

Natural orifice transluminal endoscopic surgery

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The use of flexible endoscopes for intraluminal gastrointestinal endoscopy is now entering its fifth decade and the evolution of this technique has been from simple diagnostic procedures to progressively more invasive ones. These procedures are performed by several disciplines, although mostly by gastroenterologists and surgeons. Natural orifice transluminal endoscopic surgery (NOTES) is an exciting new concept that continues the evolutionary process and has the potential to change the way endoscopy and surgery are performed¹.

NOTES implies surgery performed endoscopically by initially passing the endoscope transorally or transanally, then transluminally into areas that would not otherwise be accessible endoscopically, such as the abdomen and pelvis. This entails the intentional creation of perforations, a concept that has hitherto been considered taboo and associated with poor outcome. Theoretical advantages of NOTES over the laparoscopic approach include less invasiveness, elimination of any abdominal incision, and a reduction in postoperative abdominal wall pain, wound infection, hernia formation and adhesions¹.

In the USA and, indeed, most of the world, NOTES has been confined to the animal laboratory. Only a single group has used NOTES in humans; the first clinical procedure was carried out by Rao and Reddy in India, in a patient whose severe burn injuries of the abdominal wall prohibited safe entry into the peritoneal cavity for conventional surgery (N. Reddy, personal communication). Using a

transoral, transgastric approach these surgeons carried out a successful appendectomy. Further successful appendectomies have since been performed by this group¹.

In animals, the peroral approach has so far been linked with a transgastric route. After passing the endoscope into the stomach, an opening through the anterior gastric wall is created, with or without cautery. The opening is enlarged using additional cautery or balloon dilatation to allow passage of the endoscope into the abdominal cavity and pelvis. *Table 1* outlines fully published NOTES studies and interventions. The initial animal study was published by Kalloo and colleagues from Johns Hopkins Medical Center². These authors used a series of experiments in pigs to demonstrate the feasibility and safety of NOTES. After abdominal exploration and liver biopsy, they closed the gastric wall with endoscopic clips. The animals were fed the following day and survived for 14 days without adverse sequelae. Subsequent publications by others²⁻⁸ have confirmed the feasibility of the transgastric approach as well as demonstrating the possibility of complex procedures within the abdomen and pelvis (*Table 1*). However, these studies have also shown the potential for life-threatening complications from incomplete gastric closure. For the transanal approach, there is one report of transcolonic endoscopic cholecystectomy, again performed in a pig model⁹.

Work so far has raised a host of questions, both technical and non-technical¹⁰. Technical questions include: (1) What is the optimal

Table 1 Transgastric surgical studies in the pig model

First Author	Year	Intervention(s)
Kaloo ²	2004	Abdominal exploration and liver biopsy
Wagh ⁴	2005	Oophorectomy, partial hysterectomy
Kantsevov ²	2005	Gastrojejunostomy
Jagannath ²	2005	Tubal ligation
Park ²	2005	Cholecystectomy and cholecystogastric anastomosis
Kantsevov ⁵	2006	Splenectomy
Bergstrom ⁶	2006	Gastrojejunostomy
Merrifield ⁷	2006	Partial hysterectomy
Fritscher-Ravens ⁸	2006	Lymphadenectomy

site for gastric puncture? (2) How can injury to adjacent organs be avoided? (3) How can tissue be retracted during dissection? (4) How can major bleeding be controlled, should it occur? (5) How can tissue be approximated? Non-technical questions include: (1) What are the implications for overall patient benefit and outcome? (2) Who will perform NOTES – surgeons or endoscopists? (3) Where will NOTES be performed – in the operating room or in the endoscopy suite? (4) How will training take place? (5) Will NOTES offer a significant advantage in terms of morbidity and recovery?

These questions, particularly the non-technical ones, may be difficult to answer. In the USA, the American Society for Gastrointestinal Endoscopy (ASGE) and the Society of Gastrointestinal Surgeons (SAGES) have convened in an attempt to advance NOTES through cooperation and complementary approaches. In general, gastroenterologists have

much greater experience of transluminal endoscopy than surgeons, but they have limited understanding of abdominopelvic anatomy and are ill equipped to handle major intraprocedural complications. In order to maximize patient safety and to advance NOTES in an orderly and scientific fashion, the ASGE and SAGES have formed the Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR). This consortium will provide organization for research projects in such a way as to enhance collaboration and attract funding for key areas of study; its website (<http://www.noscar.org>) allows developments related to this initiative to be followed.

At one end of a spectrum NOTES might revolutionize abdominal surgery; at the other it may prove of only transient interest. Although a type of NOTES is already being used clinically on a limited basis in the form of endoscopic transmural drainage of pancreatic pseudocysts², its widespread adoption as a replacement for operations now performed laparoscopically (appendicectomy, cholecystectomy, tubal ligation) seems unlikely. NOTES will probably be complementary to

laparoscopic surgery; it may become the preferred approach in selected patients, such as the morbidly obese and those with severe intra-abdominal adhesions. The widespread adoption of NOTES will require many scientific and non-scientific issues to be addressed, and new endoscopes and endoscopic tools to be developed. At the very least, however, this technology will have applications within current endoscopic procedures. The reliable closure of a luminal perforation will allow the non-surgical treatment of this condition and will also permit a more aggressive resection of gastrointestinal lesions, especially those involving the deep layers of the bowel wall.

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