact cause of the obstruction may not be always evident. Calcified and inspissated fecal matter in some cases, referred to a fecalith, has been suggested to be implicated in the etiology.[3]

Currently, appendectomy is the first-line treatment in the majority of cases. In 1735, Amyand[4] was the first to describe the resection of the appendix. In 1894, McBurney[5] performed an appendectomy through a right iliac fossa incision. However, the first laparoscopic appendectomy was performed in 1983 with the introduction of minimally invasive appendectomy techniques. Owing to its merits including smaller incisions, less postoperative pain and wound infection, faster recovery, and favorable esthetic outcomes, conventional multi-port laparoscopic appendectomy (CMLA), compared to open appendectomy (OA), has been widely adopted by general surgeons. It has been used for the management of uncomplicated and complicated appendicitis and in a variety of diseases. Therefore, it is recommended in the management of acute appendicitis. With the introduction of laparoscopic surgery in 1980s, a paradigm shift emerged in the minimally invasive surgery (MIS). Natural orifice transluminal endoscopic surgery (NOTES) and single-incision laparoscopic surgery (SILS) are emerging techniques in recent years.

The main advantages of MIS are rapid recovery with less pain, less postoperative complications, and favorable aesthetic outcomes.[6] Until now, there is little consensus regarding the superiority to conventional laparoscopic techniques. Originally developed for a single disease, the laparoscopic techniques have evolved into multidisciplinary and multifaceted surgical techniques in recent years. Robotic laparoscopy, NOTES, and SILS have become popular in the 21st century.[7,8] The SILA mainly utilizes self-made or commercial single-port instruments.[8]

The main goals of SILA are to provide faster recovery and less pain with improved patient satisfaction. Resulting in less trauma to the abdominal wall, it may yield more favorable outcomes than conventional laparoscopic appendectomy.[7,8] However, it is still not a widely adopted technique, as it must be handled with straight tools in parallel with the camera and as it is associated with certain technical drawbacks compared to standard multi-port laparoscopy. The single-incision access restricts the movement for both the surgeon and assistant, which is linked to the increased surgeon fatigue and frustration. However, in many less developed countries, this equipment is not available, thereby limiting the use of SILA. It is, therefore, attempted to perform transumbilical SILA (TSILA) using conventional laparoscopic equipment that yields favorable results.

Currently, this technique is used a standard procedure for acute appendicitis treatment. In 1992, Pelosi[8] was the first to describe novel surgical method, namely transumbilical laparoscopic appendectomy (TULA). This technique has certain advantages combining the safety of extracorporeal appendectomy and an enhanced intra-abdominal laparoscopic visualization. It utilizes a single umbilical port and pneumoperitoneum is obtained. Subsequently, the inflamed appendix is externalized via that port and the appendix is removed using standard extracorporeal appendectomy. Since then, this technique has gained a wide acceptance, particularly in some European countries with favorable outcomes in children.

In this study, we aimed to present our single-surgeon experience with TULA in the treatment of appendicitis in children.

Materials and Methods

Study Design and Study Population

This single-center, retrospective study was conducted at the Department of Pediatric Surgery of Gebze Yüzyıl Hospital between January 2017 and December 2022. Before the study, a written informed consent was obtained from the parents and/or legal guardians of the patients. The study protocol was approved by Medipol University, Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (Date: February 16, 2023, No: 180). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Medical data of children aged between 1 and 18 years undergoing laparoscopic appendectomy with TULA by a single surgeon were recorded. Appendicitis was diagnosed based on the medical history of the patients, physical examination, and imaging findings. Exclusion criteria were as follows: Having interval appendectomies defined as appendectomies completed after a trial of antibiotics, open appendectomies, and multi-port laparoscopic appendectomies. In addition, cases with perforated or otherwise

complicated appendicitis were excluded. Data including age, sex, ethnicity, vital signs, and leukocyte count at the time of hospital admission, height and weight, imaging study findings, type of operation, duration of operation, intraoperative findings, duration of postoperative antibiotic use, time of resumption of diet, length of hospital stay, pathological diagnosis, complications, and follow-up duration were recorded.

