

Laparoscopic Appendectomy and Minilaparoscopic Approach: A Retrospective Review After 8-Years' Experience

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ABSTRACT

Background: This is a presentation of our 8-year experience in laparoscopic appendectomy, showing complications and results to determine the advantages and efficacy of laparoscopy.

Methods: We used this technique from December 1990 to December 1998 on 282 consecutive and non-selected patients (169 females and 113 males) with an average age of 24 years (range 5-86 years). All patients were suffering from sub-acute appendicitis or chronic appendicopathies, except for 84 (29.7%) cases of acute appendicitis and 25 (8.9%) cases of gangrenous appendicitis with peritonitis. All patients with suspected appendicitis were evaluated with a laparoscopic exploration.

Results: In 39 patients (13.9%), appendectomy was performed along with 19 enucleated or endocoagulated ovarian cysts, 8 adhesiolyses, 6 transperitoneal hernioplasties (4 right and 2 left), 2 cholecystectomies, 2 excisions of a Meckel diverticulum, 1 aspiration and suture of a right tubal pregnancy and 1 electrodesiccation of pelvic endometriosis. Thirty-five patients (12.5%) revealed the presence of a gynecological-type pathology. We performed 2 (0.7%) conversions to open exploration and experienced 6 (2.1%) complications, of which only 1 (0.35%) was a major complication: a delayed hemoperitoneum (1 liter), re-operated elsewhere, the cause of which was not identified. We performed 4 (1.4%) relaparoscopies for retrocecal abscess (three patients with primary gangrenous appendicitis and peritonitis present-

ing with an abscess in the right iliac fossa and in one patient with widespread intestinal adhesions with primary acute appendicitis). No patient with a diagnosis of a normal appendix developed an intraperitoneal abscess. Mortality was non-existent. The postoperative course, which was subjectively better than in cases operated in the traditional way, was, on an average, 2 days (range 1-18 days) for appendectomies carried out with the traditional laparoscopic technique and 1 day for appendectomies carried out with the minilaparoscopic technique (6 patients).

Conclusion: We believe that the laparoscopic technique can handle any type of clinical situation, as it can cure several pathologies during the same session with minimal trauma and maximum benefit for the patient. The advantages of a minilaparoscopy approach are based on its low invasiveness and small surgical wounds.

Key Words: Laparoscopy, Minilaparoscopy, Appendectomy, Laparoscopic appendectomy, Appendicitis, Abscess.

INTRODUCTION

After cholecystectomy, appendectomy is the most common abdominal surgical operation.¹⁻³ It is associated with a high percentage of innocent or "normal" appendectomies.⁴ If carried out in the presence of perforation and diffused peritonitis, appendectomy is accompanied by significant morbidity caused by infections of the abdominal wound and intra-abdominal abscess. The continuous development of mini-invasive surgery is justified by the numerous advantages this method provides: minor surgical trauma, a better postoperative course, exploration of the entire abdominal cavity, assessment for the existence of associated pathologies, early passage of flatus, and better cosmetic results with a rapid return to normal activity. Laparoscopic appendectomy can be simple and safe, especially with the use of mechanical suturing instruments. With a laparoscopic approach, it is also possible to cleanse the abdominal cavity more completely and more efficiently than with extended laparotomy.⁵ Also, with laparoscopy, there is little trauma of

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the peritoneal membrane, thus maintaining its antibacterial physiologic capacities, which are especially useful in acute appendicitis. As well as these advantages, laparoscopy allows for a complete exploration of the peritoneal cavity,⁶ which is indispensable when a healthy appendix is found. This capability makes it possible to identify the presence of associated pathologies, originally interpreted as appendicitis. Often, especially in women, other morbid conditions can mimic appendicitis, such as adnexitis, endometriosis, ovarian cysts, extrauterine pregnancies and even cholecystitis.⁷ All patients with suspected appendicitis were evaluated with a laparoscopic exploration. Removing a normal appendix for suspected acute appendicitis is the standard of care, and the use of a laparoscopic approach should not alter this practice. There is no added morbidity or increase in the length of hospitalization as compared to diagnostic laparoscopy. Laparoscopy adheres to the principles standardized by open surgical techniques and demonstrates cost effectiveness by preventing missed and future appendicitis.⁸ However, inflammation of the appendix starts in the submucosal layer, and inspection of the appendiceal serosa in the early stages of the disease may be misleading.

