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ORIGINAL ARTICLE

Applications of videolaparoscopic surgery in children

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Abstract

Objectives: to present the videolaparoscopies performed by the Children's Surgery Service, and study the main indications for pediatric laparoscopic surgeries, considering advantages and disadvantages over conventional open procedures.

Methods: retrospective analysis of 612 videolaparoscopies in children aged between 8 days and 17 years treated from November/95 to 2000. Basic principles of videolaparoscopy and the postoperative management of several pediatric diseases are described. The results, advantages, and complications were analyzed after a 5-year follow-up period.

Results: laparoscopic surgery allowed for a wide series of abdominal procedures conventionally carried out through open surgery, mainly for the treatment of gastroesophageal reflux disease, inflammatory acute abdomen, adhesive intestinal obstruction, biliary lithiasis, tumors, cryptorchidism, ovarian diseases, splenectomies, aganglionosis, trauma and others. Morbidity was low (1%), and mortality due to laparoscopy was nonexistent. Conversion to laparotomy occurred in only 14 cases (2.3%), mainly because of trauma. The principal advantages included minimal surgical trauma, pain and reflex ileum, short hospital stay, almost no incisional hernias and better cosmetic scars.

Conclusions: videolaparoscopy seems to be a great advance in modern pediatric surgery, allowing safer and less invasive treatment of a wide series of abdominal diseases at all pediatric ages.

J Pediatr (Rio J) 2001; 77 (5): 407-12: children, pediatric surgery, videolaparoscopy, gastroesophageal reflux, acute abdomen, trauma.

Introduction

The advancements in pediatric surgery always represent a considerable improvement for the treatment of children in general. Up until recently, all intraabdominal disorders requiring surgical treatment demanded use of laparotomy, in which all abdominal wall layers are sectioned and the gut is exposed; this procedure allowed for several possibilities of postoperative complications and inconveniences such as hemorrhage, prolonged hospital stay, infections, and undesirable scars. Laparoscopy, in this sense, used to be applied only as a diagnostic method. At the end of the 1908s, the medical field benefited from the appearance and discovery of several advantages of minimally invasive surgery in adults. Thus, microcameras connected to laparoscopes, video monitors, and fine instruments started being used and miniaturization of equipment allowed for increasing application of video-assisted surgery in children.[1]

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This study was carried out by the Pediatric Surgery services of Universidade Federal de Goiás and Hospital Araújo Jorge (Center for cancer Research of Goiás).

It is our objective to present the basic principles of pediatric videolaparoscopy and our experience with the procedure using specially-designed equipment for children, and to assess indication and advantages of the procedure in relation to open cavity surgery.

Patients and methods

From November, 1995 to November, 2000 588 patients aged 8 days to 17 years, out of which 332 were girls and 256 were boys, were submitted to 612 laparoscopies due to different disorders, as indicated in Table 1.

Table 1 - Indications for laparoscopic surgery in children

Pathological gastroesophageal reflux	126
Acute appendicitis	49
Diagnosis of acute abdominal inflammatory process	45
Abdominal cryptorchidism – unilateral or bilateral	39
– Anorchism	18
Biopsia / tumor exeresis	40
Cholecystectomy	24
Investigation of contralateral hernia	21
Staging of Hodgkin disease	16
Ovarian cysts or tumors	14
Obstruction caused by debris	14
Splenectomy	13
Investigation of neonatal jaundice	12
Malone procedure (appendicostomy)	9
Varicocele	9
Recurrent abdominal pain	9
Omental and mesenteric cysts, pseudocysts	8
Ambiguous genitalia	8
Hemolytic anemia: splenectomy + cholecystectomy	8
Dialysis catheter complication	7
DVP catheter complication	6
Intussusception	6
Foreign body removal - several	6
Liver/spleen biopsy - direct view	6
Intestinal malrotation	5
Vagotomy (chronic ulcer in adolescent)	5
Gastrostomy / ileostomy	4
Aganglionosis – colectomy	4
– serial biopsies	4
Diaphragmatic hernia (Morgagni / parahiatal)	4
Debridement in pancreatitis	4
Duplications	4
Nephrectomy	4
Rectopexy in rectal prolapse or neovagina	3
Gastric volvulus	3
Duodenal atresia	3
Meckel's diverticulum	3
Pexis in rectal prolapse or neovagina	3
Other *	13*

* Partial hepatectomy (2), hypertrophic pyloric stenosis (2), intestinal tuberculosis (2), splenic cyst (2), hepatic hemangioma (1), omental torsion (1), mesenteric lymphangioma (1), esophageal achalasia (1), wandering spleen (1).

