Two-port retrograde laparoscopic appendicectomy for complicated pediatric appendicitis using a single Hem-O-Lock clip for the closure of the appendicular stump

Basem M. Sieda

Department of General Surgery, Faculty of Medicine, Zagazig University, Zagazig University Hospitals, Zagazig, Egypt

Correspondence to Basem M. Sieda, MD, Department of General Surgery, Faculty of Medicine, Zagazig University, Zagazig University Hospitals, Zagazig, Egypt
Tel: +20 100 008 9500/+01200016007;
e-mail: drbasemsieda@yahoo.com

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Objective
The aim of this study was to assess the safety and the technical feasibility of retrograde laparoscopic appendicectomy for the pediatric population with complicated appendicitis (gangrenous, perforated, or forming mass) and to evaluate the security and advantages of closing the appendicular stump with a single Hem-O-Lock polymer clip.

Materials and Methods
This is a prospective review of 82 pediatric patients presenting with acute appendicitis, of whom 50 patients were selected, according to computed tomographic abdomen and pelvis, to have a complicated appendicitis. All the data were collected and interventions were performed in Zagazig University Hospitals during the period from December 2012 to August 2014. All cases were operated by two-port retrograde appendicectomy using single Hem-O-Lock polymer clips to close the appendicular stump. The age, the sex of the patients, and complications were evaluated. Treatment complications and outcomes were recorded for all cases.

Results
Four of the 50 patients (8%) had postoperative complications; four patients developed intra-abdominal abscess postoperatively: two of them underwent laparoscopic drainage during the same admission and the other two patients were readmitted after 1 and 2 weeks, respectively, when one of them underwent ultrasound-guided drainage and the other one improved within 48 h by medical treatment. No other complications were noted apart from one case that converted to open surgery due to a large cecal mass with a gangrenous cecal wall. The cases of postoperative abscess occurred early during our initial experience, with laparoscopic appendectomy for complicated cases.

Conclusion
Retrograde appendicectomy allows easy access to operate complicated appendicitis. The use of two ports adds an advantage to the procedure by decreasing postoperative pain. The use of a single polymer clip is as secure as two clips for the closure of the appendicular stump even for a complicated appendix.

Keywords:
laparoscopic appendicectomy, polymer clips

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Introduction

Acute appendicitis was and still is one of the most common pediatric surgical emergencies. Laparoscopic appendectomy, first performed by Semm in 1983, has become increasingly popular over the years. Children are more prone than adults to present with complicated appendicitis, especially perforation [1]. Laparoscopic appendectomy has become an accepted management modality in complicated pediatric appendicitis (CPA) as well as in uncomplicated cases [2].

The proper management technique of CPA (appendicular mass, gangrenous or perforated) had been more controversial [3]. However, in cases of complicated appendicitis, the anatomy can be obscure, and the operative time can be significantly prolonged. Laparoscopy in complicated cases of acute appendicitis can be a challenging and technically demanding procedure that requires more than basic laparoscopic skills, and requires the use of special techniques to access the complicated appendix as most complicated cases have a hidden appendix, especially the tip [4].

There are several methods for the ligation of the appendicular stump during laparoscopic appendicectomy. Many studies have shown the safety and the cost of different devices in different situations. Each technique has its own potential advantages and disadvantages. Endo-GIA staplers are expensive instruments. Titanium clips may be slipped from their primary position. A Hem-O-Lock clip is a nonabsorbable polymer clip with a lock-engagement feature and teeth within the jaws, which may provide greater security [5].

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Laparoscopic appendicectomy using a single polymeric clip to close the appendicular stump in children is a safe, feasible, and inexpensive method [6]. The use of a single clip for the closure of the appendicular stump can be used as the standard procedure in laparoscopic appendectomy whenever possible as its secure jaw favors it over single endoloop application and there is no difference in the safety in case of two-clip application [7].

Materials and Methods

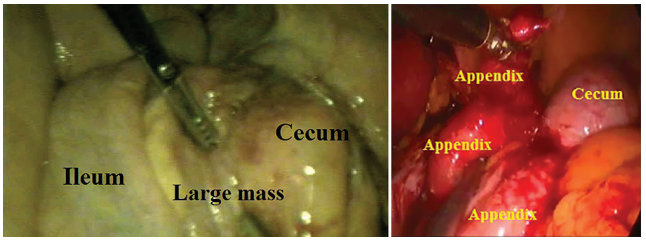
Between December 2012 and August 2014, 82 Pediatric patients presenting to our university hospital in the Emergency Room Department and/or referred from other hospitals with complicated acute appendicitis were identified from our prospectively collected data [clinical examination, fever, elevated total leukocyte count, pelviabdominal ultrasound by a senior staff, and finally the most diagnostic results are obtained from the computed tomographic (CT) abdomen and pelvis. Only pediatric population with suspected complication exposed to CT, as patients with classic appendicitis are not exposed to CT and not included in our study 50 consecutive patients from a total of 82 patients presented and diagnosed with complicated acute appendicitis were treated laparoscopically.