In an effort to improve functional and cosmetic results, new techniques and increasingly improved instruments have been developed to further reduce invasiveness. Appendectomy with a "minilaparoscopic" approach represents a variation of the standard laparoscopic technique and makes it possible to perform the operation using two 2 mm trocars and one 5 or 10 mm trocar, thereby reducing the already minimal parietal trauma. In our series, if the need arose during the operation, the 2 mm trocars were replaced with larger diameter trocars, while maintaining the 2 mm minioptic with its access gate. In fact, this 2 mm optic (Autosuture, Aesculap) is comparable to larger ones for brilliance, brightness and contrast. The use of smaller trocars with minioptics may be applicable in trauma cases or as a diagnostic procedure performed outside the operating room with local anesthesia.

MATERIALS AND METHODS

From December 1990 to December 1998, we used this technique on 282 consecutive patients with a clinical diagnosis of appendicitis (**Figure 1**), 169 females and 113 males, with an average age of 24 years (range 5-86 years). The majority of these patients were found to have subacute appendicitis or chronic appendicopathies. There

were 84 cases of acute appendicitis and 25 cases of gangrenous appendicitis with peritonitis.

OPERATING TECHNIQUE OF LAPAROSCOPIC APPENDECTOMY

Preparation of the Patient

The operation is carried out under general anaesthesia with endotracheal intubation and assisted mechanical ventilation. The patient is placed in a supine Trendelenburg position, with legs together and right arm stretched out to maintain an intravenous infusion path. We do not use a urinary bladder catheter or nasogastric tube. The operating surgeon and assistant are both on the left side of the patient; the instrument provider and instrument table are also on the left side but near the patient's feet. The videolaparoscopic equipment is on the right of the patient, facing the operators.

Operative Technique

Pneumoperitoneum is induced by inserting a Veress needle in the left periumbilical area and insufflating to an intra-abdominal pressure of 15 mm Hg. A 10 mm trocar is introduced in the same position through which a laparoscope with a 30-degree visual angle is inserted (to enable exploration of the abdominal cavity more suc-

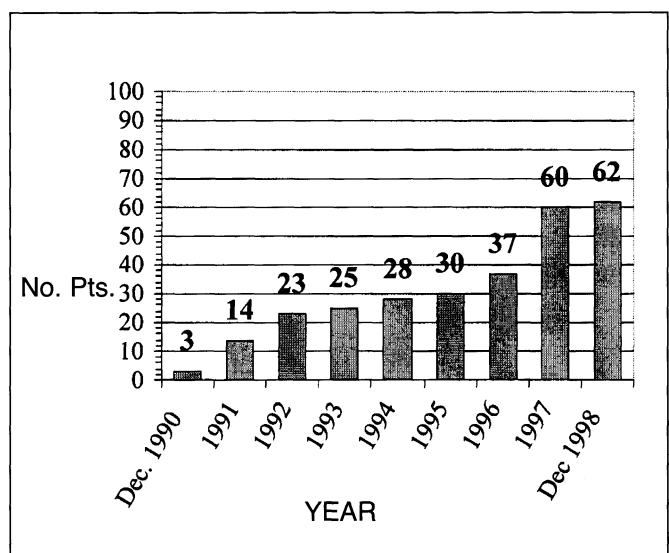
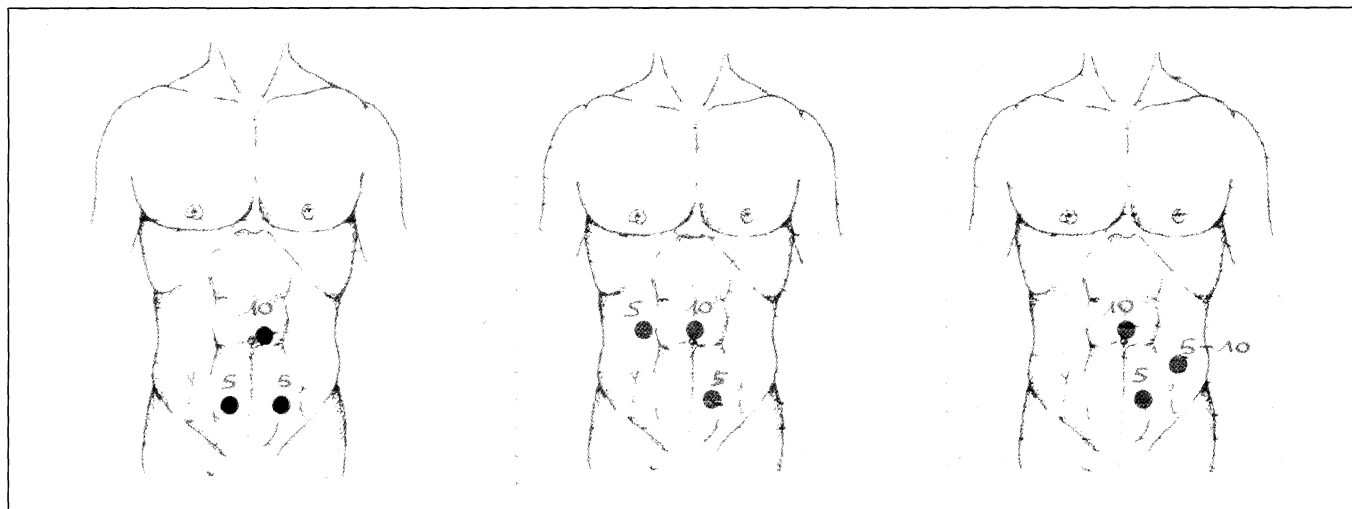