Laparoscopic approach was chosen in cases in which laparotomy would normally be indicated depending on factors such as smaller or more aesthetic laparoscopic incisions; obese children; adolescents; unconfirmed diagnosis; biopsies; availability of equipment or of accessories; and well-known indications for laparoscopy such as cholecystectomy, gastroesophageal reflux, and others.[1,2] Cases involving low morbidity of surgery; rapid recovery and good aesthetic aspect using open surgery, such as inguinal hernia and appendectomy in lean boys; and involving hemodynamically stable patients or multiple suture surgeries (for example, vesicle enlargement, biliary atresia) were not selected for videolaparoscopy.

Basic laparoscopic technique: after the child is under general anesthesia, a small incision is made to insert a trocar by naked-eye viewing of the peritoneum, or a Veress needle is inserted into the umbilicus. Using the trocar or the needle, CO_2 is infused into the peritoneal cavity with an automatic insufflator. Next, the pneumoperitoneum is insufflated to the maximum pressure of 8 to 10 mmHg, previously set at the insufflator, to create room between the abdominal and the gut for carrying out the procedures. CO_2 is not flammable to electrocautery and is rapidly diffused into the air exhaled by the lungs. Throughout the surgery, the patient is monitored with a capnograph.

A 4 or 10-mm trocar is inserted into the umbilicus or in other area allowing for better view of the region to be operated on. Through the trocar, optical catheters are connected to a microcamera and a light source allow for lighting and viewing the cavity, which is displayed on a video monitor. Using the internal view provided by the camera, other small trocars are inserted through the abdominal wall using 3 to 5-mm incisions, depending on the surgery. The optical catheters allow for enhancing the minimal details of the intraoperative procedure from 16 to 20 times. Almost all surgical procedures were recorded in video tapes or printed in photos.

Fine surgical instruments can be inserted into the openings (tongs, scissors, needle-drivers, aspirators, etc). All procedures, including sutures and anastomoses, can be carried out. Removal of organs is made through the umbilicus or small inguinotomy; it is also possible to fragment organs or tumors inside plastic bags introduced into the patient, removing the fragments through the opening of the bag left to the outside through the umbilicus. Colectomy (for treatment of congenital aganglionosis or tumors) has been carried out by our staff only transanally; in this sense, laparoscopy is used only for ligation of mesocolic vessels that cannot be reached through the anus.

The incisions made for the trocars were closed only in the muscle-aponeurotic plane with an absorbable polyglactine wire. Skin openings were closed only with adhesive tape for seven to 10 days. Analgesics were prescribed for one to three days, if necessary.

Oral diet, in cases without gastrointestinal sutures, was resumed one to eight hours after surgery depending on the type of procedure. A good acceptance was observed with most children being discharged from the hospital on the same or following day. In surgeries requiring gastrointestinal sutures, oral diet resumed after 24 to 48 hours if good peristaltic movements (appetite and intestinal noise, elimination of flatus or evacuation).

Depending on the type of surgery and on intraabdominal sutures, all physical activities representing risk for falling or blows to the patient were limited for the first seven to 30 days.

All patients were registered using protocol charts and medical records for medical follow-up. Medical records included identification, clinical status, diagnosis, pathology, surgery details, postoperative and follow-up details. Follow-up of patients is still being carried out to the present date. For assessment of abdominal aesthetics, parents were interviewed concerning satisfaction with scars 30 and 90 days following surgery; answers were scored according to what we called aesthetic satisfaction scale: bad=1; regular=2; good=3; very good=4; excellent=5.

The results of our preliminary, prospective study were based on data from charts, medical records and information provided by healthcare professionals from other states or cities where one of the authors (EE) performed surgical procedures. We did not include patients submitted to endourologic video and thoracoscopic video-assisted surgeries.

Results

We observed a wide variety of disorders treated laparoscopically (Table 1). Considering the most frequent disorders, the main indications for video-assisted laparoscopy were related to gastroesophageal reflux disease (GERD), acute abdominal inflammatory process, appendicitis, tumor biopsy or staging, nonpalpable testis, ovarian diseases, bowel obstruction, cholecystectomy, congenital aganglionosis, splenectomies, and abdominal trauma (hemodynamically stable patients).

