

TEM as a Platform for NOTES

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Transanal Endoscopic Microsurgery (TEM) offers the only established experience to date in endoluminal surgery. Dr. Monson has already presented many of the traditional utilizations of TEM surgery for the treatment of polyps and select cancers. In this paper, we will explore many of Transanal Endoscopic Microsurgery's advantages and opportunities as a platform for endoluminal surgery.

The first Natural Orifice Transluminal Endoscopic Surgery (NOTES) procedure was performed in 2003 and consisted of a transgastric appendectomy with tubal ligation by doctors Rao and Reddy in Hyderabad, India.¹ This set off a great deal of activity both within the surgical community and with our partners in the medical device industry. The first transvaginal cholecystectomy was performed in the USA by Dr. Marc Bessler at Columbia Hospital on March 20, 2007.² The procedure was done with

a hybrid laparoscopy platform using three small ports to assist in the operation. This is an important matter to note as this has been a constant challenge with the NOTES approach as originally conceptualized. The original NOTES approach comprised a flexible endoscope coming through another organ in order to carry out a procedure.

Surgical evolution is sometimes progressive and sometimes traumatic. The advent of laparoscopic surgery in the late 1980s and early 1990s involved primarily a change in access in order to perform an operation. Rather than making a large incision in the abdominal wall in order to carry out an operation, small ports were utilized. The procedure itself, for the most part, remained the same. This approach made infinite sense, at its greatest adoption, in the performance of cholecystectomy. In this operation, the intra-abdominal trauma is relatively small, taking just the cystic duct and cystic artery and removing the gallbladder from the gallbladder fossa. The conventional subcostal incision made to perform the operation represented a tremendous amount of trauma, and the benefit to the patient was readily apparent.

In talking about surgical evolution from laparoscopy to NOTES, we are looking at a very different paradigm. The issues become fourfold: access to the target organ, the procedure performed, visualization, and retraction. These are all quite different using a NOTES approach. As originally conceived, this includes gaining access through another healthy organ and performing a procedure perhaps in a different fashion with the challenge of retraction, using flexible instrumentation having inadequate strength, in order to hold the tissue and provide proper visualization.

The issue of access for NOTES surgery demands additional attention. Azurin reported a 0.8% umbilical trocar site herniation rate following laparoscopic cholecystectomy in 1,300 patients. This is a laudable figure which

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appears quite low as compared to my experience in residency. But, even if accepted as is, it begs the question of whether we as surgeons would be willing to disrupt a healthy organ in order to gain access to a diseased one. Had those same 1,300 patients been operated on in a NOTES fashion, and if a similar breakdown of the access closure of 0.8% was encountered, one would be looking at 10–13 gastric perforations or colonic perforations if one was approaching the gallbladder transgastrically or transrectally. Would we be willing to tolerate 10–13 colostomies in this group of patients? Would these patients tolerate being bowel prepped in order to undergo a cholecystectomy in a NOTES fashion?

With this as a background, I offer TEM as the ultimate approach in minimally invasive endoluminal surgery and as a potential platform for NOTES. The logic of NOTES is quite clear. When there is no abdominal incision, the patients are almost entirely devoid of pain. We have seen this for two decades in TEM surgery. Utilizing a transcolonic route in order to perform colorectal surgery makes infinite sense. One is making a defect in a target organ, not in a healthy bystander. Furthermore, entry into the peritoneal cavity during a TEM resection has been encountered and performed with safe closure dating back to the 1990s. Dr. Swanström's group beat me to this point in their publication in *Gastrointestinal Endoscopy* in November of 2008 describing porcine and cadaveric surgeries using TEM instrumentation and flexible endoscopes.³ They were able to perform liver biopsy, sigmoid resection, and hepatic wedge resection in this fashion. The strong appeal of this approach has to do with the stability of the working platform that is achieved with a Martin arm attachment to the table (Fig. 1). The strong instrument shafts allow direct dissection of heavier organs and a strong visual-spatial orientation which is often difficult to maintain with the flexible scope. Additionally, the extraction of larger specimens is easily performed. The challenges that we encounter in using TEM and NOTES as an alternative to colorectal procedures have to do with the large amount of mobilization which is



Fig. 1 TEM working platform

often necessary for colorectal surgery and the disease processes that are being operated upon. Benign disease consists of polyps and inflammatory conditions such as diverticulitis and colitis. Polyps are generally handled as if there might be a malignant component to them, and therefore, an adequate lymphadenectomy needs to be performed. Inflammatory conditions carry with them the difficulty of dissection in an inflamed area which is often both hypervascular and densely adherent making any type of dissection challenging. In 2007 in the USA, there were 240,000 colectomies performed, 140,000 of which were for colorectal cancer. Cancer represents additional challenges in terms of exploration, staging, and lymphadenectomy.

