

Low-cost laparoscopic appendectomy in pediatric patients

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Background/purpose Laparoscopic appendectomy is widely practiced worldwide and has become one of the commonly performed procedures in pediatric surgery practice. However, the cost effectiveness of the procedure remains a major concern. The present study aimed to evaluate the safety and effectiveness of the operative techniques used to reduce the cost of the procedure.

Patients and methods A prospective study was conducted on patients undergoing laparoscopic appendectomy over a period of 2 years. The techniques used to reduce the cost of laparoscopic appendectomy were as follows: (i) using reusable trocars instead of disposable ones; (ii) using monopolar electrocoagulation to seal the mesoappendix instead of staplers, LigaSure, or Harmonic scalpels; and (iii) using a handmade loop to secure the base of the appendix instead of using endoloops.

Results This study included 39 boys and 21 girls. The median age was 10 years. The mean duration of the operation was 56.5 min. No intraoperative complications

were encountered. Two cases developed pelvic hematoma and were managed conservatively with success. The mean hospitalization stay was 2 days.

Conclusion Division of the mesoappendix using monopolar electrocautery and closing the base of appendix using handmade endoloops during laparoscopic appendectomy appears to be a simple, effective, safe, and cost-efficient technique. Therefore, the use of more costly instruments, such as the endostapler, LigaSure, or Harmonic scalpel, seems unwarranted. *Ann Pediatr Surg* 12:100–103 © 2016 Annals of Pediatric Surgery.

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Introduction

Laparoscopic appendectomy is widely practiced throughout the world, especially in the last decade [1]. It has the advantages of less wound infections, improved cosmesis, decreased postoperative pain, shorter hospital stay, faster recovery, and earlier return to work in comparison with open surgery [2,3]. Although the technique of laparoscopic appendectomy was first described more than 20 years ago, the technical details are still being modified [4] and improvements can be measured in terms of complications and cost [5,6]. The hospital costs of laparoscopic appendectomy is more than the open approach, as shown by most prospective studies [7–11], but few studies have found it to be less costly [12,13]. The increase in cost is attributed to increased operative time for laparoscopic procedures [6], as well as to the higher cost of specialized instrumentation such as endoscopic stapler, endoscopic clip, LigaSure, and Harmonic scalpel [14–16].

The objective of this study was to evaluate the safety and outcome of using some techniques that reduce the cost of laparoscopic appendectomy in pediatric patients.

Patients and methods

The present study included 60 patients who underwent laparoscopic appendectomy in the period from December 2013 to December 2015. The parents of the infants had been informed about the steps of our study, including the operative technique, and an informed consent was obtained. Privacy of the participants and confidentiality of the data were maintained. A database was constructed

to include the following data for further analysis: patients' demographics, operative time, method of dissection of mesoappendix, method of ligation of the base of the appendix, operative and postoperative complications, length of hospital stay, and cost of equipments.

The study was approved by our institute review board.

Operative technique

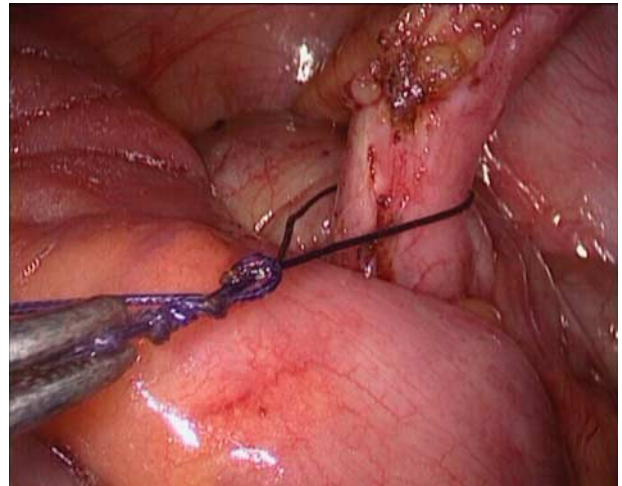
Pneumoperitoneum was introduced by Veress needle and CO₂ at 10 mmHg pressure was used. A 10 mm reusable camera port was placed in the umbilicus. Two 5 mm reusable working ports were placed at the left lower quadrant and suprapubic region. Exploration of the abdominal cavity and identification of the appendix was then done. The mesoappendix was sealed using monopolar cautery and the base of the appendix was ligated by a handmade Vicryl (Ethicon, USA) loop.