Figure 1. Number of laparoscopic appendectomies between December 1990 and December 1998.



Figures 2-4. Position of the trocars in laparoscopic appendectomy.

cessfully than with a 0 degree laparoscope). Once the diagnosis has been confirmed, another 5 mm trocar is introduced in the left suprapubic region, under the line of the pubic hair. For cosmetic reasons, the third 5 mm trocar is usually also inserted under the line of the pubic hair in the right suprapubic region, but, depending on the anatomic or pathologic variations of the cecal region, it may be positioned either in the right or left hypocondrium. If necessary, a larger caliber trocar can be used (**Figures 2-5**). The first step is to search for a Meckel's diverticulum and, in women, to assure that the uterus and adnexa are not affected by any pathology. After inserting an atraumatic forceps in the right suprapubic trocar and a curved dissector connected to the unipolar current or a bipolar forceps in the other 5 mm trocar, the next step is to coagulate the appendiceal mesentery and skeletonize the appendix. Appendectomy is carried out after securing the base of the appendix and its section.⁹ There are various methods for securing the base of the appendix: the use of three metal clips or three endoloops with transection between them so that two ligatures remain at the base of the appendix, the use of bipolar coagulation and section, the use of mechanical cutting and stapling devices, and the use of loose loops with which self-locking extracorporeal slip-knots or normal surgical knots are made with a knot-tier of our design (Croce-Olmi knot tier) -- manufactured by Karl Storz Endoscopy. This knot-tier can be used whenever an extracorporeal knot is required.^{10,11} The use of

mechanical suturing devices is the most expensive option (a 30 mm mechanical suturing device with one cartridge costs \$280) but guarantees safety in acute gangrenous appendicitis with an edematous cecum. In the case of gangrenous appendicitis endoloops (three endoloops cost \$75) or endoclips may slip off. The technique with our knot-tier instrument is more economical (three threads of traditional sutures without needle cost \$4, the multi-purpose knot-tier costs \$90), and is as safe

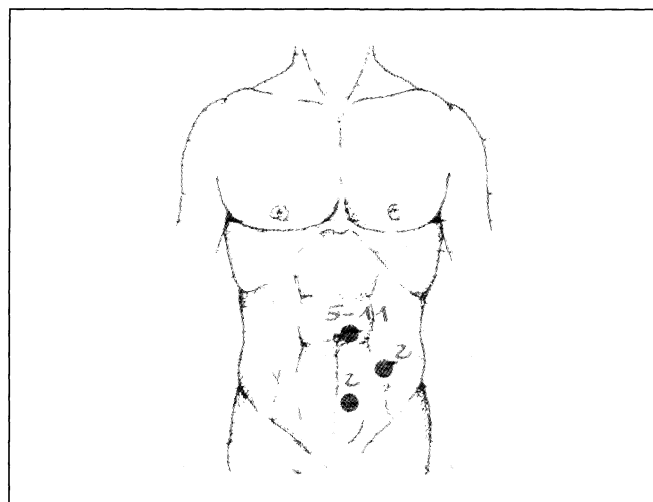


Figure 5. Position of the trocars in minilaparoscopic appendectomy.