There were no complications related to anesthesia nor to pneumoperitoneum. We also did not observe cases of hospital infections. Blood transfusion was required in cases of trauma and in one patient with chronic renal failure (CRF). Fourteen patients who were victims of trauma and two patients with CRF or bronchospasms required or were already in intensive care (2.7%). There were three cases of death due to the baseline disease, two to TCE in polytrauma patients, and one to decompensation in CRF. There were no cases of tumor implants on the trocars sites. Fourteen patients (2.3%) required change to laparatomy due to risk for hemorrhage and trauma (n=8); to splenectomy for purpura (n=1) and for renal hemangioma (n=1); to intense peritoneal adherence (n=2); or to damage to light source or camera during the surgery (n=2).

Simple complications related to laparoscopy occurred in 6 (1.0%) children for two cases of small keloids, one of allergy to iodine, one of subcutaneous emphysema, and two of very small incisional hernias. In the earlier surgeries the muscle layer of the orifices was not closed and we observed a small incisional hernia with epiploon in two patients (0.3%). Since 1996, there have been no reports other such cases. The specific technical details and the secondary intercurrences of each disorder are not included in the scope of this study.

Considering just GERD, the most prevalent indication for videolaparoscopy in our population, the one- to five-year follow-up of patients indicated two cases (1.6%) of reflux relapse; out of these two patients, one presented malnutrition and chronic diarrhea and was resubmitted to open surgery elsewhere, and the other was a neuropathic patient who presented relapse in reflux after endoscopic gastrostomy and was reoperated by videolaparoscopy. Video-assisted surgery was used in reoperation of six GERD patients after conventional open surgery or laparoscopy; five of these six patients came from other services.

Sixteen children were submitted to two or more laparoscopies, indicated for the second round of orchipexy (Fowler-Stephens), biopsies, lysis of adhesions, handling of dialysis catheters, and second examination of tumors or trauma. Twenty-two children (3.7%) did not return for later follow-up as indicated in orientation for outpatients.

With time, scars presented a tendency to become flat, and in 94 children the scars disappeared almost completely after 36 months. The aesthetic aspect, scored according to the aesthetic satisfaction scale for the last 368 patients, was reported excellent (average score of 4.6) by almost all parents and doctors in the staff.

Children presented a rapid postoperative recovery, good ability to move around with small pain and seldom use of analgesics, and, depending on the procedure, short or no postoperative ileus.

Discussion

The use of video-assisted surgery in pediatrics is a recent advancement despite the fact that Gans and Berci carried out laparoscopy by naked eye already in 1971.[2] At that time, laparoscopy was used as a diagnostic method and for small biopsies. After the first videolaparoscopic cholecystectomy in 1987,[2] there was a rapid increase in video-assisted surgery techniques in adults; in the case of children, these surgeries started following miniaturization of the equipment.

Between 1991 and 1993, the first promising results on cases of gastroesophageal reflux, cryptorchidism, acute appendicitis, and other disorders were reported.[1,3,6] From that point on, videolaparoscopy became an important factor in the reduction of perioperative morbidity, presenting

numerous advantages for children in comparison to open surgery, including cost-effectiveness to the surprise of many.[1,4,5]

Carrying out procedures of video-assisted surgery requires special training for the surgeon due to two-dimensional views through the monitor, which is quite different from the tridimensional view of open surgery. In addition, in comparison to adults, it is considerably more difficult working with instruments while having a two-dimensional view of small children due to less abdominal space.[2] Another new and important factor in laparoscopy are pneumoperitoneum complications following insufflation of CO_2; in this sense, the implication for anesthesia care is that the procedures requires continuous monitoring of CO_2 expiration using a capnograph and controlling ventilation for a maximum level of 35 to 40 mmHg.[7] As in the case of our population, in which there were no hypercapnia effects, pneumoperitoneum is well-tolerated by children when observing intraabdominal pressures lower than 10 mmHg.

Laparoscopy is considered an advancement especially in cases of GERD with or without hiatal hernia;[8,9] cryptorchidism (undescended testis);[10,11] acute abdominal inflammatory process when diagnosis is difficult, especially in adolescent girls;[1,12,13] abdominal trauma (including stab and gunshot wounds);[14] bowel obstruction;[15,16] congenital megacolon (laparoscopic endorectal pull-through instead of colostomy);[6,17] ovarian diseases;[18,19] cholecystectomy;[20] splenectomy;[6,21] diagnosis through biopsies[1,6,22] staging of Hodgkin disease and other tumors;[23,24] diaphragmatic hernia; gastric volvulus;[25] cysts and diverticula; and diagnosis of jaundice and contralateral inguinal hernia.[1,26,27] In addition to the indications for laparoscopic surgery presented in Table 1, there are many other indications in the literature that we have still not used.