Preoperative Preparation

In our institution, laparoscopy or TULA is used as a standard MIS approach. The umbilicus is gently cleansed using a betadine-impregnated cotton swab at least 30 min preoperatively. No prophylactic antibiotics are given, as the patients are already prescribed. Standard complete blood count, complete biochemistry, blood group and bleeding profile, direct abdominal graphy, and ultrasonography (USG) are performed in patients with clinically acute appendicitis. On USG, suspicious findings that cannot be distinguished clearly are monitored and additional pathologies are ruled out. Contrast-enhanced computed tomography (CT) is performed in patients in whom the definitive diagnosis cannot be made with USG. Intravenous fluid and antibiotic (ampicillin-sulbactam, amikacin, and metronidazole) treatments are administered to patients who are diagnosed with acute appendicitis and scheduled for surgery. No intraoperative urine probe or nasogastric tube is inserted. If necessary, the patient is positioned without being woken up during surgery.

Operative Technique

All patients were operated under general anesthesia in the supine position. For the first port access, a long-acting anesthetic (bupivacaine 0.5 mg/kg) was administered subcutaneously in the umbilical region for pain management. A half-moon incision was made inferior to the umbilicus. An 11-mm trocar was inserted into the cephalad aspect of the umbilical fascia (Fig. 1). The patient was positioned in the Trendelenburg position with a 30° angle in the left side. After pneumoperitoneum, the abdominal cavity was meticulously evaluated. Subhepatic and pericecal space and the pouch of Douglas were examined whether there was any free fluid or abscess. The appendix was attempted to be visualized as much as possible (Fig. 2). Through the same incision line, a second 5-mm trocar was mounted adjacent to the first trocar to create a short gap in the umbilical fascia. This port was used as the working port. Free fluid or abscess was aspirated, when necessary. Mesoappendix was

Figure 1. A 10-year-old girl underwent a transumbilical single-incision laparoscopic appendectomy. A half-moon incision was made inferior to the umbilicus. An 11-mm reusable cannula was introduced into the cephalad aspect of the umbilical fascia followed by insertion of a 5-mm grasping forceps inferior to the cannula for mobilization of the cecum and appendix.

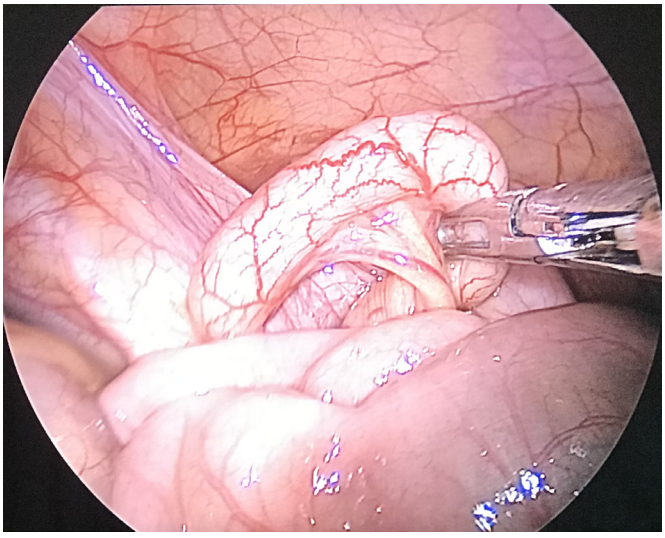

Figure 2. Visualization of inflamed appendix (phlegmonous) and it is externalized through the umbilicus

sealed with LigaSure™ (Medtronic Inc., MN, USA). After the mesoappendix was released, the camera and working port was relocated to better remove the appendix from abdomen. A second 5-mm telescope was placed into the second port with an angle of 30°. The working port was placed into the 11-mm trocar. The tip of the appendix was hold using a grasping forceps. The camera was first retrieved and, then, the appendix was removed from the abdomen, as in OA (Fig. 3). The umbilical fascia was closed with 2–0 polyglactin sutures. In patients in whom the appendix is not long enough to be resected or in severely complicated cases in whom dissection is not possible, a third or fourth

