

Original Paper

Gasless Trans-Umbilical Laparoscopically-Assisted Appendectomy in the Pediatric Population: An Early Experience

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Abstract

Background: *The aim of this study is to determine the feasibility and safety of the single-port gasless trans-umbilical laparoscopically-assisted appendectomy in the pediatric age group at a single center in a tertiary university hospital in Jordan.*

Methods: *Between April 2018 and July 2019, the surgical records of all patients aged between 0 and 13 years treated with trans-umbilical laparoscopic-assisted appendectomy TULAA for a suspected appendicitis following a clinical, laboratory and ultrasound findings were reviewed retrospectively. Baseline characteristics, white blood cell count, operative time, intraoperative findings, need for additional trocars or for conversion, length of hospital stay and surgical complications were reported.*

Results: *36 cases were included in the study, 23 (64%) were completed successfully using the gasless TULAA technique. Gas insufflation was needed in 10 (28%) cases and only 3 (8%) had to be converted to the three-port laparoscopic appendectomy technique. There was no significant difference between the gaseous and gasless groups in terms of baseline characteristics, BMI, surgery duration, postoperative recovery period or length of stay. However, the group of patients who needed gas insufflation to complete the procedure had a higher white blood cell count compared to the gasless group. The surgery was completed successfully by senior general surgery residents in 27 (75%) cases while the consultant's intervention was needed in the remaining cases. The gasless TULAA group were less likely to require complex analgesia (i.e., IV analgesia) compared to the gasless group (OR=0.683).*

Conclusions: *Gasless TULAA is a feasible procedure that can be performed safely by surgical residents as an initial approach for all grades of acute appendicitis in the pediatric age group.*

Keywords

gasless TULAA, appendicitis, appendectomy

1. Introduction

Acute appendicitis is the most common cause of acute abdomen in the pediatric age group with more than 78,000 cases reported in the United States yearly (Kozak, DeFrances, & Hall, 2006). The surgical techniques to perform appendectomy are manifold, ranging from the conventional open approach OA, all the way to the more innovative, minimally-invasive approaches such as the Trans-Umbilical Laparoscopically-Assisted Appendectomy TULAA.

Historically, Semm (1983) was the first to describe the three-port laparoscopic appendectomy TLA in the pediatric age population in Endoscopy. The first significant case series describing the utilization of laparoscopic appendectomy in the pediatric age group was reported by Valla et al. (1991).

Since then, the utilization of minimally-invasive approaches in pediatric surgery has been gaining wide acceptance among pediatric surgeons worldwide and laparoscopic appendectomy is now considered the standard treatment for acute appendicitis in most centers around the world.

The one-trocar appendectomy was first proposed by Pelosi and Pelosi (1992). This technique requires the use a laparoscopic lens with pneumoperitoneum to exteriorize the inflamed appendix and then perform a standard extracorporeal appendectomy. It profited from new advancement in the field of laparoscopy to implement a new minimally invasive approach that combines the good visualization of laparoscopy and the ability to perform a safe traditional open appendectomy from a single small umbilical incision.

Again, Valla et al. (1999) was the first to present a large case series of pediatric patient treated using the Trans Umbilical Laparoscopically Assisted Appendectomy TULAA technique. Other authors, including Ohno et al. (2012) and Sesia et al. (2015) also reported a high number of cases with excellent results.

To minimize the postoperative pain that might be caused by abdominal wall tension during pneumoperitoneum, gasless TULAA has been proposed as an innovative modification to the approach originally described by Pelosi and Pelosi.

We present our experience with the use of gasless TULAA technique for complicated and uncomplicated appendicitis with explanation of the technique used, safety, length of stay and postoperative complication.

2. Materials and Methods

This is a retrospective analysis of the surgical records of all children between 0 and 13 years of age who underwent TULAA for acute appendicitis between April 2018 to October 2019 were collected and analyzed. All the procedures were performed at the pediatric surgery center at The Jordan University Hospital by a pediatric surgery consultant and senior general surgery residents.

Initially, all cases were started by a senior general surgery resident using the gasless TULAA approach. If the appendix is not visualized or enough mobilization could not be achieved, CO₂ gas insufflation is added next to create pneumoperitoneum (Pressure: 10 mmHg, Flow: 4 L/min) and provide better visualization of the surgical field. Finally, the procedure is converted to the Three-Port Laparoscopic Appendectomy as a last resort if all the aforementioned interventions fail.