Techniques for cost reduction

- (1) Using reusable trocars instead of disposable ones (Karl Storz, Germany).
- (2) Instead of using staplers, LigaSure (Covidien, Minnesota, USA) or Harmonic scalpel, the appendicular mesentery dissection was performed using a Maryland forceps or a hook attached to the monopolar cautery. Small successive bites are taken for thermal coagulation very close to the appendix where the branches of the appendicular artery are smallest.

(3) Instead of using endoloop, the appendiceal stump was secured by three handmade loops using 2/0 Vicryl and by, pulling one end of the loop, the knot slid down the base of the appendix. To form the loop, first we made one short limb and one long limb. The short limb is knotted three times around the long limb making a surgical knot; then it was wrapped three times above the surgical knot to make the loop. The loop was tested extracorporeally using a curved mosquito forceps to push the wrap and knot to make sure that they slide easily. The loop was then inserted into the abdominal cavity, and the loop was moved to the base of the appendix, which was ligated by the three manually made loops, placing two of them in the proximal portion of the appendicular base, and one few millimeter distally. Appendectomy performed by cutting the appendix between the two proximal knots and the distal knot using endoscopic scissors and retrieved through the umbilical trocar.

Fig. 2



A handmade loop made out of a polyglactin suture.

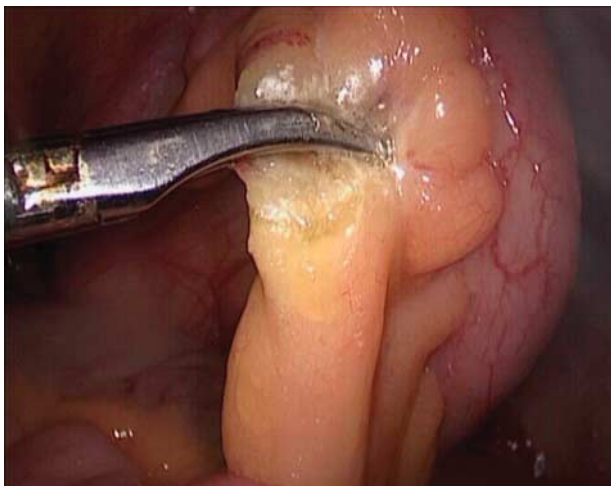
Table 1 Patients' demographics

Variables	
Median age (years)	10
Sex	
Male	39
Female	21
Appendix	
Not perforated	38
Perforated with localized peritonitis	22

Table 2 Operative outcome

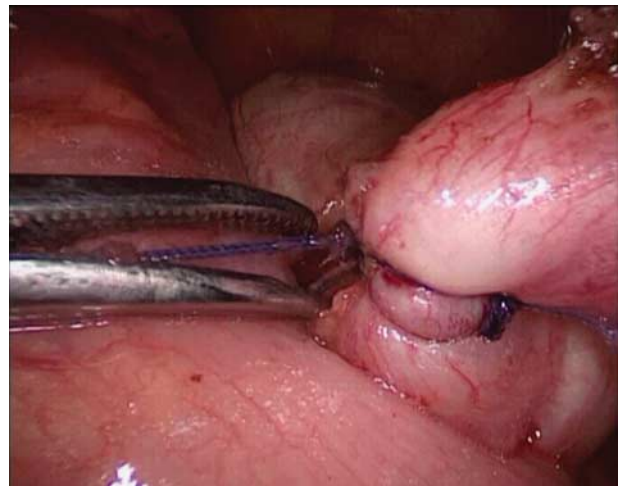
Variables	
Mean operating time (min)	56.5
Intraoperative complications	0
Conversion	0
Mean length of hospital stay (days)	2
Morbidity	
Hematoma	2
Wound infection	4

Fig. 1



Skeletonization of the appendix using monopolar diathermy.

