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Clinical Study

Pediatric Appendectomy in a Resource-Limited Setting: Laparoscopy Versus Laparotomy

Cheikh Tidiane Mbaye[1 *], Cheikh Diouf[1], Florent Tshibwid A Zeng[2], Mohamed Thom Diagne[3], Mory Sangare[1], Assane Sarr[1], Christ Momo Tsague[1], Omar Mbaye[1], Amadou Moustapha Sar[3], Mohamed Dieng[3], Alassane Baro[3] , Ousmane Dabo[3], Ibrahima Diallo[3]

[1] *Unit of Pediatric Surgery, Ziguinchor Regional Hospital Center, Ziguinchor, Senegal*
[2] *Department of Pediatric Surgery, El Hadj Ibrahima Niass Regional Hospital Center, Kaolack, Senegal*
[3] *Department of General Surgery, Ziguinchor Regional Hospital Center, Ziguinchor,Senegal*

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Appendectomy
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Abbreviations
HIC - High-income country
LIMC - Low, middle-income country

Abstract

Introduction: *Laparoscopy has increasingly become popular in the treatment of acute appendicitis. Despite its many advantages, it is not yet a routine practice in low-income countries like Senegal. Scarcity of research papers from Africa on the comparative benefits of laparoscopy has prompted the present study.*

Methods: *This is a descriptive and analytical prospective study over 24 months, from January 2022 to December 2023, in the pediatric surgical units of La Paix Hospital and of the Regional Hospital of Ziguinchor.*

Results: *This study includes 64 appendectomies (29 laparoscopy and 35 open). The mean age was 12 years (range 5-15 yr). There were 41 males and 23 females. The appendix was in the classic position in 77% of cases. The mean delay of therapeutic intervention was 16 hr for laparoscopy and 8 hr for laparotomy ($p=0.001$). The mean operating time was 87 min for laparoscopy and 46 min for laparotomy ($p<0.001$). Significant postoperative pain was noted in 2 patients after laparoscopy and in 7 after laparotomy ($p=0.126$). The mean hospital stay was 36 hr for laparoscopy and 65 hr for laparotomy ($p<0.001$). There were no complications after laparoscopy while 5 complications were registered after laparotomy, representing 14% ($p=0.043$).*

Conclusion: *Laparoscopic appendectomy in children appears to have considerable advantage over laparotomy in a resource-limitted setting.*

INTRODUCTION

Appendectomy is one of the most common surgical procedures done in children.[1] The two most widely used surgical techniques are laparotomy through a Lane's or McBurney's incision and laparoscopy.[1] Although laparotomy is safe, effective, simple and associated with a low morbidity and mortality rates, it is being replaced by laparoscopy which offers more advantages in terms of operating time, hospital stay, post-operative pain, time to resume activities, aesthetic appearance of scars and post-operative complications.[1-4] Many randomized controlled trials were conducted to determine the best surgical approach.[2,5,6] Laparoscopy is preferred in high-income countries (HIC), while it is still not available in many low- middle-income countries (LMIC), where most of the institutions still do open appendectomy.[7]

The adoption of laparoscopic surgery in LMIC has been sporadic for various reasons. Some of the obstacles are intrinsic of the health care system (e.g. inadequately trained personnel) while others financially driven (e.g. non-availability of equipment). The cost of initial setting-up and maintenance of laparoscopic surgery equipment has been reported in some studies as the main inhibitory factor for minimally invasive surgery in LMIC.[7] Moreover, in many LMIC it is difficult to implement new approaches in surgery, not only among patients but also among local surgeons.[8] Only a few studies have been done in Africa on the pediatric laparoscopy. Therefore, we intended to assess the role and benefits of laparoscopy in our establishment.

PATIENTS AND METHODS

Study Design and Setting

We conducted a descriptive and analytical prospective study over 24 months, from January 2022 to December 2023, in the pediatric surgical units of the La Paix Hospital and the Regional Hospital of Ziguinchor.

Population Study

All patients under 16 years of age whose had clinical and sonographic features of acute uncomplicated appendicitis were included in this study. We excluded all those who were found to have complicated appendicitis on surgical exploration and those with negative histology for appendicitis.

Surgical Technique and Post-operative Protocol

Laparotomy was performed through a 3 to 4 cm transverse, muscle preserving incision at the right iliac fossa. Ligation-section of the mesoappendix was done with 3-0 polyglactin. After exposing the appendicular base, 3 Kocher's camps were applied at the basis and section of the appendix was done between the 2 proximal forceps. Appendicular stump was ligated with 2-0 polyglactin and the exposed mucosa was ablated with electrocautery.