Pediatric patients constituted 11 cases with an appendicular mass (Fig. 1a), nine cases with an appendicular abscess (Fig. 2), five cases with a gangrenous appendix (Fig. 3a), 21 cases with a perforated appendix at the tip, and four cases perforated near the base (Fig. 4).

Laparoscopic appendicectomy was performed with the patient under general anesthesia; the abdomen was dripped and prepped in the ordinary manner with insufflation of CO_2 pneumoperitoneum. The insufflation pressure was controlled automatically and kept below 12 mmHg. Foley's catheter was inserted after the induction of anesthesia to empty the bladder. It was mandatory because the Foley catheter is helpful in decompressing the bladder, thereby maximizing the viewing field and improving the working space and allowing the demarcation of the dome of the bladder. A monitor was positioned to the right of the patient.

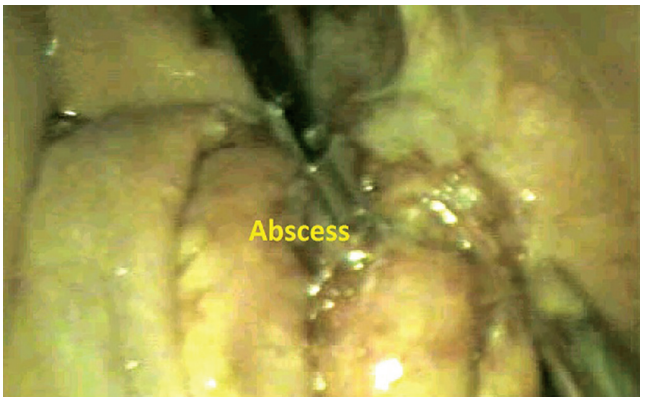
A two-port was used; the first or the optical trocar was a 10 ml trocar used for the camera, using a safety port, a thorough look with the scope done for the abdomen with more focus on the pelvis. Once the procedure is started and the laparoscope has been inserted, steep Trendelenburg positioning allows proper placement of the remaining trocar. The other trocar was inserted under complete vision. It was a 10 mm trocar for the introduction of the clip applier at the left midclavicular line.

Figure 1



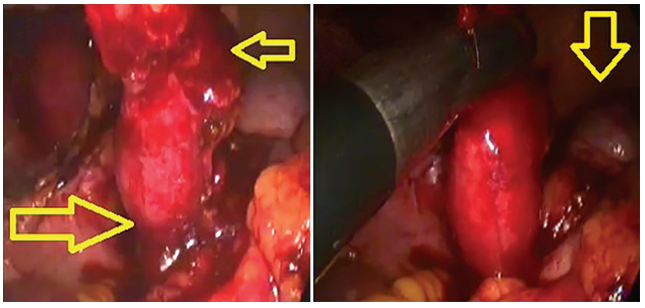
A large appendicular mass.

Figure 2



An appendicular abscess.

Figure 3



A gangrenous appendix.

After all of the trocars have been placed, placing the patient left side down aids gravity in relocating the small bowel away from the appendiceal/cecal field of vision.

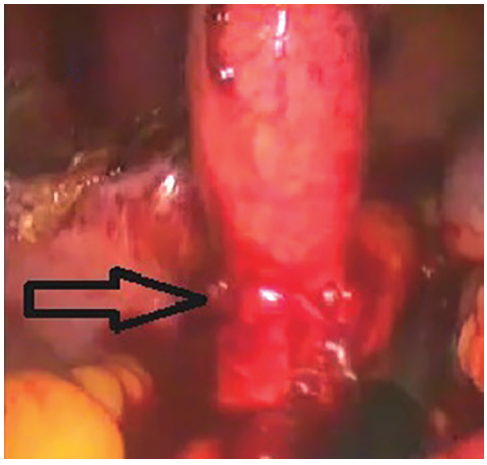
In recent and past cases, disposable equipment was used, whereas in early cases, the equipment was nondisposable.

