
NATURAL ORIFICE TRANSLUMENAL ENDOSCOPIC SURGERY (NOTES) A CRITICAL APPRAISAL

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Change, is part of surgery but change is never easy to accept. If you look back of surgery, excellence was associated with big incisions: "Big scar, big surgeon." was the old concept until 1987 when Philippe Mouret¹, first doing laparoscopic cholecystectomy broke this concept. Surgery with no scars was an impossible reverie. Now natural orifice transluminal endoscopic surgery (NOTES) is being performed, and the philosophy of surgery will be dramatically changed. Transluminal surgery has the potential to break the physical barrier between bodily trauma and surgery, representing an epical evolution in surgery.

NOTES is next major paradigm shift in surgery, laparoscopy was major paradigm shift in 1980s and 1990. Antony Kalloo (USA) publication of trans-gastric peritoneoscopy in 2004² catapulted NOTES from absurdity to the necessity. After that Recardo Zorron (Brazil)³ performed hybrid transvaginal NOTES cholecystectomy in March 2007, Marc Bessler (USA)⁴ had underwent hybrid NOTES transvaginal cholecystectomy with 3 abdominal trocars. In Strasbourg, France in April 2007 totally NOTES transvaginal cholecystectomy with Verese needle for insufflations⁵ was done by Marescaux⁵ and in June 2007 Lee Swanstrom (USA)⁴ was doing the first hybrid NOTES transgastric cholecystectomy with 2 abdominal ports used for laparoscopic closure of stomach. In a brief time period, NOTES has been shown to be

feasible in numerous laboratory animal studies and also in limited human studies⁶⁻⁸. As the data accumulate and instrumentation improves, NOTES may play a role in the future of abdominal surgery.

The Procedure: The core concept NOTES consist of introduction of a flexible endoscope through one of the body's natural orifices, perforation of a viscous, and performance of abdominal surgery using endoscopic visualization. The endoscope may be inserted through the mouth, anus, urethra, or vagina with puncture of the stomach (the esophagus for mediastinal exploration), rectum, urinary bladder, or vagina, respectively. For transgastric surgery, a standard gastroscope is passed through the mouth into the stomach. A small anterior gastrotomy is made, typically with an endoscopic needle knife. A wire is passed through the site into the abdominal cavity, and then the tract is enlarged with an endoscopic dilating balloon to accommodate the endoscope. Transcolonic and transvesical operations use similar methods for entering the peritoneal cavity.

Once the endoscope in advanced into the abdominal cavity, a pneumoperitoneum is generated using endoscopic insufflations⁷. The scope is maneuvered to view the organ of interest. Standard endoscopic instruments, such as biopsy forceps and polypectomy snares, are then passed through the working channels and used for tissue manipulation. When the operation is

completed, the endoscope is returned to the lumen of this viscous and the viscerotomy is closed.

Advantages

In addition to no scar, no hernia, no wound infection, the immunologic impact of NOTES may be favorable for the patient. A recent laboratory study from Case Western Reserve University showed lower levels of tumor necrosis factor- α (TNF- α) after NOTES peritoneoscopy compared to laparoscopic abdominal exploration and laparotomy⁹. NOTES may lead to less impairment of the peritoneal immune system and possibly even improved oncologic and infectious outcomes. Natural orifice surgery may decrease the degree of abdominal adhesion formation. Much like laparoscopy, the minimal access nature of NOTES might diminish the stimuli for adhesions and, subsequently, reduce the incidence of postoperative bowel obstruction or simplify future abdominal operations. Another possible derivative of NOTES is single port laparoscopy and other hybrid procedure. As an example, a cholecystectomy might be performed through a single 10-mm umbilical port. NOTES can likely be performed without the need for general anesthesia. As no skin incision is made, the requirement for analgesia might be satisfied with conscious sedation. Therefore, NOTES could be performed in the intensive care unit or endoscopy suite, rather than a standard operating room.

The NOTES team and its equipment are portable. A single endoscopy tower house is all of the necessary equipment. Furthermore, most NOTES procedures are performed without sterile instruments, but with scopes subjected to high-level disinfection. This makes NOTES amenable to austere environments, such as battlefields and developing countries, where sterilization equipment is not available.

Finally, the esthetic benefits of NOTES. The public at large has become captivated with the concept of “no-scar” abdominal operations. This is feasible with pure NOTES cases, although esthetics should not be the driving force behind NOTES.