The standard laparoscopic treatment in gastroenterology of adults is cholecystectomy. In pediatrics, biliary lithiasis is less frequent but videolaparoscopy is still the better surgical approach.[1,6,28] In pediatric patients, we currently understand that the standard laparoscopic treatment is that of GERD considering the high incidence and morbidity of the disease.[4,8] Among the several techniques employed, laparoscopic Nissen fundoplication (360-degree fundoplication) is the most important one. The Nissen fundoplication allows for the lowest risks for relapse and is especially indicated in neuropathic and malnourished pediatric patients.[1,8] There are other techniques of 180-degree fundoplication, namely Boix-Ochoa and Thal; these techniques are, thus, related to less risk for postoperative dysphasia but to higher risk for relapse.[9,29] In our population, the incidence of relapse (2.7%) was lower than that reported in the literature (5 to 20%) despite our follow-up period of 5 years.[4,8,9,29] Several authors have reported lower rates of perioperative complications in laparoscopy, in comparison to open surgery, while also reporting the same rates of cure of gastroesophageal reflux.[4,8,29]

In other services operating with large populations, laparoscopic appendectomy is the most widely used surgery;[12,14] in this sense, it is indicated especially in cases of children who are obese or aged older than 10 years, of patients with atypical clinical status, of adolescent girls, and of complicated appendicitis. We understand that in lean children with no evidence of plastron conventional, small-incision surgery is still more advantageous.

In pediatric oncologic surgery, the introduction of videolaparoscopy for carrying out biopsy and staging procedures that are minimally invasive and offer rapid recovery, has allowed for earlier start of chemotherapy of various types of tumors with less risk for dehiscence and infections.[22,23] In open-cavity surgeries, it is usually recommended to start chemo- or radiotherapy after cicatrization of laparotomy (8 to 10 days); however, this still offers high risk for dehiscence, infection, and incisional hernias. In turn, after laparoscopy, it is possible to start chemotherapy 24 to 48 hours later. Less pain and surgical hemorrhage alone are two positive factors for better quality of life of children with cancer.

The main reason for indication of laparoscopy in large European centers is lysis of adhesions in cases of bowel obstruction.[1] We understand that laparoscopy is the better solution in these cases when there is no history of diffuse peritonitis or peritoneal sclerosis in peritoneal dialysis patients. The procedure should be indicated early.[16] Considering that digestive perforations account for most complications and conversions to laparotomy, careful insertion of the trocars must be carried out. Due to distention of the loops, trocars must be inserted by naked eye view of the peritoneum; also, late intervention is another frequent reason for conversion to laparotomy since it frequently encounters intestinal necrosis.[15,16]

Pediatric trauma is one of the main causes of morbi-mortality in children. The current trend is the conservative treatment of closed trauma with lesion to solid organs. In this case, pediatric patients usually remain hospitalized for longs periods of time while evolution of the lesions are monitored by imaging exams and hemodynamic status. Hemoperitoneum usually causes pain and prolonged paralytic ileus. Hollow viscus perforation can remain undetected for days, especially in comatose children.[30] Thus, laparoscopy allows for early examination of the cavity, pneumo-peritoneal lavage, cauterization and raffia with rapid recovery and less risk for hospital infection; it also allows for avoiding twofold rupture of the spleen.[14]

In trauma caused by stab or gunshot wounds, the usual approach is immediate laparotomy. The frequency of laparotomies in which there are not intraabdominal lesions (unnecessary laparotomies) varies from 4 to 52%. These frequencies could be reduced if there were better examinations and clinical follow-up, in addition to early laparoscopy. At our services, we carry out laparoscopic examination of the abdominal cavity whenever possible; moreover, the incision can sometimes used for introduction

of optical catheters. Cavity lavage, debridement, raffia, and drainage can be easily carried out without laparotomy; in this case, laparoscopy offers faster recovery and improved cosmesis than laparotomy. Careful imaging and clinical exams can considerably decrease the need for unnecessary laparotomies or laparoscopies.[1,30] In cases of hemodynamically unstable patients and diaphragmatic rupture, video-assisted surgeries and artificial pneumoperitoneum are contraindicated.

