

Minilaparoscopy-Assisted Natural Orifice Surgery

Daniel A. Tsin, MD, Liliana T. Colombero, MD, Johann Lambeck, MD, Panagiotis Manolas, MD

ABSTRACT

Background and Objectives: New technology has allowed us to perform major abdominal and pelvic surgeries with increasingly smaller instruments. The ultimate goal is surgery with no visible scars. Until current technical limitations are overcome, minilaparoscopy-assisted natural orifice surgery (MANOS) provides a solution. The aim of this study was to examine our clinical and experimental experience with MANOS.

Method: Minilaparoscopic abdominal instruments were used together with a large vaginal port, which was used for insufflation, visual purposes, introduction of operative instruments, and specimen extraction. Minilaparoscopy-assisted intraperitoneal transgastric appendectomy was done in simulators (Lap trainer with SimuVision, Simulab Corp., Seattle, WA).

Results: Since 1998, we have used this technique in 100 cases including ovarian cystectomies, oophorectomies, salpingo-oophorectomies, myomectomies, appendectomies, and cholecystectomies. Some oophorectomies were performed after vaginal hysterectomy in cases where vaginal extraction was not possible. In this case series, we had only one complication, a case of postoperative fever after an ovarian cystectomy, which was diagnosed as drug-related fever. Our limited simulator experience showed that MANOS is a feasible technique for performing transgastric appendectomies.

Conclusion: It may take several years for natural orifice surgery to become standard care. Meanwhile, MANOS could encourage and expedite this process.

Key Words: Natural orifice surgery, Minilaparoscopy, Culdolaparoscopy, Culdoscopy.

INTRODUCTION

The field of minimally invasive surgery has evolved tremendously in recent years; thus, minilaparoscopy has, in many cases, replaced conventional laparoscopy. Smaller abdominal ports not only offer cosmetic advantages but also have important clinical implications.¹ New technologies promise to lead us to an era of even less-invasive procedures. Natural orifice transluminal endoscopic surgery (NOTES) is a novel concept that involves a port of entry through a natural orifice to the peritoneal cavity to perform diagnostic and therapeutic surgical interventions.^{2,3} Natural orifice surgery might be superior to laparoscopic surgery in reducing postoperative abdominal wall pain, wound infection, hernia formation, and adhesions.⁴ Recently, several reports have demonstrated the technical feasibility of the per-oral transgastric² and transcolonic approaches.⁵ Current endoscopes and instruments, however, are too flexible and insufficient to provide robust grasping and anatomic retraction. Until technical improvements become available, use of current instruments combined with minilaparoscopy could overcome these limitations.

The use of the vaginal route for endoscopic procedures is not new. In 1901, Dr. Ott described ventroscopy,⁶ some years later, Klaften presented colpolaparoscopy,⁷ and Decker and Cherry reported culdoscopy.⁸ Culdoscopy was the preferred endoscopic method used by gynecologists for many years. Although abandoned in favor of laparoscopy, in recent years we have witnessed a resurgence of vaginal endoscopic techniques. In 1998, we introduced culdolaparoscopy, which entails the use of minilaparoscopy to assist natural orifice surgery.^{9,10} With this technique, the posterior vaginal fornix is used for the insertion of the larger, 10-mm or 12-mm port, which serves visual function similar to culdoscopy and is used for introduction of operative instruments and extraction of specimens.

The aim of this study was 2-fold: to examine our clinical

The Mount Sinai Hospital of Queens, Department of Minimally Invasive Surgery, Long Island City, New York.

Presented at the 15th International Congress and Endo Expo 2006, SLS Annual Meeting, Boston, Massachusetts, USA, September 7, 2006.

Address reprint requests to: Daniel A. Tsin, MD, Director of Minimally Invasive Surgery, The Mount Sinai Hospital of Queens, Long Island City, New York, 25-10 30th Ave, Long Island City, NY 11102, USA. Telephone: 718 898 5101, Fax: 718 746 4174, E-mail: LaserGYN@aol.com

© 2007 by JSLS, *Journal of the Society of Laparoendoscopic Surgeons*. Published by the Society of Laparoendoscopic Surgeons, Inc.

experience with culdolaparoscopy, a technique that combines operative culdoscopy (a natural orifice surgery) with minilaparoscopy; and to examine the feasibility of MANOS to perform transgastric appendectomies.