We have been performing radical TEM surgery for treatment of cancers receiving neoadjuvant chemoradiation and being downstaged to ypT2N0 cancers. We are reliant upon the reaction of the index cancer to be an indicator of the tumor response microscopically in any lymph nodes. The operation is started endoluminally by a marking around the lesion circumferentially using the electrocautery to yield a 1-cm margin. This highlights an important facet of operating endoluminally via the NOTES approach. It is essential to have established landmarks in your target organ as visualization sometimes becomes difficult once there is even a small amount of smoke or blood in the field. The rigid TEM equipment, however, does allow for full-thickness transection and lymphadenectomy down to the puborectalis or presacral space in the same plane as one operates in performing a total mesorectal excision. Using this approach, we are able to excise large segments of bowel, up to 12 cm in length. This can either be a hemircumferential or a sleeve resection. We generally view this as both the last step of staging and the first step of treatment. If there is full-thickness invasion with T3 pathology, radical surgery is recommended. If the tumor is ypT2 or less, this represents a therapeutic approach requiring close clinical follow-up. To date, I have personally treated 261 patients with TEM, 41% of whom have had invasive cancer and 77% of whom have had neoadjuvant therapy. We recently presented a case-matched study of 30 TEM patients to 43 TME patients with T2 carcinoma with chemoradiation, showing a 3.3% local recurrence rate with TEM, which is not statistically different than 2.3% local recurrence rate with TME.⁴ This is currently in print. This holds an exciting option for the select usage of this approach to cancers with neoadjuvant therapy in the future. While this represents exciting results from individual experiences, they need to be corroborated in larger, multi-institutional experiences.

Many of the challenges of closing the bowel with the NOTES procedure are highlighted with TEM. Stay sutures need to be placed circumferentially in four quadrants in order to perform the anastomosis, and to date, there are no flexible instrumentations that allow this to be done reliably.

The long solid shafts of the TEM equipment allow for this type of work to be done. This remains a very significant barrier to be crossed in the NOTES forum. Furthermore, when dealing rectally with lesions after neoadjuvant therapy, on occasion, a diverting stoma is utilized. While this is quite acceptable and customary in dealing with rectal cancer, clearly this would not be an acceptable outcome for someone having another organ operated upon.

This author's opinion is that the ultimate utilization of NOTES will be in a very different format than what has been proposed to date. A combined NOTES laparoscopic TEM approach makes a great deal of sense, where some of the upper mobilization will be done laparoscopically and some of the lower pelvic work will be done using TEM equipment. I have had experience doing this faced with difficult problems to avoid complete conversion or permanent colostomy. The beauty of this approach is that it allows for excellent visualization endoluminally in the most difficult part to see from above, which is the very low rectum, and excellent visualization higher-up in the area that is difficult to visualize with the TEM equipment. Lastly, there is the ability to handle larger blood vessels with these straight instruments quite readily in a fashion that is not available with flexible endoscopy. To date, I have performed 42 of these "incisionless" procedures where the cancers have been delivered from below. This represents an exciting option as we move forward.

Lastly, as Dr. Whelan has presented on endoscopic mucosal resection, some of the new devices that are becoming available, such as the Olympus R Scope which is a prototype form that has dual-channel adjustable working ports, are going to allow different things to be carried out with flexible instruments.

As a growth of experience occurs worldwide in doing all sorts of NOTES surgery as well as transluminal surgery, new applications will arise in parallel with new instrumentation. The path to the future will certainly utilize more forms of endoluminal surgery. There are a multitude of challenges oncologically, technically, and functionally that need to be overcome in order for us to apply this more broadly. Furthermore, the applicability of something that is more technically challenging in a field such as colorectal surgery where less than 20% of the operations are being done laparoscopically causes pause. Clearly, the logic of approaching colorectal disease endoluminally through the colon has a tremendous advantage over some other organ sites. TEM, or variations of TEM, offers an exciting possibility to advance in this field.

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