Other applications of laparoscopy include urologic surgeries such as nephroctomy,[31] adrenalectomy,[32] vesico-ureteric reflux,[33] varicocele,[1] pyeloplasty,[1] and so on. However, the advantages of these applications are still not established, considering that, in conventional surgeries, surgeons apply small posterior or suprapubic incisions more aesthetically acceptable and can manage the retroperitoneum without paralytic ileus.[6]

Less frequent, though recognizedly advantageous, indications for videolaparoscopy that allowed excellent results were related to intestinal invagination without resection,[34] omental and mesenteric cysts,[1] Meckel's diverticulum (enterectomy),[1,6] duplicitas and lymphangioma (transumbilical), splenectomy with or without cholecystectomy,[6,21] poor intestinal rotation,[35] gastric volvulus,[35,36] wandering spleen,[1] diaphragmatic hernias (hiatal and Morgagni), antegrade continence enema in situ appendix procedure (Malone antegrade continence enema),[37] handling dialysis catheters or fluid derivation, debridement in acute pancreatitis, and many others.

The indication of videolaparoscopy is still controversial for treatment of hypertrophic pyloric stenosis,[6,38] inguinal hernia in children,[26,27] early appendicitis in small or lean children,[1,12,13] renal biopsy, and varicocele.[32] In all of these controversial cases, open surgery apply small incisions, are easy to carry out, and present low morbidity. It is suggested, however, that with the new instruments with 2 to 3-mm in diameter there may be advantages in indicating videolaparoscopy. We understand that videolaparoscopy can be applied to cases of varicocele and investigation for contralateral hernia only in large children. The absolute majority of renal biopsies can be carried out by puncture techniques.

Laparoscopy allows for carrying out the same procedures of open surgery avoiding sectioning of abdominal wall and exposure of the gut.[1,2] Studies have shown that due to lesser trauma there is a milder inflammatory response and there are less endocrinometabolic and cardiovascular alterations.[1,28,39] A great advantage of laparoscopic approach is less postoperative pain associated with decrease in breathing difficulties and in use of analgesics; it also allows for a rapid return to normal activities in children, who are usually not prone to staying at rest.

Moreover, still, laparoscopy allows for minimal bleeding and the incisions leave minimal scaring or disappear, allowing for better aesthetic effect. Laparoscopy does not cause incisional hernias in the muscle-aponeurotic plane; micro-incisions present lesser risk for abdominal wall adhesions, for serosity, and for hematoma. The procedure requires less use of suture wires, since there is no laparotomy. Due to less exposure and less intervention in the gut, the procedure is devoid of postoperative paralytic ileus and intestinal distention, allowing for earlier realimentation of children. Still, the hospital stay is also shorter and with less risk for hospital infections.[1,2,5]

In comparison to open surgeries, the loss of fluid and the hydroelectrolytic alterations due to evaporation in the serosas in laparoscopy are insignificant. The microcamera provides a full view of the cavity and enhancement in size and detail of structures that is not possible in laparotomy (other than full laparatomy) procedures. There is also less risk for forgetting foreign objects in the cavity.

The main disadvantages reported for videolaparoscopy are need for special training in video-assisted surgeries, elevated cost of equipment, and higher risk for lesions such as digestive perforations by the trocars, cauterization of biliary pathways, and difficulty to control large hemorrhages.[1,2,40] Acidosis and hypercapnia may also occur if the ventilation is not appropriate with safe levels of intraabdominal CO_2 pressures.[1,7] Observing careful selection of patients and techniques, none of the referred complications occurred.

Video-assisted surgery equipment is expensive but there is a tendency to decrease in prices following competition between manufacturers. However, considering that hospitals charge for use of the equipment, the cost of the apparatus should be recovered in one or two years. Reusable equipment and shortening operative time also cooperate in cost-effectiveness of laparoscopy.[5] Considering various factors such as costs of supplies, operating time, medication, length of stay, dressing for wounds, and other care factors, US authors have carried out a cost analysis of laparoscopy and concluded that there are increased global savings (hospital, family, and social) in comparison to laparotomy.[4,5]

We concluded that videolaparoscopy is a great advancement in modern pediatric surgery that allows for less invasive and safer care of most pediatric abdominal disorders in children of all ages; this procedure presents numerous advantages in comparison to laparotomy as long as carefully indicate and carried out within adequate surgical and anesthetic principles.

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