The appendix was identified. Any part of the appendicular shaft was stayed by a nontraumatic grasper and pushed to the abdominal wall at the Mcburney point detected by pressing from the outside,

and a 2/0 proline suture on a straight needle or a curved rounded needle was passed from the abdominal wall to the appendix to the abdominal wall again and tied extracorporeally, the gangrenous appendix cases were the most difficult cases for staying. Reorientation and thorough exploration of the pelvis was performed to demarcate the extension of the appendicular mass or the retroperitoneal abscess.

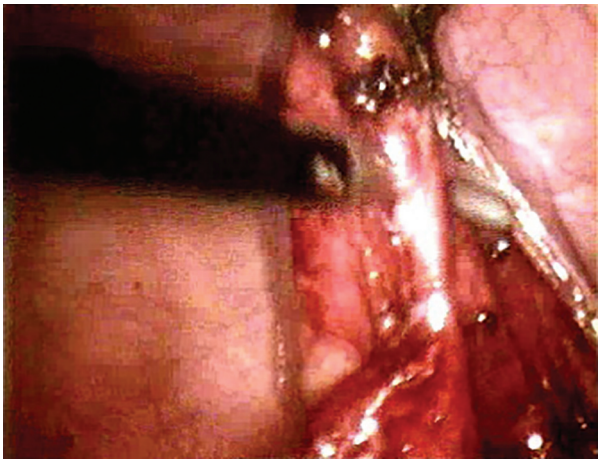
The appendix was freed, dissection of appendicular vessels was performed (Figs. 5 and 6), but dissection was difficult due to disturbed anatomy. The vessels were difficulty dissected after a window was created in the mesoappendix beside and adherent to the base; a clip applier was introduced and a single Hem-O-Lock polymer clip (L, XL clips) was fired at the appendicular base (Figs. 7–9), and another titanium clip or a polymer clip was applied distally.

Figure 4



Perforation near the base of the appendix.

Figure 6



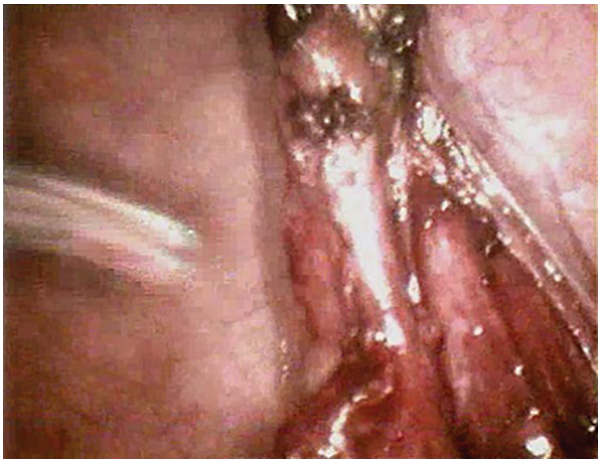
Dissection of appendicular vessels.

For cases with perforation at the base, the polymer clip was applied more proximally. Six out of the nine cases with appendicular abscess necessitated opening the peritoneal reflection or tolds line to access the pus.

One case necessitated transfixing the base of the appendicular stump. The appendix was transected between the proximal polymer and the distal titanium clip or the distal polymer clip over a piece of gauze (Figs. 10 and 11); the mesoappendix was then divided using bipolar diathermy (Fig. 12) or an endoloop. The stay suture dislodged and the freed appendix was placed in sterile gauze and removed with the 10 mm port.

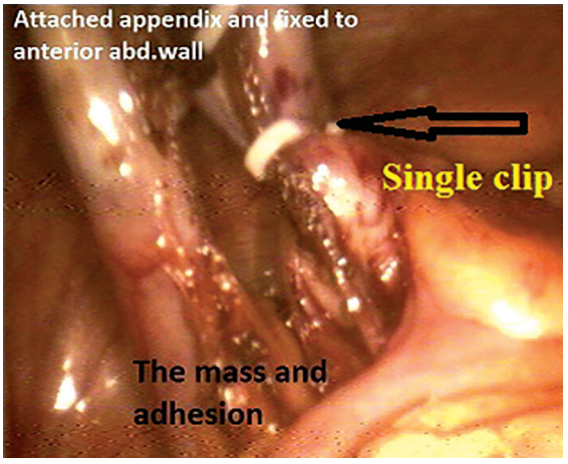
The 10 mm port was reinserted, peritoneal lavage and suction was completed, and hemostasis was secured. Patients had a Jackson-Pratt drain placed in the pelvis after the completion of the appendectomy.