MATERIALS AND METHODS

Clinical Experience

Preoperative Evaluation

The study population included female patients with benign surgical conditions. Before surgery, all patients underwent bimanual pelvic examination. If the pouch of Douglas was obliterated, the patient was not considered a candidate for culdolaparoscopy. All women had antibiotic prophylaxis with metronidazole and cephalosporins. In select cases, bowel preparation was performed.

Operating Room Assembly

The operating room was assembled following the standards for gynecological laparoscopic surgery, the only difference being the position of the monitors: one of them was placed cephalad, by the patient's right shoulder and the other by the patient's left foot. This disposition of the monitors was essential to allow proper visualization throughout the surgery, especially when the surgeon was operating from the vaginal port. Both monitors were movable and had an articulated arm, facilitating the view when the surgeon changed positions (**Figure 1**).

All procedures were performed with the patient under general anesthesia with endotracheal intubation. Patients were placed in a semi-dorsolithotomy position. We utilized Allen-Type telescopic stirrups and Venodyne boots. The vagina was cleaned with 10% povidone iodine, and a pelvic examination was carried out to confirm that no obstruction was present of the posterior cul-de-sac. A Foley catheter was placed, and a uterine manipulator (ZUMI-4.5, Circon Cabot, Racine, WI) inserted. A weighed vaginal speculum was used to allow proper exposure of the posterior fornix. Pneumoperitoneum was induced with a Veress needle inserted in the infraumbilical area. The minilaparoscope was introduced in most cases through a 3-mm infraumbilical port with 2 additional 3-mm ports.

The posterior cul-de-sac was visualized with the minilaparoscope. A plastic rod that was 10 mm in diameter and 46 cm in length (PortSaver, ConMed, Utica, NY) was mounted inside an insufflating cannula of 12 mm in di-

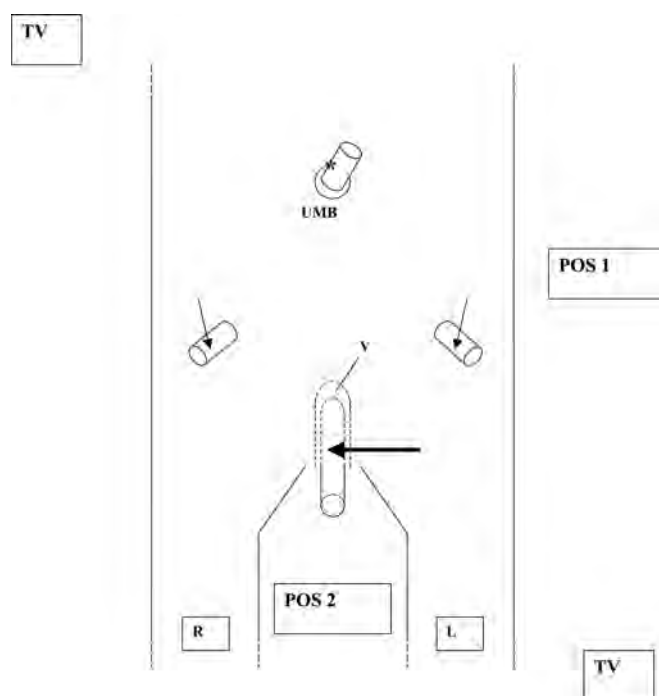


Figure 1. Schematic depiction of culdolaparoscopy. L and R: patient's feet; UMB: umbilicus; V: vagina; POS 1-POS 2: surgeon's positions; TV: monitors' location; black star: umbilical port; thin arrows: lower abdominal quadrant ports; thick arrow: vaginal port.