The data involving patients' demographics, preoperative white blood cell count and neutrophil relative percentage (%), operative time, intraoperative findings, pathology of the resected appendix, recovery period after surgery, length of stay and postoperative complications were collected.

Data were analyzed using Microsoft Excel and SPSS 25.0 (SPSS Inc., Chicago, IL). Discrete variables are reported as number and percentages. Continuous variables are reported as a mean and standard deviation. A two-tailed Student's t test and single factor ANOVA were used for comparison of means and calculating the *p*-value. Odds ratio analysis was used to test the strength of association between outcomes. A two tailed P value of < .05 was considered statistically significant.

The study was approved by the local ethical committee and an Informed consent was obtained from all patients enrolled in the study.

3. Pre and Postoperative Management

At our institution, all children reporting abdominal pain with suspected appendicitis should have a preoperative abdominal US to confirm the diagnosis.

Those that lack the clinical or ultrasonographic evidence of appendicitis are managed conservatively. They are admitted for at 24 hours while their symptoms are monitored with serial examination.

Oral intake was allowed to be resumed immediately after full recovery from anesthesia upon the patients' desire "ad libitum" in all cases. They are finally discharged from hospital if they have no pain and have resumed and tolerated full oral diet.

Simple analgesia in the form of Paracetamol syrup or suppositories were given "pro re nata" in all cases and stepped up to stronger forms like Perfalgan IV as needed.

4. Surgical Technique

The procedure is performed under general anesthesia. All patients undergoing surgery are given IV antibiotics preoperatively. A 10-15 mm longitudinal incision is made directly through the umbilicus to access the abdominal cavity Figure 1a. A 5-mm laparoscopic lens and a 5-mm laparoscopic forceps are then introduced through the umbilical incision without a trocar Figure 1b. To give a better visualization of the surgical field, the abdominal wall fascial layer is lifted up using a grasper at the umbilical cicatrix and the abdominal wall is lifted manually at the right iliac fossa. Once the appendix is identified and dissected free Figure 1c, the tip of the appendix is grasped and exteriorized through the umbilicus Figure 1d and 1e. If the appendix could not be visualized or extracted due to dense adhesions or abnormal location, the adhesions are taken down by finger dissection through the umbilical incision

followed by a second lock using laparoscopic lens. If all the previous measures failed to mobilize the appendix, a 5-mm trocar is inserted and carbon dioxide (CO₂) pneumoperitoneum is achieved to expand the surgical field, a laparoscopic grasper is then introduced into the abdominal cavity through a separate incision in the umbilical cicatrix just next to the trocar. An operating lens is sometimes used to visualize the appendix and operate a laparoscopic instrument using the same incision. Once the appendix is exteriorized Figure 1f, a conventional extracorporeal appendectomy is performed by dividing the mesoappendix and ligating the base of the appendix Figure 1g and 1h. A peritoneal lavage is done if necessary. The wound is closed cosmetically and sterile dressing applied for 48 hours Figure 1i.

Conversion to the TLA technique is considered as a last resort for the difficult appendix after failed attempts using the TULAA technique by introducing one or two additional 5 mm trocars.

Drain insertion was not needed in all cases.