Figure 5



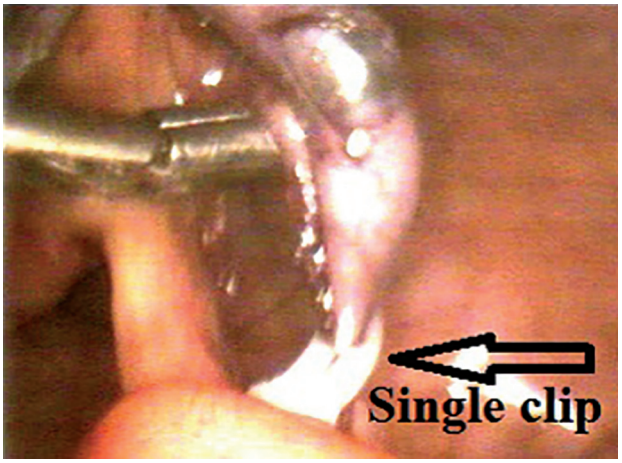
Dissection of appendicular vessels, while the appendix stayed to the abdominal wall.

Figure 7



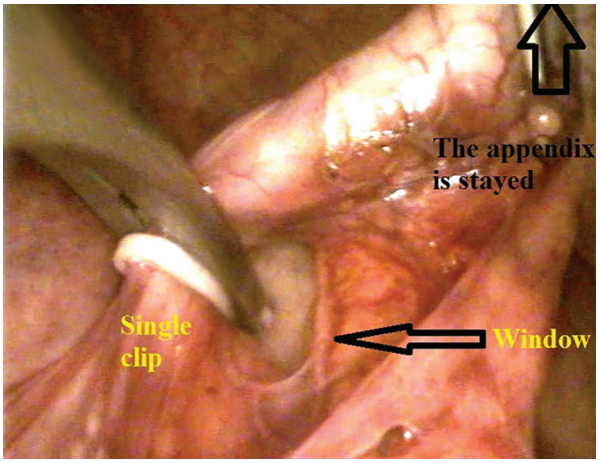
A single clip applied at the base, while the appendix stayed and the tip forming mass and hidden.

Figure 8



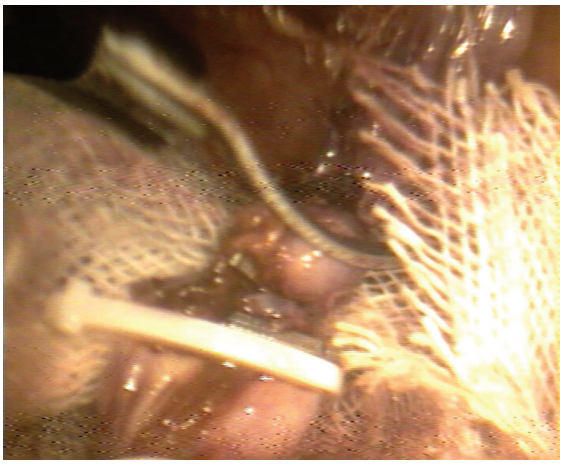
Single clip.

Figure 9



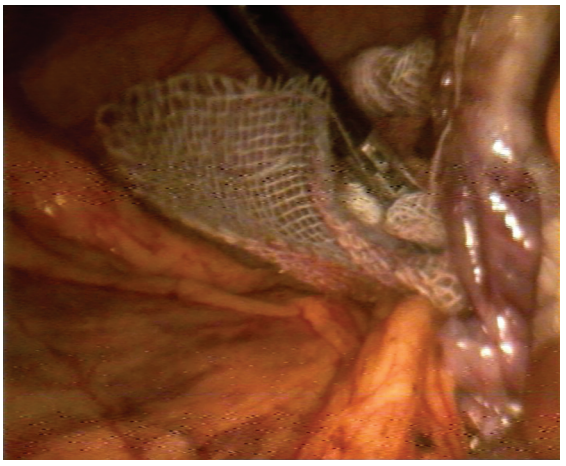
Single clip.

Figure 10



Cutting above the single clip over a piece of gauze.

Figure 11



Cutting above the single clip over a piece of gauze to remove the appendix within it.

Figure 12

Division of the mesoappendix with bipolar.

The insufflated gas was released and the skin edges were approximated with absorbable sutures. Postoperative analgesia and perioperative intravenous antibiotics were administered using third generation cephalosporin. An oral diet (diet as tolerated) was resumed usually within 12 h, and the drain was removed after 24 h.