and as fast as the other ligature techniques.¹² After having sectioned the appendix and coagulated the appendiceal stump, the appendix is guided into the 10 mm umbilical trocar, gradually withdrawing the optic until it comes out of the trocar along with the appendix. We do not invert the stump because studies have shown no advantage of inversion over simple ligation and division.^{13,14} In the case of purulent peritonitis, it is sufficient to wash the cavity carefully without leaving any drainage. After removing the instruments and desufflating the pneumoperitoneum, the small cutaneous incisions are sutured.

OPERATING TECHNIQUE OF MINILAPAROSCOPIC APPENDECTOMY

Preparation of the Patient

The position of the patient and the surgical team is the same as in the standard laparoscopic appendectomy technique.

Operative Technique

After inducing pneumoperitoneum by introducing the Veress needle in the left iliac fossa, on which the 2 mm trocar is mounted (MiniSite Introducer, Autosuture - USSC), and reaching an endoabdominal pressure of 15 mm Hg, the abdominal cavity is penetrated on the Veress guide, which is gradually withdrawn. A 2 mm, 0 degree, mini-optic (Autosuture, USSC) is then introduced. After confirming the diagnosis, and with the possibility of proceeding with a minilaparoscopic technique, another 2 mm minitrocar is introduced in the suprapubic region, under the line of the pubic hair. The third and only 5 or 10 mm trocar (depending on the size of the appendix and on the type of instruments the surgeon has decided to use) is inserted on the left and inside the umbilical scar, both for cosmetic reasons and to obtain a better angulation of the operating instruments and the optics (**Figure 4, 5**). With this trocar, the operator carries out dissection, coagulation, hemostasis and suturing activities using standard 5/10 mm instruments. The surgical procedure is the same as that used in traditional laparoscopic appendectomy. Once the diagnosis is confirmed, a 2 mm forceps (MiniSite Endo Clinch) is inserted in the suprapubic trocar, and a curved dissector connected to the unipolar current or bipolar pliers is inserted in the 5/10 mm trocar. The next step is coagulation of the appendiceal mesentery and skeletonization of the appendix.

Appendectomy is carried out after ligation of the base of the viscera and its section.² The technique we have designed for this stage of the operation is safe and quick. After having introduced a pre-shaped loop (SurgiTie or Endoloop) in the 5/10 mm umbilical trocar, the 2 mm forceps is threaded through the pre-shaped loop and used to pick up the appendix. At this stage, it is sufficient to guide the knot around the appendiceal base. After tightening the first knot, the endoloop is withdrawn, and the thread is sectioned with laparoscopic scissors introduced in the same trocar. A second, more distal loop is positioned, but, unlike the first one, it is not cut. In this way, it is possible to make the appendix taut, creating traction with the endoloop rod or simply with the thread, which is in the 5/10 mm trocar, saving one passage and the use of a forceps. The appendix can then be sectioned between the two knots with microscissors (MiniSite Endo Sciz) introduced in the over-umbilical trocar and gradually withdrawing the thread to which the appendix is attached out of the trocar. As with appendectomy carried out with the standard laparoscopic technique, we do not place any drains. After extracting the instruments and desufflating the pneumoperitoneum, only the umbilical incision is sutured; the two cutaneous mini-incisions are sealed with simple steri-strip plasters.