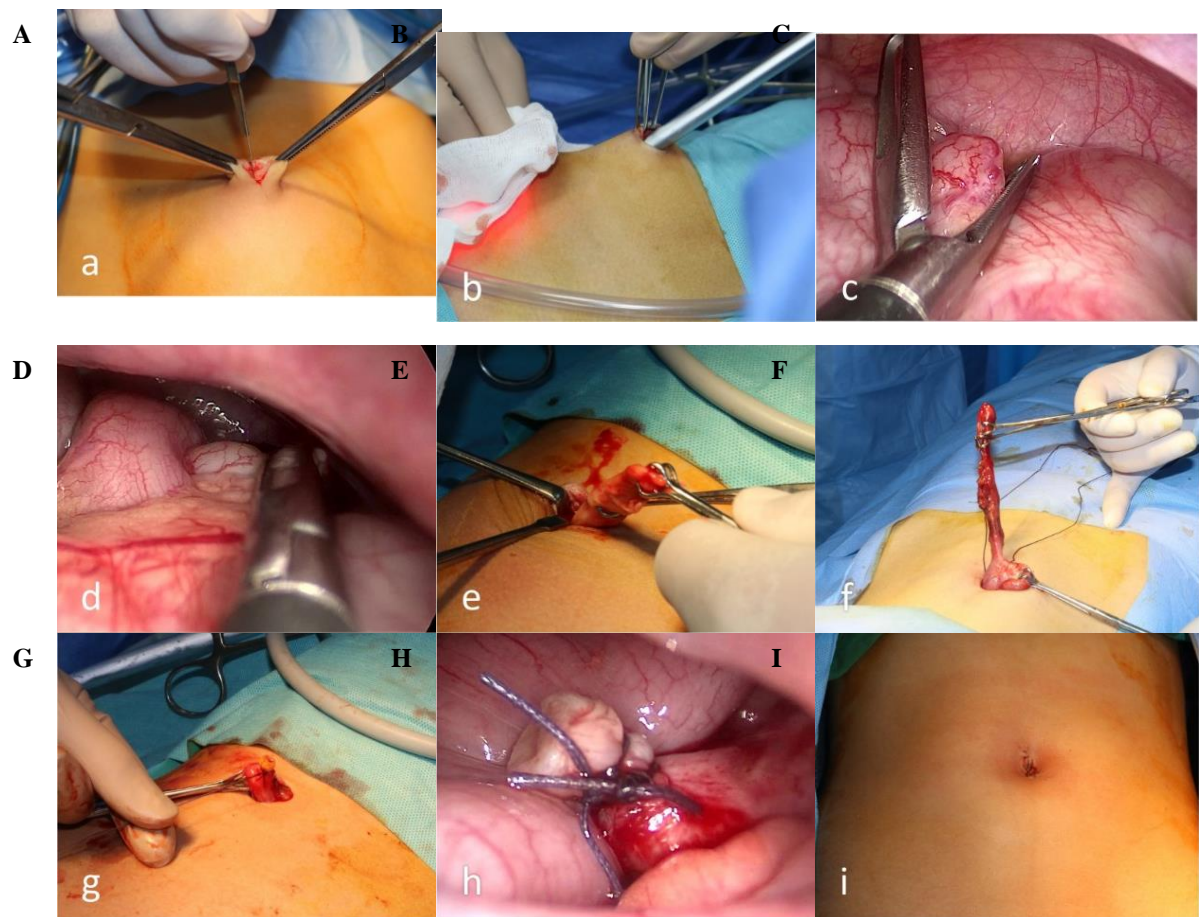


Figure 1. (A) Umbilical Incision. (B) Laparoscopic Lens Insertion with Manual Lifting of the Abdominal Wall. (C) Identification of the Appendix. (D) The Appendix is Grasped from the Tip. (E) Exteriorization of the Appendix. (F) Exteriorization Complete. (G) Extracorporeal Appendectomy. (H) The Appendiceal Stump. (I) Skin Closure

5. Results

During the study period, a total of 36 patients, 21 (58%) males and 15 (42%) females, aged between 0 and 13 years, with suspected appendicitis were initially treated with gasless TULAA at our institution. The demographic characteristics of the patients is summarized in Table 1.

All appendectomies were started using the gasless TULAA technique and they were performed by senior general surgery residents under the pediatric surgery consultants' direct supervision. Gas insufflation or additional trocars were only added if necessary. The consultant steps in to complete the procedure if the resident performing the procedure is facing a great difficulty visualizing or mobilizing the appendix due to thick adhesive bands and abnormal appendix location. The procedure was completed by a surgical resident in 20 cases, while the consultant stepped in to complete the procedure in 7 cases which are proved to have been difficult of the 36 cases in our study. Gasless TULAA was completed successfully in 27 (75%) of them. Gas insufflation was needed in 10 (28%) cases due to difficulty in visualizing the appendix, one case (3%) needed the use of one additional trocar and three more cases (8%) case had to be converted to the TLA technique by adding two more trocars due to sever inflammation and dense adhesions. No patient had to be converted to the open technique.

Mean duration of surgery, from skin incision to skin closure, was 63.9 minutes for the gasless group and 76.2 minutes for the gaseous groups ($p = 0.125$), which indicates that gas insufflation can be added if needed at no significant time increment. The overall mean operative time was 67.6 (range 30-120) minutes. The wide range can be explained by varying grades of appendicitis.

The procedure was completed successfully by a 5th year general surgery resident in 14 (39%) cases, 7 (19%) cases were completed by a 4th year resident and 6 (17%) cases by a 3rd year resident. However, the consultant had to step in to complete the procedure in 9 (25%) cases, 3 of which were converted to the TLA technique.