Statistical analysis

Categorical qualitative variables were expressed as absolute frequencies (n) and relative frequencies (%). The 95% confidence interval for rates were calculated to interfere with the rate of occurrence in the population. All statistics were performed using SPSS, 22.0 for windows (SPSS Inc., Chicago, Illinois, USA) and MedCalc, 13 for windows (MedCalc Software bvba, Ostend, Belgium).

Results

A total of 82 patients were diagnosed with complicated acute appendicitis. The diagnosis of complicated appendicitis in all patients was based on clinical and confirmed by CT findings. About 50 patients (60.9%) with a positive CT scan underwent two-port laparoscopy. Thirty-two patients (39.1%) with vague symptoms and negative CT imaging were observed and underwent classic laparoscopic appendicectomy.

Pediatric patients constituted 21 cases with a perforated appendix at the tip, four cases perforated near the base, 11 cases with an appendicular mass, nine cases with an appendicular abscess, and five cases with a gangrenous appendix (Table 1).

Forty-two (84%) male and eight (16%) female patients underwent surgery. Patients' age ranged from 9 to 16 years (mean 13.5 years). All appendectomies were completed laparoscopically, except two patients. One patient with an appendicular mass, unhealthy base, and a gangrenous cecal wall was converted to open surgery and we proceeded for right hemicolectomy. The other patient had previous transverse suprapubic incision for intussusceptions and very difficult adhesiolysis, and so we converted the laparoscopic approach to open surgery.

All patients were operated using one proximal clip for the stump, except one patient, who required an extra transfixation suture below the single proximal polymer clip, and this was due to defective clips at the time of operation, explained by slippage of three clips after locking into the jaw of the clip applier and failed reinsertion of two of them; the last clip was inserted and secured with transfixation. This also occurred in the early cases.

Four of the 50 patients (8%) had postoperative complications. Four patients (8%) developed intra-abdominal abscess (IAA) postoperatively: two of them underwent laparoscopic drainage during the same admission, and the other two patients were readmitted after 1 and 2 weeks, respectively, and one of them underwent ultrasound-guided drainage and the other one improved within 48 h with the use of invanz intravenously and metrinidazole rectally (Table 2).

No other complications were noted. None of these patients were readmitted for port-site complication. The postoperative abscess occurred early during our initial experience with laparoscopic appendectomy, and it was the first case of CPA performed laparoscopically. The postoperative course of all patients was uneventful, except for the patients who developed postoperative IAA.

Table 1 The type of complication and the number of patients

Complications	*n* (%)	95% CI (%)
Perforated tip	21 (42)	26–64.2
Perforated near base	4 (8)	2.1–20.4
Appendicular mass	11 (22)	10.9–39.3
Appendicular abscess	9 (18)	8.2–34.1
Gangrenous appendix	5 (10)	3.2–23.3

CI, confidence interval.

Table 2 Postoperative complications (intra-abdominal abscess) and the timing of management

Timing of intervension for post operative complication	First admission	Second admission after 1 week	Second admission after 2 weeks
n (%)	2 (2.8)	1 (1.4)	1 (1.4)
95% CI (%)	0.3–10.3	0.3–7.9	0.3–7.9
Method of management	Laparoscopic drainage	Underwent US-guided drainage	Improved within 48 h with the use of invanz intravenously and metronidazole rectally.

CI, confidence interval; US, ultrasound.

All patients were discharged from the hospital within 2 days, except for the four patients with abscesses and the case of right hemicolectomy, which necessitated the patient to stay up to 6 days postoperatively. All patients were followed for at least 30 days in the outpatient clinic by the attending physician and resident doctors.

Discussion

In our study, we excluded this technique for noncomplicated cases; hence, we added CT pelvis to confirm our diagnosis. Many other studies have emphasized the role of CT and other scores to avoid operation or performing a negative appendicectomy [8]. It has been suggested in the past that laparoscopic appendectomy for CPA in children is not a safe procedure and should be avoided [9]. Our recent findings suggest that laparoscopy can be a main therapeutic procedure instead of open appendicitis in these complicated cases. Taylor [10] recommended only the open approach in cases with appendiceal masses if diagnosed well by ultrasound. This was not supported in our current study in which most of the cases with appendiceal masses were successfully treated laparoscopically, except one case. Most cases were diagnosed preoperatively on the basis of CT of the abdomen and the pelvis.