RESULTS

Appendectomy by means of laparoscopy has proved to be possible in 280 patients. We had only 2 (0.7%) conversions with a right subcostal minilaparotomy in a patient with subhepatic and retrocecal subserous gangrenous acute appendicitis (as it was impossible to isolate the appendix) and another conversion for inadequate instrumentation in a patient with perforation of the cecum. The cases were all subacute appendicitis or chronic appendicopathies, except in 84 (29.7%) cases of acute appendicitis with no perforation and 25 (8.9%) cases for gangrenous acute appendicitis with peritonitis. We found a subhepatic appendix in 9 patients (3.2%). In 57 (20.3%) patients, there were associated pathologies. Thirty-five (12.5%) patients had a gynecological pathology: 19 patients had ovarian cysts (17 right and 2 left), 6 patients had rupture of the ovarian follicle (4 on the right side and 2 on the left side), 8 patients had adnexitis, 1 patient had pelvic endometriosis and 1 patient had a right tubal pregnancy. In 22 (7.8%) other patients, there were the following: 8 adhesions in the right lower

Table 1.
Associated pathologies 57/280 (20%) and
associated operations 39/280 (13.9%).

No. patients	Associated gynecological pathology	Associated operation
17	right ovarian cyst	Excision or endocoagulation
2	left ovarian cyst	Excision
4	right ovarian follicle rupture	
2	left ovarian follicle rupture	
8	adnexitis	
1	right tubaric pregnancy	Aspiration and suture
1	pelvic endometriosis	Electrocoagulation
No. patients	Associated other pathology	Associated operation
8	adhesions in right iliac fossa	Adhesiolysis
4	right inguinal hernia	TAPP
2	left inguinal hernia	TAPP
3	adenomesenteritis	
2	Meckel's diverticulum	Resection
2	cholelithiasis	VLC
1	appendiceal ileum invagination	
Total	57/280 (20%)	39/280 (13.9%)

abdominal quadrant, 6 inguinal hernias (4 in the right side and 2 in the left side), 3 mesenteria adenitis, 2 cholelithiasis, 2 Meckel's diverticulum and 1 appendiceal ileum invagination in the cecum (**Table 1**). In 39 (13.9%) patients, the appendectomy was performed along with 19 endocoagulated or enucleated ovarian cysts, 8 adhesiolysis with significant adhesions in the right iliac fossa, 4 right transperitoneal hernioplasties and 2 on the left side, 2 cholecystectomies, 2 excisions of a Meckel diverticulum with an endo-GIA (Autosuture USSC), 1 aspiration and suture of a tubal pregnancy and 1 electrodesiccation of pelvic endometriosis (**Table 1**).

There were 6 (2.1%) postoperative complications: 2 hemoperitoneum (0.7%) and 4 intra-abdominal abscesses (1.4%) -- 1 delayed hemoperitoneum (1 liter), the cause of which was not identified, re-operated elsewhere on postoperative day 10 (after the patient had been discharged on day 3); and another hemoperitoneum (500 mL) that required a relaparoscopy, the cause of which was bleeding from an umbilical trocar site. There were 4 (1.4%) relaparoscopies for retrocecal abscess (due to incomplete cleansing or washing of the abdominal cavity and because drainage was not used), and there were

3 (12%) patients (Indians of South America) with primary gangrenous appendicitis and peritonitis and an abscess in the right iliac fossa. One patient had widespread intestinal adhesions with primary acute appendicitis. This patient had persistent fever from a retrocecal abscess and required laparotomy after a second relaparoscopy for significant adhesions on day 9 (**Table 2**). No patient with an original diagnosis of normal appendix developed an intraperitoneal abscess. In summary, 5 (1.7%) patients required relaparoscopies that were resolute in 4 cases (80%). There were no intraoperative complications, no wound infections and no mortalities in our series. In our experience, the operation takes about 25 minutes (range 15-30 minutes) in non-acute appendicitis and 40 minutes (range 15-60 minutes) in cases of acute or gangrenous appendicitis. In all patients who underwent a laparoscopic surgical operation, the postoperative course was, on the average, 2 days (range 1-15 days). Peristaltic activity and passage of flatus were present the morning after the operation, making it possible to discharge the patient on day 2, without painful symptomatology and with a rapid return to work activities. In the same period, we submitted 6 patients to mini-laparoscopy, 3 of whom were of pediatric age (5 years).

Table 2.

Complications of laparoscopic appendectomy: 6/280 (2.1%).

