

Natural orifice surgery and single port access applied to colorectal surgery: the new era of intrarectal surgery?

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Introduction

Recently, natural orifice surgery (NOS or NOTES) evolved from sporadic experimental reports to clinical series and multicentric studies. Since the early concept from pioneers as Kalloo and Kantsevov in the US (1) and Rao and Reddy from India (2), NOTES has emerged in recent years as a promising new alternative to open and laparoscopic surgery for abdominal surgery. Potential benefits in avoiding surgical incision complications as incisional hernias, adhesences, intestinal obstruction, scars, and wound infection, together with better cosmesis is the goal for new research in minimally invasive surgery. This evolution led to first successful series clinical applications in the literature for transvaginal and transgastric NOTES (3).

Transcolonic NOTES surgery was a matter of subject of few recent experimental studies, suggesting that the access could be an attractive option for treating colonic and abdominal diseases (4-9). Technical obstacles for the colonic access are risk of infection and leaks, safe entrance in the abdominal cavity and reliable colonic closure and remained as barriers slowing transcolonic clinical applications. The research group at our Institution effectively developed new flexible techniques on transcolonic studies in animal set, and a transcolonic perirectal access was designed to allow access and therapy in the abdominal cavity and retroperitoneal space. Besides the enthusiasm, surgical community early identified many issues for NOTES flexible techniques, and soon have migrate to the easier adaptation of one site laparoscopy, and so LESS colorectal resection is an emerging technique, continually growing in numbers and acceptance worldwide.

Intrarectal surgery seems to conjoin all the advantages of Transanally Endoscopic Microsurgery (TEM) together with transanal extraction of the specimen (Natural Orifice Specimen Extraction, or NOSE (10)) and Transcolonic NOTES, performed either with flexible or with rigid instruments. If we imagine that in few years, colorectal surgery will be performed predominantly through natural orifices, using single-ports, endoscopes, transluminal devices, and even one-arm robotics and miniature robots and cameras, it would be possible to reach resections of any part of the colon since new technology become available.

Evolution of the concepts of single access surgery and NOTES

Since 2007 early clinical human applications of the new method were reported, after IRB approval for human trials on NOTES in different countries. Since Zorron et al, Marescaux et al, Zornig et al, and Branco et al described successful NOTES transvaginal cholecystectomy in early 2007 (7-14), other groups follow and published their initial clinical results. Transgastric surgery was also clinically presented in meetings by Rao and Reddy using available endoscopic instruments and la-

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ter successful transgastric PEG rescue was described by Marks et al. (2,15). Transvaginal NOTES appendectomy was first described by Palanivelu et al. (16) and Ramos et al presented a first series of transvaginal NOTES sleeve gastrectomy (17). Current estimation of published clinical cases reached nearly 1200 cases (3), and two important multicentric studies were also published: an international multicenter trial IMTN Study (18), and the German Registry D-NOTES (19).

Previous clinical work regarding use of natural orifice surgery for cancer surgery was described by Hazey et al using a transgastric access to evaluate pancreatic cancer (20), and Zorron et al by transvaginal approach to perform liver, peritoneal, great omentum and ovarian biopsies to evaluate carcinomatosis (21). In the small series on NOTES surgery for cancer, natural orifice tumor implantation were not yet described, but are a matter of concern in performing oncologic resections.

Since the beginning of natural orifice surgery, few investigators choose the transcolonic route (4-9). The transcolonic approach has several theoretic advantages over the transgastric route, eliminating the need for scope retroflexion for upper abdominal surgery, allows a more direct access route and closer than a transgastric approach, and the anorectum allows passage of larger-diameter instrumentation and retrieval of larger specimens. Transcolonic and transvaginal extractions of specimens in laparoscopic surgery has been more constantly used in recent years to allow larger organs NOTES (22-7). Transvaginal colectomy assisted by minilaparoscopy was first described in clinical setting by Lacy et al, naming the technique as MA-NOS (28) in a patient for sigmoid cancer, and Burghardt et al reported a case of hybrid transvaginal right colectomy (29).