Fig. 3



The handmade loop securely closes the appendix base.

Results

During 2 years period, 60 patients with acute appendicitis were performed laparoscopically. The study included 39 (65%) males and 21 (35%) females. The patients' demographics are shown in Table 1.

No intraoperative complications were encountered, as bleeding due to imperfect sealing of the blood vessels, or thermal injury to nearby structures as the cecum.

Two patients had postoperative hematoma relieved on conservative treatment and both were treated on out-patient basis. Four patients had infection at the umbilical trocar site, managed by antibiotics and daily dressing.

None of the patients required conversion to open operation due to a problem of dissection of mesoappendix or difficulty in appendicular stump ligation. Outcomes are shown in Table 2.

No costly equipments were used in the operation and a single package of Vicryl ligature 2/0 was enough to form 3 handmade loops at a cost of about 6 USD (Figs 1–3).

Discussion

Laparoscopic appendectomy has become safe and effective and now, it is one of the most common procedures performed by pediatric surgeons [17]. However, cost effectiveness is still a major concern, because laparoscopic operative procedures are still more expensive than open surgery, and this is one of the main drawbacks [18,19].

The higher cost of laparoscopic appendectomy is based on the disposable equipments, such as disposable trocars, laparoscopic endostapler, endoloops or tissue-sealing devices [20,21]. In this study, we proved that these devices may not be necessary in routine appendectomies.

All laparoscopic appendectomies in this study were performed by using reusable trocars, thus deducting the cost of disposable trocars. This reduces the cost by 300 USD per case.

The division of the mesoappendix was done using a Maryland forceps or a hook, connected to a monopolar diathermy.

Another method for division of the mesoappendix is the stapler. This method was reported in 1990 and became popular thereafter. The studies in the literature are mainly on titanium or absorbable polymer clips. Staplers allow simultaneous sealing and division of both the mesoappendix and the appendix base. Studies have shown that this technique is both easy to apply and safe [17,20]. According to Lukish *et al.* [22], the disposable equipment costs for appendectomies performed with one firing of an endostapler were 201 USD per case.

Electrothermal bipolar vessel sealing system is another tool for sealing the mesoappendix, however, it is expensive. In Egypt, the price of the machine (LigaSure; Covidien) costs 30 000 USD and the instrument costs 600 USD.

The use of Harmonic scalpel is another method for sealing the mesoappendix; however, it also expensive. Lukish *et al.* [22] reported a cost of 400 USD per case when this method was used.

To ligate the appendix base, we used a handmade loop using a 2/0 Vicryl (Ethicon) package. This costs 6 USD on average. This loop is easy to construct and apply, and it secures the stump safely.

Endoloop is another method used to secure the appendix base. It can be made of silk or polyglactin, and can be of various thicknesses. The use of endoloop has been reported by several authors to be safe in closing the appendix stump and it has a lower cost as compared with staplers [23–26]. Endoloop, however, are far more expensive than handmade loops. Their average price is around 100 USD in this locality.

Although suture closure of the appendix base (as in open surgery) is cheap, it has a disadvantage of prolonging the operation time [27,28]. To do this, a knot can be prepared within the abdomen or prepared extracorporeally and

pushed into the abdomen. Intracorporeal tie knot requires more experience than other methods. Studies have shown that suture closure of the appendix base is as safe as other methods [27,29].

Cost reduction, however, has its drawbacks. Concerns such as thermal injury risk and difficulty in hemostasis were addressed [30]. In this study, we did not encounter such drawbacks. Perhaps because of the small size of the appendicular artery branches in the pediatric age group we did not encounter difficulties in controlling bleeding. This cannot be guaranteed in adults. We did have two cases developed postoperative hematoma though, which were managed successfully with conservative treatment.

Conclusion

Division of the mesoappendix using monopolar electrocautery and closing the base of appendix using the handmade endoloop during laparoscopic appendectomy appears to be simple, effective, safe, and a cost-efficient technique. Therefore, the use of more costly instruments to such as the endostapler, LigaSure, or Harmonic scalpel seems unwarranted.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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