Table 1. Demographic Characteristics

	Gasless TULAA (n=23)	Gaseous Group (n=13)	<i>P</i> value
Age (years) [mean (range)]	8.2(3-12)	8.7(4-13)	0.558
Gender [n (%)]			
Male	13(57%)	8(62%)	
Female	10(43%)	5(38%)	
BMI kg/m ² [mean(SD)]	17.6(3.31)	16.6(2.77)	0.342

BMI, body mass index; SD, standard deviation.

The mean duration of surgery was also similar between groups ($p = 0.125$). The mean duration to complete the surgery was 66 minutes for the 5th year residents, 55 minutes for 4th year resident, 58 for 3rd year residents while the cases that needed intervening from the consultant were completed in 81

minutes in average ($p = 0.119$).

Of the 36 appendectomies performed, 25 (69%) were acutely inflamed, 4 (11%) was perforated gangrenous appendix, 6 (19%) were categorized as normal non-inflamed. All categories were based on the pathologist examination which correlated well with the gross impression during surgery.

The mean recovery period after surgery was 1.08 days while the mean length of stay was 1.4 days. There was no difference between the gasless and gaseous in the mean recovery period after surgery (26.7, 27 hours respectively, $p = 0.959$) or mean LOS (1.44, 1.75 days respectively, $p=0.301$).

To assess the post-operative pain, the type and number of doses of analgesia needed by each patient after surgery were collected and analyzed. The gasless TULAA group were less likely to require complex analgesia (i.e., IV analgesia) compared to the gasless group (OR=0.683, 95% CI 0.376-1.243). In our study, we had only one patient (3.7%) come back with an umbilical wound infection which was treated with a single course of oral antibiotics as an outpatient which is less than the infection rate reported by centers around the world (Koizumi, Kobayashi, Nakase, Takagi, & Fukumoto, 2015). No other complications were reported in our study.

There was no difference in the cost effectiveness between the two groups in our study.

6. Discussion

For the past 2 decades, the TLA has been widely accepted as the standard treatment for acute appendicitis in the pediatric age group in most centers around the world with a proven safety profile in all grades of appendicitis (Vegunta, Ali, Wallace, Switzer, & Pearl, 2004; Zwintscher, Johnson, Martin, & Newton, 2013; Goh et al., 2005). However, the quest to minimize minimally invasive surgery even further has led surgeons to newer means of access to the abdominal cavity with less surgical trauma and thus decreasing postoperative pain and eventually surgical costs.

The TULAA technique was first proposed by Pelosi and Pelosi (1992) in adults. Due to the difficulty in extracting the appendix through the umbilicus, it did not gain a huge popularity in adults possibly also due to the general perception of the surgical community that a totally laparoscopic approach is better than a hybrid procedure. However, it was heavily adopted by pediatrics surgeons due to the anatomical proximity between the umbilicus and the ileocecal junction and the elasticity of the abdominal wall in pediatric patients which almost limited the use of TULAA to this age group (Esposito, 1998; Perin & Scarpa, 2016).

In children, complications arise from CO₂ insufflation for pneumoperitoneum during laparoscopy include gas embolism, cardiovascular compromise, hypercapnia and diaphragmatic splinting (Tobias, 1998). These risks are minimized by limiting the pressure to 8-15 mm Hg.

The first reports of gasless laparoscopic surgery were first published in the 1990s when surgeons had to come up with new techniques to maintain exposure of the surgical field during certain procedure when an airtight abdomen can't be maintained and to counter act the hemodynamic effect of co₂ insufflation during long procedures (Paolucci, Gutt, Schaeff, & Encke, 1995; T. U. et al., 2010).

Lee et al. (2014) as the first to describe the use of gasless TULAA in adults. He showed that gasless laparoscopy-assisted trans umbilical appendectomy is a feasible, safe, and cost-effective technique for appendectomy in uncomplicated appendicitis with good cosmetic results. It did not increase the rate of complications and represents a possible alternative to the TLA technique.

Stanfill et al. (2010) showed that TULAA is a reasonable alternative to the standard minimally invasive technique for appendicitis in both acute and ruptured situations. All analyzed complications were similar between the groups, suggesting that TULAA is an acceptable surgical method in pediatric patients for all stages of appendicitis.

One of the potential downfalls of the gasless TULAA technique is the decreased overall observation of the peritoneal cavity added to that difficulty in mobilizing intra-abdominal contents with a single instrument.

7. Conclusions

According to our experience, the gasless TULAA technique is a feasible option for the treatment of appendicitis in the pediatric age group. Our data shows that the procedure can be done safely by general surgery residents without increase in complication rate or mortality.

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