ameter and 15 cm in length. The plastic rod and the cannula were placed against the posterior fornix. The weighed speculum was removed and the uterine manipulator, together with the rod, was pushed upward and anterior. It is important that the point of pressure made by the rod is in the center of the cul-de-sac and clearly identifiable with the minilaparoscope. When necessary, the bowel was pushed aside with a probe. A small incision was done via minilaparoscopy at the tip of the pressure point to aid the penetration of the rod and the cannula. Under minilaparoscopic surveillance, the trocar was inserted into the cul-de-sac with gentle, steady pressure (**Figure 2**). At this time, the insufflation line was attached to the vaginal port. The patients' thighs were brought to the horizontal position while keeping the knees flexed. Culdolaparoscopy was then performed with 3-mm-abdominal instruments, and a large vaginal port. The function of the ports changed depending on the nature or stage of the procedure. The vaginal port was used for placement of instruments larger than 3 mm, such as endoscopic gastric anastomosis clamp, clip applier, grasper, morcellator (**Figure 3**), and for specimen extraction (**Fig-**



Figure 2. Introduction of the vaginal port. A plastic rod mounted inside an insufflating cannula is inserted into the cul-de-sac under minilaparoscopic surveillance.



Figure 3. The vaginal port is used for introduction of large operative instruments.

Figure 4). If necessary, a 10-mm telescope was introduced via the vaginal port.

Gynecological Procedures

Ovarian cystectomies, oophorectomies or salpingo-oophorectomies were done with minilaparoscopy elements via the abdominal ports.^{10,11} The vaginal port was used for insufflation, became the operative port for 5-mm to 12-mm instruments, including gastrointestinal anastomosis clamp, 5-mm bipolar coagulator, and 5-mm scissors.



Figure 4. Specimen extraction via the vaginal port. The adnexa is placed into an endoscopic bag and removed vaginally.

Specimen extraction was always done vaginally, either directly or within an endobag.

Myomas were enucleated by using established laparoscopic techniques.¹⁰ The vaginal port was utilized to introduce a 10-mm plastic rod to help in the exposure of the myomas, since 3-mm instruments were not powerful enough for traction and exposure of large myomas. After enucleation, a 10-mm laparoscopic tenaculum was placed transvaginally. Myomas oblong in shape up to 8 cm in diameter were grasped with the tenaculum and pulled through a colpotomy. For larger myomas, a motorized morcellator was used transvaginally. The incision of the posterior cul-de-sac was then closed with a 2-0 chromic suture placed endoscopically or vaginally.

Appendectomies

The base of the appendix was identified, and the mesoappendix isolated and cut with the aid of monopolar scissors. At this point, the surgeon positioned himself between the patient's legs and looked at the monitor positioned by the patient's right shoulder. The laparoscope remained in the umbilical port or was changed to a left lower quadrant port according to the surgeon's convenience. The ETS endoscopic linear cutter (Ethicon Endo-Surgery Inc., Cincinnati, OH) 12 mm in diameter with a cut length of 35mm was introduced through the vaginal port. The base of the appendix was placed on the opened cutter with the aid of 2 graspers; the stapler was closed around it and fired. The mesoappendix was stapled and transected. Once the appendix was amputated, the cutter was withdrawn and an endoscopic bag was intro-

duced through the 12-mm trocar. The appendix was placed into the bag and the trocar, together with the endoscopic bag containing the specimen, was pulled out through the vagina. Pneumoperitoneum was restored via an abdominal port if necessary. The vaginal trocar was reintroduced and irrigation and suction were carried out through it. The incision in the posterior fornix was closed with an absorbable suture placed vaginally.

The vaginal port was used as the operative port for instruments that were 5 mm to 12 mm, including 5-mm laparoscopic scissors, 5-mm suction-irrigation probe, 10-mm endoscopic bag, and the 12-mm endocutter. The abdominal ports were utilized to introduce the minilaparoscope, scissors, graspers, and dissectors.¹