N°	Pts	Sex	Age	Complication	Diagnosis	Treatment	Resolution
1	D.A.	F	14	Hemoperitoneum (1 lt)	Sub-acute appendicitis	Laparotomy	Yes
2	C.S.	M	33	Hemoperitoneum (500 mL) to the umbilical trocar	Acute appendicitis	Relaparoscopy	Yes
				0.7%			
3	M.A.	F	30	Abscess in right lower abdominal quadrant	Acute appendicitis	Relaparoscopy	Yes
4	C.E.	M	47	Retrocecal abscess with peritonitis	Gangrenous appendicitis and drainage	Relaparoscopy	Yes
5	W.E.	F	30	Retrocecal abscess with peritonitis	Gangrenous appendicitis and drainage	Relaparoscopy	Yes
6	V.R.	M	30	Retrocecal abscess	Gangrenous appendicitis with peritonitis	Relaparoscopy and drainage	No, Relaparoscopy and laparotomy
				1.4%			
Total	6			2.1%			

In all patients, it was possible to undertake appendectomy by means of minilaparoscopy. There were no intra-operative or postoperative complications in this series, and the average duration of operation was 35 minutes (range 15-50 minutes). Peristaltic activity and passage of flatus were present the morning after the operation, and the patients were discharged on day 1, without painful symptomatology and with an immediate return to normal, everyday activities.

DISCUSSION AND CONCLUSIONS

The most common objection to laparoscopic appendectomy is that it involves three cutaneous incisions instead of just a single 3-5 cm laparotomy. In fact, such a laparotomy is possible only in thin patients without anomalies in the position of the appendix. The presence of marked obesity or retrocecal and subhepatic appendicitis, or the presence of another pathology may require an even larger laparotomy incision. On the other hand, most all pathological situations can be visualized with laparoscopy without having to enlarge the cutaneous incision. If the operation should need conversion, this

can be done (as it was in one of our cases) with "ad hoc et loco optimo" minilaparotomy on the basis of the anatomic and pathological situation. With a minilaparoscopic approach, it is also possible to visualize all anatomic pathological situations with a further reduction of the parietal trauma associated with "traditional" laparoscopic techniques. A great advantage of laparoscopy, apart from the lack of painful symptomatology, enteroplegia¹⁵ and an early return to normal work activities, is that it allows for the diagnosis and, if necessary, the cure of other abdominal and pelvic pathologies. An exploration of the entire abdominal cavity can be performed, which would otherwise be impossible with the standard cutaneous incision, according to McBurney.¹⁶ Laparoscopy reduces rate of wound infection (because the appendix is usually brought out through the laparoscopic cannula and does not touch the abdominal wall) and shows no increase in other complications.¹⁷⁻¹⁹

Intra-abdominal abscess remains a significant cause of morbidity following appendectomy. In a retrospective review of open appendectomy, Schmit found 36 post-

appendectomy intra-abdominal abscesses (PAIAA) — an incidence of 2.8%; the incidence of PAIAA increased as the degree of appendiceal pathology increased. PAIAA occurred in 3.2% of patients with gangrenous appendicitis and in 8.7% of patients with perforated appendicitis.²⁰

Okoie,²¹ in a large series of 1024 patients, reported that 23 patients (2.2%) developed abscess after appendectomy; non-operative treatment was successful in 21 patients (91.3%), drainage by laparotomy was performed in 1 patient (4.3%) and by the transrectal route in another patient (4.3%). In another work on open appendectomy, non-operative treatment was successful in 8 patients (80%), and 2 patients (20%) also needed a percutaneous drainage after medical treatment.²²

We believe that the higher rate of postoperative intra-abdominal abscess after appendectomy for perforated appendicitis is due to inadequate peritoneal washout with saline solution (5 liter) and the absence of abdominal drainage. Nevertheless, this rate is similar in open and laparoscopic surgery.²³ In our experience, the cause of postoperative peritoneal abscess depended on the absence of the abdominal drainage.

Finally, the operative times of about 35 minutes from induction of pneumoperitoneum to suturing of all cutaneous incisions are comparable with traditional appendectomy.

Surgery using mini instruments was no more difficult than standard laparoscopic appendectomy and achieved a superior cosmetic outcome. The advantages of minilaparoscopy are based on its low invasiveness due to small surgical wounds.

Our experience suggests that a laparoscopic approach for the treatment of appendicitis is minimally invasive, safe and effective in all stages of appendicitis, including acute, gangrenous and perforated appendicitis.

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