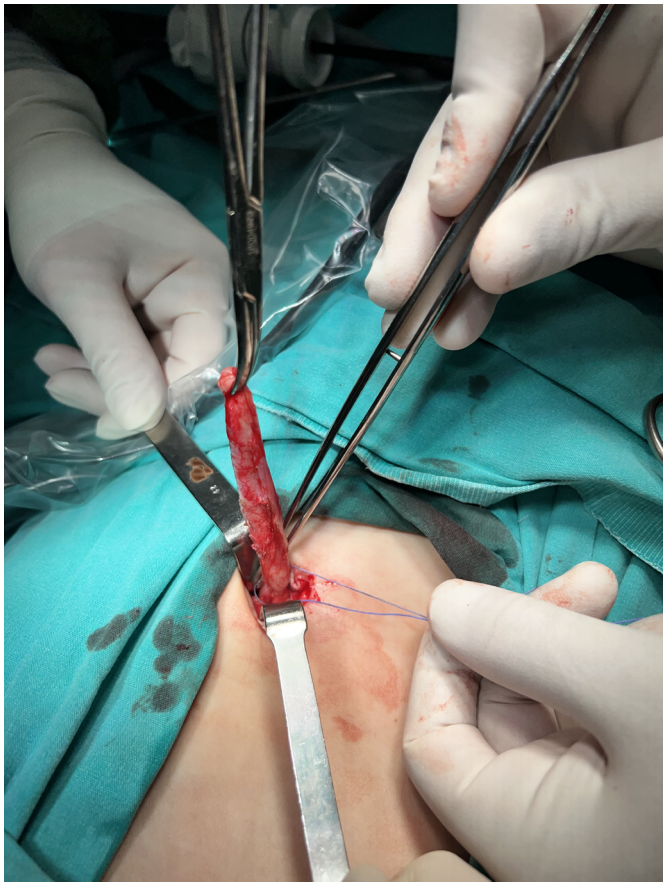

Figure 3. Following mobilization of the cecum and appendix, an extracorporeal appendectomy was performed.

trocar was used. These cases were excluded from the study.

Postoperative Management

Unless perforated, treatment with the same antibiotics was continued for 24 h and then discontinued. All perforated appendicitis cases received a regimen of ceftriaxone (50 mg/kg per day in two administrations) plus metronidazole (10 mg/kg per dose q8 h) and continued until discharge. Re-feeding started 12 h after surgery with uncomplicated appendicitis, 24 h in the other cases. Patients who remained afebrile for ≥24 h and had no pain resuming full oral diet was discharged. At 1 week, the patients were scheduled for follow-up and pathology results were evaluated. Complications were recorded. All patients were evaluated for scarring one month after surgery (Fig. 4)

Statistical Analysis

Statistical analysis was performed using the SPSS for Windows version 21.0 software (IBM Corp., Armonk, NY, USA). Continuous data were presented in mean±standard deviation (SD), while categorical data were presented in number and frequency.

Figure 4. Postoperative umbilical scar.

Results

Of a total of 79 patients, 55 (69.6%) were boys and 24 (30.4%) were girls with a mean age of 10.4±2 (range, 5–17) years. The most common symptoms were abdominal pain in 89.8% (n=71), anorexia in 31.6% (n=25), nausea in 36.7% (n=29), vomiting in 52.1% (n=65), and fever 13.9% (n=10). In the laboratory examinations, leukocytosis was identified in 62 (78.4%) patients and C-reactive protein value was elevated in 10 (87.3%) patients. Significant ultrasonographic findings were observed in 58 (73.4%) patients. The diagnosis was made in 21 (26.5%) patients using CT. All patients were operated on based on imaging findings. The surgery was performed using thoracoport-assisted laparoscopy. The procedure was completed as thoracoport assisted-laparoscopic appendectomy in 72 (91.1%) patients. A second port was needed in two patients and a third port was needed in three patients. In two patients, conversion from laparoscopic surgery to open surgery was performed. One of these two patients had an omental injury and intra-abdominal bleeding at the trocar entrance. In the other patient, open surgery was continued, as the appendix was fragmented. The mean length of hospital stay was 1.4±1 (range, 1–5) days. Postoperatively, two patients (0.6%) showed umbilical infection and one patient (0.01%) had intra-peritoneal abscess which was treated with intravenous antibiotics.