Recent guidelines recommended immediate surgery for an appendicular mass by open surgery against the laparoscopic approach, and using a single incision adds

more advantage to the laparoscopic approach [11], which is in agreement with our study, but we used two ports instead of the single port. Early operation, in contrast, has the benefit of being curative in the index admission and ensures early return to work and higher compliance [12]. The previous concept that surgery is difficult in a state where the inflamed appendix is buried deep in the mass and the bowel loops are friable is no more a valid argument at present, due to the improvement in anesthesia, the electrosurgical unit, and antibiotics [13].

In retrospective studies, the incidence of postoperative IAA formation after laparoscopy in children with CPA varies anywhere between 5.8 and 41%, and in our study, it was 8%, but our study was for complicated cases; the improvement in the percentage was supported by the use of the two-port technique and the accepted method of dissection by the retrograde approach, In another recent study conducted and reported by Arash et al. [14], comparing laparoscopy with open appendectomy for CPA, no IAA occurred after laparoscopic appendicectomy for uncomplicated appendicitis. In other studies, the overall infection rate including port-site infection and IAA was 2.54% in uncomplicated cases and it was 7.32% in complicated cases [15]. A study conducted by Nasher [16] revealed results similar to our results, and he used a technique considered to be the same as our approach.

A study similar to our study conducted by Partecke [6], from January 2009 to December 2009, included 82 patients in the prospective, nonrandomized trial; a single Hem-O-Lock MLX polymeric clip was applied. The data collected included the age, the sex, the number of clips used, complications, and the preoperative white blood count and C-reactive protein. He found a lower incidence of postoperative IAAs and surgical site infection, and he attributed his results to both the laparoscopy and the single polymer clip used. It is partially similar to our study, but we used a larger number of patients over a larger period of time.

In the Mariadason series [17], six of their 37 patients having severe right lower abdominal pain were subsequently found to have abscesses, and they reported that the disadvantage of the conservative management is the chance of misdiagnosis by conditions such as intussusception, and cancer cecum may be treated conservatively by mistake, adding considerable morbidity.

Walz et al. [18] conducted a study and documented that all study patients with complicated appendicitis had drains placed in the abdomen for drainage. A high degree of suspicion and the use of imaging helps in the diagnosis and the early treatment of postoperative IAA. In a recent study, it was suggested that the placement of drains in the right lower quadrant might be beneficial in patients with complicated appendicitis, especially perforated appendicitis and localized abscess cavities. In that study, 80% of the patients with CPA had an uneventful laparoscopic appendectomy. All these patients had drains placed in the right lower quadrant. In our study, we treated about 96% of the patients with laparoscopy, but we inserted the drain in only the left midclavicular port despite being less dependent, but patients did not need extra incision.

In our study, the use of a polymer clip was a must as we operated on complicated cases, and securing the stump was of utmost importance, and because the safety of the single clip was proved in our study, future cases will be subjected to the same technique. Our study on single clip usage was in complete agreement with other international studies, [19]with nearly the same number of patients, but a shorter period of study. Our findings compared favorably with others in terms of the safety and the feasibility.

Conclusion and recommendations

Laparoscopic appendectomy seems to be a safe alternative for the treatment of complicated appendicitis in children. The use of two ports added an advantage for the procedure by decreasing postoperative pain, decreasing the hospital stay, decreasing the incidence of port-site complications, and providing better cosmoses. Placement of drains is a must. Complicated appendicitis should not be considered as a contraindication for laparoscopy. Retrograde appendicectomy facilitated the treatment of complicated appendicitis, especially for appendicular mass and perforated appendix, and yield the best results, especially with the use of polymer clips that ensure secure closure of the stump even in a perforated appendicitis.

Endoscopic staplers are expensive instruments. Titanium clips may be slipped from their primary position or cut through edematous tissue. A Hem-O-Lock clip is a nonabsorbable polymer clip with a lock-engagement feature and teeth within the jaws; the jaw provides considerable safety to apply only one proximal clips, which ensures complete lumen closure that is as strong as with two clips, but it is more advantageous than using two clips in being less time consuming and less costly, all of which may provide greater security. Using polymeric clips to close the appendicular stump in children

is a safe, feasible, and inexpensive method. We, as well as many others, have also adopted the Hem-O-Lock for laparoscopic appendicectomy. As the safety of the single clip was proved in our study, we recommend that future cases be subjected to the same technique.

Acknowledgements

Conflicts of interest

None declared.

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