Culdolaparoscopy During Vaginal Hysterectomy

We used this approach to perform simultaneous cholecystectomies and difficult oophorectomies. The sleeve of a trocar was secured with a purse-string type suture. The vagina was packed with soaked gauze. The insufflation was done via the vaginal port until pneumoperitoneum was achieved. Then a 10-mm diameter 30-degree angle laparoscope was placed vaginally for visualization. The abdominal ports were then placed under culdoscopic surveillance. Oophorectomy was performed by applying bipolar coagulation and cutting to the mesovarium with 5-mm laparoscopic scissors introduced through the vaginal port. When necessary, 3-mm forceps and scissors were inserted through the abdominal trocars. The ovaries were extracted through the vaginal port utilizing a 5-mm grasper, and hemostasis was secured. The abdominal ports were removed under culdoscopic surveillance, and finally the vaginal cannula was extracted. The closure of the vaginal port was done vaginally.¹²

For cholecystectomy, the hilum was dissected. Calot's triangle and supra-Calot's triangle were clearly identified. The clip applier was introduced through the umbilical port. The cystic duct and the cystic artery were transected, and the gallbladder was dissected off the gallbladder bed with the hook cautery. When the specimen was extracted, a 5-mm scope was introduced through an abdominal port, and the specimen was removed through the vaginal port by using an endobag. Extraction was accomplished by removing the vaginal packing, releasing the purse-string suture and finally, extracting the trocar and the gallbladder.¹³ Alternatively, the procedure was done by limiting the size of the abdominal trocars to 3mm and introducing the clip applier via the vaginal port.

Experimental Work

Our transgastric peritoneoscopy experience was limited to simulators. We used a laparoscopic trainer (Lap trainer with SimuVision, Simulab Corp., Seattle, WA; www.simulab.com) and a simulated esophagus and stomach (Laparoscopic Nissen fundoplication model, Simulab Corp., Seattle, WA; www.simulab.com). We also used a nasogastric (NG) tube and a gastroscope. Condoms were used to simulate endobags, and gummy worms to simulate the appendix. A condom tied at its rim was secured with a long 0 Prolene suture at the end of the NG tube. The condom was loaded at the end on the NG tube. Vaseline ointment was used to aid in the introduction into the stomach via the esophagus.

A minilaparoscope was placed through the umbilical port, together with 2 additional minilaparoscopy ports. An incision was done in the stomach with minilaparoscopic scissors. A grasper was used to retrieve the condom from the stomach. With the condom inside the simulated abdominal cavity, the specimen was loaded in the bag. With the aid of 2 graspers, and by pulling the NG tube, the specimen was extracted transgastrically. In other experiments, we used a gastroscope to place and remove the condom with a simulated specimen by grasping at the rim of the condom and followed the maneuvers described before for the NG tube. The closure of the gastric incision was done minilaparoscopically using a straight needle and a 3-mm endoscopic needle blocker (Endoscopic curved needle driver, Cook Ob/Gyn, Spencer, IN). The universal tying technique was used for suturing.¹⁴ Alternatively, a conventional minilaparoscopic needle holder was used for contralateral or ipsilateral tying. In some experiments, a long straight needle was placed directly via the abdominal wall.¹⁵

RESULTS

We performed 100 minilaparoscopy-assisted natural orifice surgeries including 55 oophorectomies and salpingo-oophorectomies, 2 ovarian cystectomies, 27 myomectomies, 3 appendectomies. In addition, 13 procedures were performed during vaginal hysterectomy: 10 oophorectomies and 3 cholecystectomies. In one case, a lesion in segment 5 of the liver was observed; a liver biopsy was carried out by introducing a biopsy forceps via the right lower quadrant port. Pathological examination showed a fibrous subcapsular nodule.

We encountered only one complication; one patient who underwent an ovarian cystectomy developed a drug-re-

lated fever that improved after discontinuation of the antibiotics. No patients developed an infection. Follow-up visits up to 2 months after surgery revealed no complications.

Our laboratory experiments with the peroral transgastric approach in simulators demonstrated the feasibility of MANOS in performing appendectomies.