Discussion

Over the past decade, laparoscopic surgery using one umbilical incision has been increasingly adopted in the treatment of pediatric appendicitis. Compared to standard open surgery, the MIS has certain advantages, including simpler abdominal cavity exploration, improved diagnostic workup and differential diagnosis, and less postoper-

ative pain. The length of hospital stay is also shorter, as paralytic ileus resolves more rapidly in patients resuming food intake early.[1] The TULA was first described in children in 1998 by Esposito[9] and Valla et al.[10] were first treated patients with this technique in 1999. Using this approach, benefits of the laparoscopic technique are used, as enhanced visualization allows the surgeon to visualize the abdominal cavity and reach the appendix easily.[11,12] In pediatric surgery, single-port-assisted and hybrid laparoscopic appendectomies have become popular, owing to the ability of the surgeon to reach the appendix and remove it through the umbilical port, offering an extracorporeal appendectomy procedure.

Furthermore, the utilization of an optical trocar during surgery allows the development of surgical instruments such as graspers and cleansing tools that are critical in complicated appendicitis cases. During TULA, external appendectomy is performed through the traditional open surgery, thereby shortening the length of hospital stay and reducing the costs of surgery.[13,14] In addition, TULA is associated with less postoperative pain, shorter duration of pneumoperitoneum and diaphragm stimulation, and improved cosmetic outcomes.[14,15] Taken together, TULA seems to be easier than laparoscopy with a shorter learning curve. Our center is a low-volume center for MIS and learning curve for laparoscopic appendectomy is at least 10 surgeries, while for TULA it is <5 surgeries, irrespective of the stage of appendicitis. The TULA utilizes a laparoscopic approach, followed by an OA technique, leading to effective and reliable results.[16,17]

From the technical perspective, considering a shorter distance between the umbilicus and the cecum and a more flexible abdominal wall in children, the transumbilical excision is easier in this group of patients than in adults, facilitating appendix removal through the umbilicus.[18] In many studies including pediatric patients, the appendix was simply removed through the umbilicus without dissecting the peritoneal adhesions of the cecum and the mesoappendix; however, in some studies, the peritoneal attachments were dissected.[18-20] In our daily practice, we do not dissect the peritoneal attachments of the appendix and the cecum in pediatric patients to remove the appendix easily through the transumbilical incision. We believe that intracorporeal dissection of the mesoappendix with LigaSure™ is simpler in children and adolescents than adults, as the peritoneal attachments are thinner in this population. Although the SILA can be successfully performed in 98.9% of patients without additional ports, it has a longer operation time than TULA.[21,22] Of note, all these three laparoscopic appendectomy methods have similar postoperative outcomes.[23]

Nonetheless, there are some limitations to this study. First, this study is single-center and retrospective with a small sample size. Second, the type and timing of the surgeries were selected at the discretion of the surgeon. Despite all these limitations, this study showed the usefulness and feasibility of TULA in young adolescents, as TULA is associated with certain advantages over CMLA and even previous SILA procedures.

Conclusion

TULA seems to be a useful alternative to CMLA in children and young adolescents with a shorter operation duration, a shorter postoperative length of follow-up time in the hospital stay and a low rate of conversion to open surgery. Based on these findings, TULA is feasible for CMLA, as it is associated with lower extended resection and complication rates. Nevertheless, further large-scale studies are warranted to confirm these findings.

Disclosures

Ethichs Committee Approval: The study protocol was approved by Medipol University, Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (Date: February 16, 2023, No: 180). The study was conducted in accordance with the principles of the Declaration of Helsinki.

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Conflict of Interest: None declared.

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