Transcolonic NOTES using rigid transanal systems was subject of research in recent experimental and cadaver studies. Whiteford et al showed the feasibility of rigid NOTES sigmoid resection in three cadavers, using transanal endoscopic microsurgery, allowing en-bloc lymphadenectomy and transanal retrieval and anastomosis (30). In their impression, the main obstacles for the use of rigid systems in colorectal surgery are the acute angle created by the sacral promontory and the limited reach of current instruments. Sylla et al successfully performed a technique using rigid transanal resection of the colon and sometimes a transgastric flexible access to allow mobilization of the colon, in a set of 14 non-survival and cadaver animal experiment (31). Leroy et al described a combined technique using flexible and rigid transrectal and flexible transgastric accesses to perform sigmoidectomy in a pig model (32). The technique using the concept of Totally NOTES resulted in survival of all 5 pigs, and no signs of postoperative infections. Transanally Endoscopic Microsurgery (TEM), developed and described by Buess et al in the early 80's is currently the best minimally invasive alternative for most benign lesions of the rectum, and represent pioneer efforts in the field of natural orifice surgery (33). Sylla et al described a case of transorificial rectal resection using TEM technology with mini-laparoscopic assistance allowing successful oncologic resection (34), and our group published oncologic TME using Perirectal NOTES Access (PNA), using flexible colonoscope to enter and dissect the mesorectal envelope (35).

Total mesorectal resection allied to en bloc lymphadenectomy with high ligation of inferior mesenteric artery is the standard of care of oncologic curative resection of rectal adenocarcinoma. As described by Heald in 1982, a precise plane of dissection allowed improved oncological respectability without tumor cell spillage, improving results and decreasing the indication for abdominoperineal resection (36-7). As experienced by our study group, an adequate TME with preservation of the mesorectal envelope can be achieved using flexible or rigid transcolonic technique, performed in the opposite direction (down-to-up, from anal to rectosigmoid junction), performed along embryologic fusion planes, beginning the dissection by gaining access to the presacral plane located between the mesorectum and the presacral fascia. Entry and subsequent dissection in this avascular plane using flexible endoscopic equipment was more hazardous than formal laparoscopy due to limited instrumentation, but retroperitoneum improved the exposure and dissection inside the anatomic plane.

Single access surgery

A logical evolution of laparoscopy is reducing the number of percutaneous ports, though avoiding multiple incisions of the skin, with possible better results in cosmetic and reducing hernia sites. The terms Single Access Surgery (SAS), Laparoendoscopic Single Site surgery (LESS), Single Port Access surgery (SPA), SILS, and many others were used to describe the approach either using all tro-

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cars installed inside the umbilicus, or through a single-incision port. However, current single access devices can usually represent a larger incision (perhaps a minilaparotomy) hidden by the umbilical scar, possibly more painful, and with an potential increased risk of infection and hernia. The difficulty in allow triangulation by the instruments is now being solved by new instruments, but only more consistent results will show if LESS is an “advance” after laparoscopy, or it has too many problems to be overcome. However, colorectal surgery and surgical indications in which large specimens shall be extracted, LESS is a simplification of an accessory, allowing good preliminary results. Performing single port surgery for colorectal diseases since 2009, our group identified good indications for right colon resections and rectosigmoidectomy, even in obese patients (Figs. 1A and 1.B).



A Fig. 1 - A. Single port sigmoidectomy. External view of working port and instruments. **B** Single port sigmoidectomy. Postoperative aspect with drainage.