DISCUSSION

Nowadays, major surgical procedures are being performed laparoscopically with increasingly smaller instruments. Small ports and instruments have many advantages over large ones, such as anesthesia requirements,¹⁶ less postoperative discomfort,¹⁷ decreased risk of adhesion formation,¹⁸ and reduced risk of incisional hernias.^{19,20} However, some technical limitations may be encountered with small ports, particularly when rapid insufflation, forceful irrigation or extraction of large specimens is required. Culdolaparoscopy, a minilaparoscopy-assisted natural orifice surgery, offers the advantages of minilaparoscopy while allowing optimal insufflation, irrigation, extraction of large operative specimens, and the utilization of large-diameter instruments.

Major concerns following the use of the vaginal route are the risk of pelvic infection, trauma to adjacent structures, dyspareunia, and cul-de-sac adhesion.^{10,21} In our 7-year experience with culdolaparoscopy, we have not seen any of these complications. This is in agreement with previous reports demonstrating an extremely low incidence of complications with colpotomy²² and culdoscopy.²³ It should be noted that with culdolaparoscopy the vaginal trocar is inserted under laparoscopic surveillance. This approach virtually eliminates the complications attributed to culdoscopy, where instruments are blindly inserted. Nevertheless, in addition to insertion of the trocar under laparoscopic view, a meticulous endoscopic technique is essential. The trocar should not be introduced or forced into the cul-de-sac unless the protruding point is unquestionable under laparoscopic view. The insertion should be done precisely in the midline of the posterior fornix.²⁴

The evolution of flexible endoscopes and endoscopic devices has recently enabled per-oral transgastric and transenteric abdominal procedures in animal models. This approach to the peritoneal cavity has potential for a wide array of diagnostic and therapeutic procedures. So far, several interventions have been successfully accomplished in animals, such as liver biopsy,² oophorectomy and partial hysterectomy,²⁵ cholecystectomy,^{5,26} and tubal

ligation.²⁷ Some technical limitations, though, have emerged with the use of this approach. Current endoscopes are too flexible, do not provide strong grasping and retraction, and they may not properly reach remote structures. In addition, multi-channel scopes are needed to allow the use of several instruments and to provide traction/countertraction. In view of this, we developed MANOS and successfully applied it in simulators. Our study suggests the technical feasibility of performing appendectomies with the MANOS approach in humans.

A major issue needs to be addressed with natural orifice surgery. This approach requires the creation of a perforation, yet considered a major complication of endoscopy with significant morbidity and mortality. Although animal models have had good evolution and gained weight in experimental work,^{2,5,25–27} safe and simple devices for gastrotomy and intestinal closure must be ensured before MANOS and NOTES are applied in clinical practice.

CONCLUSION

Culdolaparoscopy is a feasible, simple, safe technique that avoids additional and larger abdominal ports, potentially decreasing the morbidity associated with conventional operative laparoscopy while overcoming the limitations of minilaparoscopy. This approach enabled us to perform gynecological and nongynecological procedures utilizing abdominal ports no larger than 3 mm or 5 mm.

The progress in flexible technology will eventually enable us to perform major abdominal and pelvic procedures without any visible scarring. Meanwhile, MANOS may facilitate the transition into this new era of endoscopic surgery.

References:

1. Tsin DA, Colombero LT, Mahmood D, Padouvas J, Manolas P. Operative culdolaparoscopy: a new approach combining operative culdoscopy and minilaparoscopy. *J Am Assoc Gynecol Laparosc.* 2001;8:438–441.
2. Kalloo AN, Singh VK, Jagannath SB, et al. Flexible transgastric peritoneoscopy: a novel approach to diagnostic and therapeutic interventions in the peritoneal cavity. *Gastrointest Endosc.* 2004;60:114–117.
3. Hochberger J, Lamade W. Transgastric surgery in the abdomen: the dawn of a new era? *Gastrointest Endosc.* 2005;62:293–296.
4. Ko CW, Kalloo AN. Per-oral transgastric abdominal surgery. *Chin J Dig Dis.* 2006;7:67–70.