Laparoscopy was performed using 3- and 5-mm trocars. Telescope was inserted through the 5-mm umbilical trocar (T1) and two working 3-mm trocars were inserted through the right (T2) and left (T3) iliac fossae. Grasper through T2 held the tip of the appendix and forceps or bipolar coagulating scissors thorugh T3 was sued to section the mesoappendix. The appendicular base was tied with extracorporeal knots using 2-0 polyglactin. Section of the appendix was done with a scissors between the two ligatures through T3. Afterwards, the appendix was extracted through the umbilical port using an endobag.

Post-operatively, all patients received antibiotics (amoxicillin plus clavulanic acid and metronidazole) for 7 days and two analgesics (paracetamol and tramadol) for 7 days. Enteral feeding was started 12 hr after surgery in both groups. Criteria of discharge included tolerance of full enteral feed, absence of nausea or vomiting, normal range of vital signs, clean operative wound or absence of pus discharge after the treatment of surgical site infection.

Data Collection and Statistical Analysis

The parameters studied were age and sex of patients, anatomical location of the appendix, time delay of surgical intervention, operative time, and outcome data such as postoperative pain, length of hospital stay and complications.

Data collected from medical records and operating room registers were entered in Excel spread sheet (Microsoft Office 2013) and analyzed using SPSS (Statistical Package for Social Sciences) version 18. Comparisons between the laparoscopy and the laparotomy groups were done using Pearson's chi-square test or Fisher's exact test for discrete data and Analysis of Variance (ANOVA) for continuous data. Statistical significance was defined as P value <0.05.

RESULTS

We had done 64 appendectomies (29 laparoscopy and 35 laparotomy). The mean age was 11.9 $\pm$ 2.7 years (range 5-15 yr). There were 41 males and 23 females (sex ratio of 1.78). The appendix was paracecal in 76% of cases. (Fig 1)

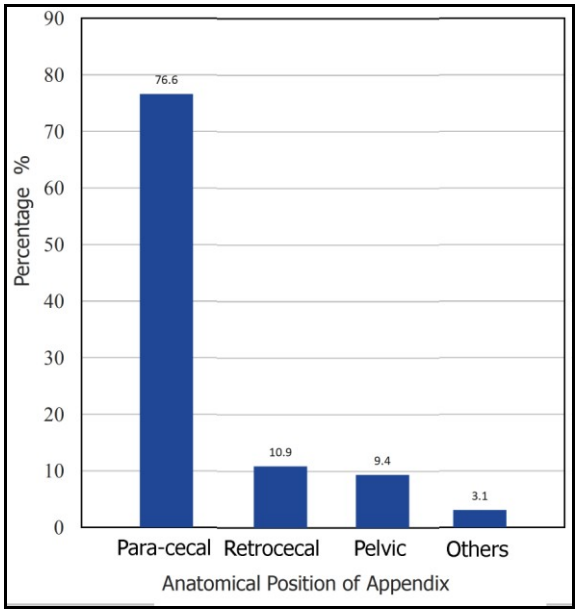

Fig 1. *Anatomical position of the appendix*

Comparison of laparoscopic and open appendectomy is summarized in Table-1. The mean delay of surgical intervention and the mean operative time were shorter for open surgery. Postoperative pain and mean length of postoperative hospital stay were signioficantly more for open suregry. All the five postoperative complications were seen in open surgery group (Table-2).

Table 1: Comparison between laparoscopic and open appendectomy

Parameters	Technique		P-value
	Lap	Open	
Mean delay of surgery (hr)‡	16	8	0.001
Operative time (min)‡	87	46	< 0.001
Post-operative pain (n)*	2	7	0.126
Post-operative stay (hr)‡	36	65	< 0.001
Complications (n)†	0	5	0.043

*‡ANOVA, *Pearson's chi-square test, †Fisher's exact test*

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Table 2: Complications according to Clavien-Dindo classification

Category	n	%
Grade II	3	8.6
Surgical site infection	3	8.6
Grade IIIb	2	5.8
Adhesive small bowel obstruction	1	2.9
Incisional hernia	1	3.9

DISCUSSION

Over the last two decades, laparoscopic appendectomy in children has become the gold standard in HIC. However, it is still not widely unavailable in LMIC.