Down-to-up intrarectal NOTES TME using single port

Down-to-up TME Perirectal NOTES Access (PNA) using rigid intrarectal laparoscopy and single port device implies in an initial low circular full-thickness access to the anatomic plane of presacral space, evolving the dissection cephalad and circumferentially (Fig. 2A). The patient is placed in lithotomy position and received single dose of intravenous antibiotic prophylaxis. Transabdominal laparoscopic high ligation and left colon liberation can be performed at the beginning or after the mesorectal resection. Rectal lumen is disinfected by iodopovidone solution, and a disposable Single Port Access device (Triport, Olympus, Japan) is transanally inserted. The device has 3 channels for instrumentation, and two additional channels for CO₂ insufflation. The pressure for intracolonic insufflation is set to 10mm Hg. A laparoscopic camera and instruments are inserted through the port to act intraluminally (Fig. 2B). The inferior limits of the tumor are identified, and the lower limit of resection is chosen, at the desired line of anastomosis (Fig. 2C). The full-thickness circular incision reached the plane between presacral fascia and rectal fascia posteriorly, and the posterior wall of the vagina anteriorly, with cephalad progression. Transanal extraction of the specimen and section of the proximal colon is achieved (Fig. 2D). A transverse coloplasty is performed in the proximal colon to improve functional results and handsewn coloanal anastomosis is performed.

Flexible retrorectal NOTES TME

Perirectal NOTES Access (PNA) for TME with flexible colonoscope implies in an initial low posterior perforation to the anatomic plane between the presacral fascia and the fascia propria, evolving the dissection proximally and circumferentially (Fig. 3A). Preparation of the patients is similar as described above. The necessary equipment is an endoscopic set consisted by a single channel videocolonoscope and a laparoscopic set. An anoscope is transanally inserted, and the rectum is clo-

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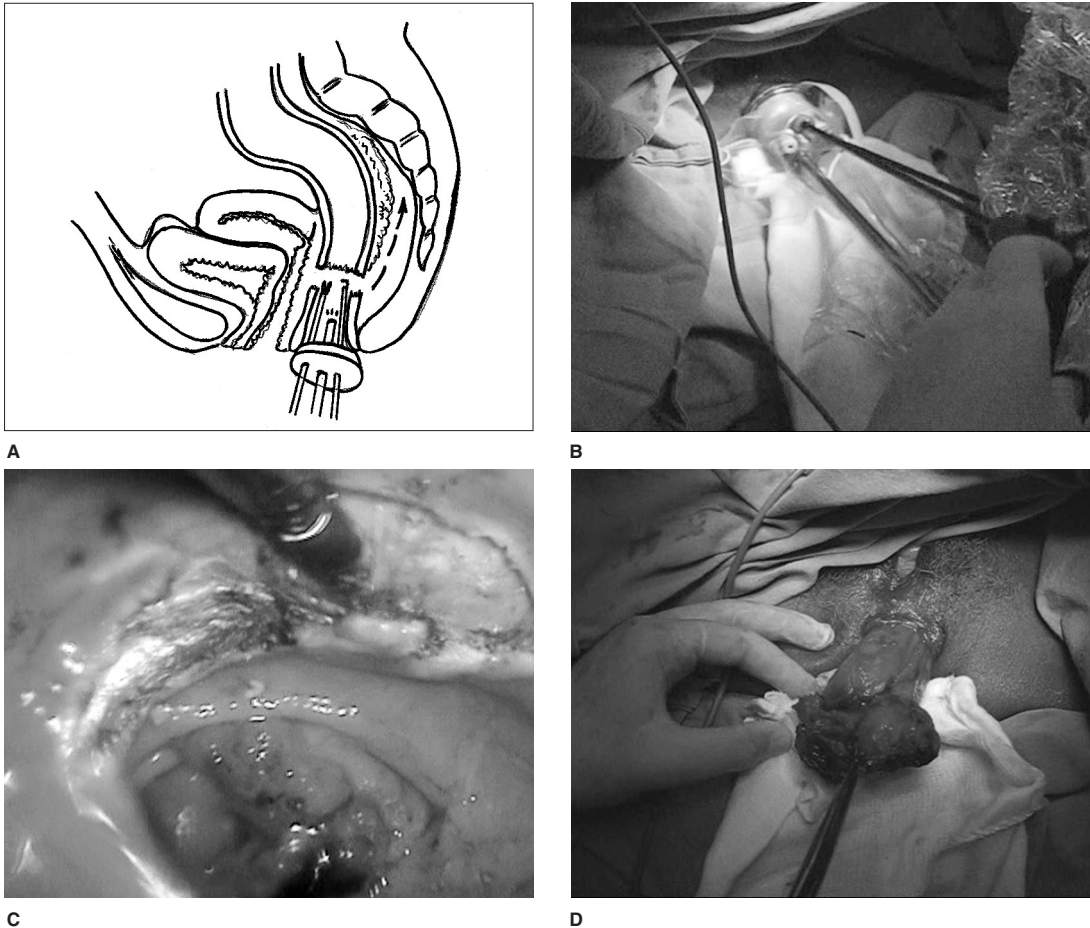