5. Pai RD, Fong DG, Bundga ME, Odze RD, Rattner DW, Thompson CC. Transcolonic endoscopic cholecystectomy: a NOTES survival study in a porcine model. [*Gastrointest Endosc.* 2006;64:428–434.](#)
6. Ott V. Ventroscopia. *Zhurnal Akusherstva I Zbenskikh Boleznel.* 1901;15:1045–1049
7. Klaften E. Culdoscopy [letter to the editor]. *Am J Obstet Gynecol.* 1948;55:1071–1072.
8. Decker A, Cherry T. Culdoscopy, a new method in diagnosis of pelvic disease. *Amer J Surg.* 1944;64:40–44.
9. Tsin DA. Development of flexible culdoscopy [letter to the editor]. *J Am Assoc Gynecol Laparosc.* 2000;7:440.
10. Tsin DA. Culdolaparoscopy: a preliminary report. [*JLS.* 2001; 5:69–71.](#)
11. Tsin DA, Espinoza de los Monteros JA, Colombero L. Laparoscopic techniques for extracting ovarian teratomas. [*J Am Assoc Gynecol Laparosc.* 1996;3:283–286.](#)
12. Tsin DA, Bumashny E, Helman M, Colombero L. Culdolaparoscopic oophorectomy with vaginal hysterectomy: an optional minimal-access surgical technique. [*J Laparoendosc Adv Surg Tech.* 2002;12:269–271.](#)
13. Tsin DA, Sequeira RJ, Giannikas G. Culdolaparoscopic cholecystectomy during vaginal hysterectomy. [*JLS.* 2003;7:171–172.](#)
14. Semm K. *Operative Manual for Endoscopic Abdominal Surgery.* Chicago, IL: Year Book Medical Publishers; 1987.
15. Davila F, Davila U, Montero JJ, et al. Colectostomía laparoscópica con un solo puerto visible subxifoideo de 5 mm. *Rev Mexicana de Cirugía Endoscópica.* 2001;2:14–16.
16. Faber BM, Coddington CC. Microlaparoscopy: a comparative study of diagnostic accuracy. [*Fertil Steril.* 1997;67:952–954.](#)
17. Risquez F, Pennehoaut, McCorvey R, et al. Diagnostic and operative microlaparoscopy: A preliminary multicenter report. [*Hum Reprod.* 1997;12:1645–1648.](#)
18. Almeida OD, Val-Gallas JM, Rizk B. Appendectomy under local anesthesia following conscious pain mapping with microlaparoscopy. [*Hum Reprod.* 1998;13:588–590.](#)
19. Montz FJ, Holschneider CH, Munro MG. Incisional hernia following laparoscopy: a survey of the American Association of Gynecologic Laparoscopists. [*Obstet Gynecol.* 1994;84:881–884.](#)
20. Rabinerson D, Avrech O, Neri A, et al. Incisional hernias after laparoscopy. [*Obstet Gynecol Surv.* 1997;52:701–703.](#)
21. Miller CE. Methods of tissue extraction in advanced laparoscopy. [*Curr Opinion Obstet Gynecol.* 2001;13:399–405.](#)
22. Ghezzi F, Raio L, Mueller MD, Gyr T, Buttarelli M, Franchi M. Vaginal extraction of pelvic masses following operative laparoscopy. [*Surg Endosc.* 2002;16:1691–1696.](#)
23. Copenhaver EH. A critical assessment of culdoscopy. [*Surg Clin North Am.* 1970;50:713–718.](#)
24. Neely MR, McWilliams R, Makhlof HA. Laparoscopy: routine pneumoperitoneum via the posterior fornix. [*Obstet Gynecol.* 1975;45:459–460.](#)
25. Wagh MS, Merrifield BF, Thompson CC. Endoscopic transgastric abdominal exploration and organ resection: initial experience in a porcine model. [*Clin Gastroenterol Hepatol.* 2005;3: 892–896.](#)
26. Park PO, Bergstrom M, Ikeda K, Fritscher-Ravens A, Swain P. Experimental studies of transgastric gallbladder surgery: cholecystectomy and cholecystogastric anastomosis. [*Gastrointest Endosc.* 2005;61:601–606.](#)
27. Jagannath SB, Kantsevov SV, Vaughn CA, et al. Peroral transgastric endoscopic ligation of fallopian tubes with long-term survival in a porcine model. [*Gastrointest Endosc.* 2005;61: 449–453.](#)