Drawbacks

Creating a hole, intentionally in one of the viscera repudiates decades of surgical dogma. The patient might be susceptible to infectious and immunologic consequences that are not present in laparoscopy and conventional surgery. The inherent flexibility of the endoscope impedes achieving a stable operating field. In-line endoscopic tools have a restricted range of motion and limited degrees of freedom. In addition, in-line instrumentation and optics do not allow triangulation of the visual field and instruments, a concept found to be critical in laparoscopy. Besides the prototypes used in the laboratory, most currently available equipment is inadequate for performing retraction, meticulous dissection, and bimanual manipulations. As a purposeful viscerotomy is made in NOTES, its secure closure is imperative to ensure the safety of the operation. Initial laboratory work managed the viscerotomy without closure or by occlusion using a percutaneous endoscopic gastrostomy (PEG)-type gastrostomy tube⁹. Both methods were fraught with high rates of intraabdominal contamination in the porcine model. There is no reliable, simple, and safe method for achieving full-thickness, water-tight closure of the viscerotomy thus; more reliable methods that achieve full-thickness closure of the viscerotomy are currently being investigated.

Achievements so far

The seminal publication by Kalloo and colleagues led to the organization of the Apollo group. Shortly after the

publication of transgastric peritoneoscopy, the Apollo group published reports on transgastric tubal ligation¹⁰, gastrojejunostomy¹¹, and splenectomy¹² in a porcine model. Recently, members of the Apollo Group collaborated in the performance of per oral transgastric ventral hernia repairs in a porcine model. These publications were significant in that complex operations were shown to be feasible using NOTES techniques and the animals survived without undue complications. Many teams followed the Apollo feasibility Group's lead and performed animal studies. Transgastric appendectomy¹³, cholecystectomy, 14 and oophorectomy¹⁵ were performed. The Transcolonic¹⁴ approach has been used to perform cholecystectomy, and the transvaginal approach has been used in laboratory animals to perform nephrectomy¹⁶. Combined transrectal and transgastric approaches allow performance of complex small bowel resections with intracorporeal formation of anastomoses¹⁷. Reliable closure of the viscerotomy is the critical step in avoiding intra-abdominal infection. Leaving the viscerotomy open and PEG tube occlusion of the gastrotomy were shown to be inadequate in the porcine model. Endoscopic clips, as might be used in a bleeding vessel, have also been used with some success¹⁸. However, clips only provide mucosal approximation, and a full thickness closure comports with proven surgical principles. Numerous devices have been used to attempt full thickness closure. One such instrument is the NDO Plicator. Closure of full-thickness gastrotomies has been shown to be reliable with the NDO Plicator¹⁹. Survival studies in laboratory animals have shown minimal rates of intraabdominal infections after transgastric peritoneoscopy and closure with the NDO Plicator. Another group has developed a method of gastrotomy closure using a commercially available

overtube and suturing device²⁰. A method of transluminal access has been developed by the Penn State group that might obviate the need for full thickness closure, deemed the self-approximating transluminal access technique (STAT)²¹. In animal studies, the Ohio State group has closed gastrotomies with a bioabsorbable plug, such as might be employed in inguinal hernia repair²² As in laparoscopy, the intra-abdominal pressure requires continuous monitoring during NOTES. Unchecked insufflations' might lead to abdominal compartment syndrome. A recent study has shown that pressure transducers fitted to the end of a gastroscope or passed through a working channel detect intraabdominal pressure with a high degree of correlation with actual intra-abdominal pressure²³. Adequate retraction is imperative to safely perform complex abdominal operations, such as cholecystectomy. The group from the University of Texas-Southwestern has developed a clever method using intra-abdominal magnets to provide retraction during NOTES procedures²⁴.

The Absolute Pre-requisites

The NOTES surgeon should be expert in flexible endoscopy, abdominal anatomy, and surgical technique. He or she should be facile in managing the pre- and postoperative care of the patients and, in particular, should be capable of handling complications from the procedure. Many would argue that NOTES surgeons should be able to perform an operation laparoscopically and conventionally, as conversion to one of these modalities is a possibility in any NOTES procedure. Trainees should dedicate a substantial amount of time to laboratory endeavors, as this is where skills can be safely honed before clinical application.

The Future of NOTES

While it is improbable that we are on the brink of widespread pure clinical

NOTES, there are many potential applications of NOTES that will likely manifest. Given the portability of NOTES equipment and the requirement for only conscious sedation, natural orifice surgery is ideally suited for the intensive care unit. There are two potential scenarios that have been described that are amenable to ICU NOTES: diaphragm pacing and peritoneoscopic examination for ischemic bowel^{25,26}.

The minimal equipment requirements and the need for high-level disinfection, rather than sterilization, make NOTES appropriate for developing regions of the world. The transportable nature of NOTES might be applicable for battlefield abdominal exploration. NOTES do not signal the demise of

traditional gastrointestinal surgery or laparoscopy. It is plainly evident that extraordinary advances are required before NOTES can be considered for widespread application. Rather than succumbing to the fervor for NOTES, we must take a circumspect view of NOTES. Diligent laboratory research is imperative, followed by cogent clinical trials. Above all, regard for patient safety must prevail. Only those with vast laboratory experience with NOTES should contemplate clinical NOTES procedures. Initially, only patients enrolled in clinical trials should undergo NOTES. Finally, the burden is on NOTES investigators to perform due diligence on this nascent field and ensure that we are doing the right thing for our patients.

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