Fig. 2 - A. Schematic view of rigid “down-to-up” transcolonic Perirectal NOTES Access (PNA) for total mesorectal excision for rectal cancer using single port device. The port is inserted transanally, and circular intraluminal full-thickness incision allows entry into the presacral space and dissection in the anatomic oncologic plane from below. **B.** Transanally insertion of a disposable single port Access device. A laparoscopic camera, a 5mm grasper and a semiflexible laparoscopic hook were inserted through the port to allow intraluminal dissection. **C.** The inferior limits of the tumor were identified, and the lower limit of resection was chosen. Full-thickness circular incision reached the plane between presacral fascia and rectal fascia posteriorly, and the posterior wall of the vagina anteriorly. **D.** Full mobilization was achieved, allowing transanal extraction of the specimen and section of the proximal colon.

sed by a circumferential purse-string suture. After the closure above the limit of rectal section, the distal rectum is disinfected. The anal verge is identified, and a small posterior incision is performed exactly in the planned line of rectal resection, using monopolar cautery under direct vision. The access orifice is tested by digital exploration, and the colonoscope is inserted directly in the perirectal retroperitoneal space (Fig. 3B). Total mesorectal resection is progressively accomplished using endoscopic monopolar scissors in the oncologic plane between the presacral fascia and the mesorectal fascia (Fig. 3C) and finally reaching the peritoneal cavity. Due to oncological principles of high vascular ligation, a laparoscopic camera is inserted transumbilically, and a high ligature and section of inferior mesenteric artery at the level of aorta insertion is performed using a standard 3-trocar technique, also to liberate the splenic flexure. The specimen is grasped and fully transanally extracted (Fig. 3D), and transanal stapled anastomosis is performed. Proximal colostomy in the right transverse colon is performed in most cases to protect the low anastomosis.

Early results

A total of 5 patients with elective surgical indication for oncologic resection for rectal cancer were submitted to transcolonic flexible endoscopic NOTES TME with laparoscopic assistance. The interventional team is always multidisciplinary, composed by a general surgeon, a gastroenterologi-