In this study, laparoscopy rate was 45% which is similar other published reports from LMIC.[9] In HIC, laparoscopy is the standard approach for

suspected acute appendicitis.[10] We did less laparoscopy, especially in emergency services, due to non-availability of surgeon or operating room staff trained in laparoscopy. This could also explain the long delay before doing laparoscopic surgery as compared to open appendectomy.

Most of the study subjects were adolescents, with mean age of 12 years, matching with the peak age of childhood appendicitis.[11,12] Doing laparoscopic appendectomy in young children poses challenges in our setting due to lack of instruments suitable for this age group, thus frequently necessitate conversion to open surgery. The sex ratio of 1.78 in our series is similar to the published data.[12,13] Although gender was not a criterion for the selecting the surgical modality in our center, laparoscopy appears to be more advantageous in girls for differential diagnosis of adnexal pathologies.

According to the literature,[14] the paracecal position is the most common anatomical position of appendix, followed by retrocecal and pelvic positions. We found the same proportion in our series. Laparoscopic may be more advantageous in the background of these anatomical variations, allowing easy access without extension of parietal wall incision.[10] Complete exploration of the abdominal cavity is possible with laparoscopy that may reveal Meckel's diverticula and other associated anomalies.[13] However, the benefits of laparoscopy are debatable when the intensity of inflammatory processes hinders dissection, leading to an increase in operative time and especially if extraction of the appendix requires enlarging an port site orifice.[1]

The time to treatment varies depending on the context.[1] In our study, the mean time delay of therapeutic intervention was significantly longer with laparoscopy. In our settings, preparing for laparoscopy takes more time due to the need of mobilizing a surgical team trained in laparoscopy. Additionally, since the operating room is occupied for longer time during laparoscopy, it had to be scheduled in consideration of the other emergency operations. However in HIC, the mean time delay of treatment was similar for both groups.[4]

The longer operative time is a frequently cited disadvantages of laparoscopy.[15] It is attributable to initial setting-up time and any subsequent instrument malfunctioning or troubleshootings during the procedure.[16] Meta-analyses[3,16] have shown that even though laparoscopy takes longer time than open surgery, this was not statistically significant. Longer operative time with laparoscopy was also observed in our series. However, some studies showed minimal[3,4] or no difference[16] in operating time of the two modalities. Some of the authors have even claimed shorter operating time with laparoscopy.[6] These differences may be due to selection bias and experience of the operating surgeon.

Postoperative analgesic requirement is considerably reduced after laparoscopy.[17] Studies have reported less pain with laparoscopy[18,19]. In our series, though postoperative pain was less with laparoscopy, it not statistically significant.

For children undergoing surgery, the time taken for returning to normal activities such as attending school is of paramount importance. It also reduces the long-term psychologic consequences of prolonged hospitalization.[16] The postoperative hospital stay is consistently shorter with laparoscopy.[13] Meta-analyses[1,16,20] have confirmed this observation. Laparoscopy has a lower rate of ileus and postoperative pain, allowing early mobilization and a shorter hospital stay.[1]

Laparoscopy is also reduces wound infections and postoperative adhesive bowel obstruction.[21] In our series, 5 patients operated by laparotomy had complications. Surgical site infection was seen 3 cases, followed by 1 case of adhesive small bowel obstruction and 1 case of postoperative incisional

hernia. There were no complications in the laparoscopy group. These differences were statistically significant. However, most of the complications of open surgery were minor (Clavien-Dindo Grade-II). Only two complications (Grade IIIb) required surgery, one of which was an emergency.

Despite limitted resources of our settings, laparoscopy appears to be more advantageous than laparotomy, with a reduction in hospital stay and post-operative complications. To reduce the time delay of surgical intervention and operative time, it is essential to strengthen coordination between the emergency room and operating room personnels.

STUDY LIMITATIONS

The small sample size is a limitation of this study. Furthermore, the surgeons' level of experience in laparoscopy was not taken into account. It would have been pertinent to do cost-analysis and to compare the outcomes between beginners and experienced surgeons.

CONCLUSION

Laparoscopy has considerable advantages over laparotomy, even in a resource limitted setting with limited expertise. It should be adopted in all pediatric surgery departments where laparoscopy expertise and equipment are available.

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Address for communication: *Dr. C Mbaye,*
Email: mbayecheikhtig@hotmail.fr

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