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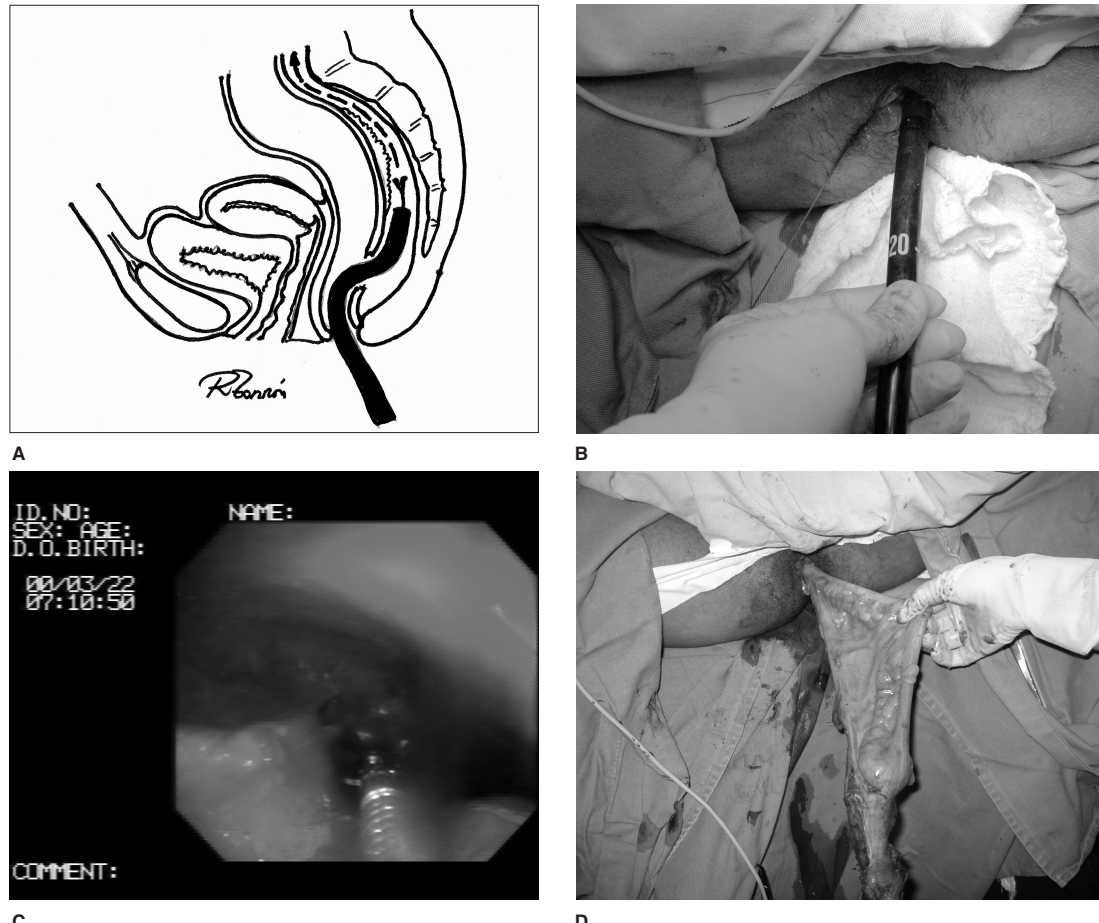


Fig. 3 - A. Schematic view of flexible transcolonic Perirectal NOTES Access (PNA) for total mesorectal excision for rectal cancer using a standard colonoscope. **B.** The endoscope is inserted directly in the presacral space, 3cm above the dentate line, allowing flexible dissection in the anatomic oncologic plane from below. **C.** The colonoscope is inserted directly in the perirectal retroperitoneal space through the incision, parallel to the rectal lumen. Total mesorectal resection is progressively accomplished using endoscopic monopolar scissors inside the ideal oncologic plane of dissection. **D.** Transanal extraction of the specimen.

st-endoscopist, and surgical residents. After survival studies in swine model during previous 10 months, solving problems of spatial orientation, insufflation, and instrumental development, inclusion of human series was approved by the institutional review board for transcolonic NOTES clinical trials.

Preliminary results showed good postoperative course of the patients with few complications recorded. Surgical specimens showed adequate circumferential and distal margins, with regular amount of lymphnodes retrieved. Operative times were long, specially in cases of flexible surgery (350-410min). There was a conversion to open surgery, in a patient with a bulky tumor that was not mobilisable by laparoscopic maneuvers. Transfusion was not required, and a complication was recorded in only one patient who claimed of transitory paresthesia of both feet due to intraoperative positioning that disappeared after 10 days.

Future perspectives

Natural orifice surgery, besides enthusiasm and the promising potential advantages, didn't signalized superiority in any medical indication over standard surgical therapy yet (38). Experimental and clinical studies still demonstrates that evolution of technology is needed to expand the possibilities of the new field, allowing safety and efficiency of NOTES techniques.

Single Access surgery can already be applied to colorectal surgery, and it is being recognized as a similar boom as experienced by laparoscopy, in a smaller scale. The fact that this new method re-

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quires a small learning curve, allied with the available instruments and ports, with immediate cosmetic benefit, is attracting surgeons and patients to this solution. Next years, more developments and indications are expected for umbilical surgery, maybe in short time formal laparoscopy.

NOTES applied to colorectal surgery may represent the first true application resulting in palpable benefit for the patient. The adherence to the principles of oncologic resection is vital, and opens a wide range of possibilities of future applications of transcolonic NOTES for colorectal surgery. Despite advantages over existing laparoscopic and open methods cannot be distinguished in this early stage of the concept, flexible or rigid single port transorificial performance of colorectal operations seems promising.

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