

UROLOGIC NOTES: WHERE ARE WE AND WHERE ARE WE GOING?

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Summary.- The natural orifice transluminal endoscopic Surgery (NOTES) approach has been successfully reported by several surgical teams in different specialties. Urologic teams have recently presented several experimental and clinical experiences with the technique. Our aim is to review the initial experience with NOTES in minimal access urological surgery.

Keywords: Transnatural orifice surgery. Minimally invasive surgery. Laparoscopy.

Resumen.- La cirugía endoscópica por orificios naturales ha sido reportada con éxito por numerosos grupos en distintas especialidades. Recientemente, grupos urológicos han reportado experiencias clínicas y experimentales con este abordaje. Nuestro objetivo es revisar la experiencia inicial con la cirugía endoscópica por orificios naturales, como parte de la cirugía mínimamente invasiva.

Palabras clave: Cirugía por orificios naturales. Cirugía mínimamente invasiva. Laparoscopia.

INTRODUCTION

Natural orifice transluminal endoscopic surgery (NOTES) involves the intentional penetration of hollow viscera with an endoscope in order to access the abdominal cavity and perform an intraabdominal operation (1). Nowadays, NOTES has been expanding in clinical setting and several different experiences have been reported. Cholecystectomy has been performed through transvaginal approach or by a technique which gathered the ports at the umbilicus (2,3). Appendectomies have been reported through transgastric approach or with the use of a single port technique (4). Urology has significantly cooperated in the development of different surgical minimal access techniques and NOTES is sure gaining momentum in our field.

The initial experience in transnatural orifice surgery was performed by Antony Kalloo in transgastric surgery in 2004 (5). The preliminary experience with transnatural orifice surgery confronted several questionings such as the safety entrance into a



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healthy hollow organ lumen while keeping in mind adequate closure methods and the minimization of potential morbidity (6).

The well-known concept of triangulation in laparoscopic surgery implies the use of 3 trocars for right performance. The risk related to the use of trocars has been reported of 0.003-0.3 % for both vascular and visceral injuries (7). Then, deployment of a single trocar would decrease an already low percentage of complications with the caveat of difficult surgical performance due to the lack of space. The latter has been addressed through the design of novel bent instruments that offer the possibility of wider maneuverability.

The novel transnatural orifice surgery is in the spotlight nowadays and we present the standing of the technique on today's urology.

THE IMPORTANCE OF NOVEL IDEAS IN MINIMALACCESS SURGERY

Laparoscopic teams worldwide have provided their ideas, variations and tricks to perform different challenging techniques in the endoscopic environment. Urological laparoscopy has overcome the time of being considered an experimental technique to become a fully reasonable option for the surgical treatment of different urological diseases like clinically localized prostate carcinoma, adrenal masses and ureteropelvic junction obstruction (8-10).

The advances and different objectives accomplished with laparoscopy have not only developed the endoscopic technique itself, but established the principles inherited by the more recent robotic surgery (11). The transnatural orifice approach has been successfully reported by several surgical teams in different specialties. Evolution has granted success in minimally access surgery. We have witnessed enormous advances for laparoscopic surgery in the last few years and the options for the adequate performing of this surgery are growing on an everyday basis. Animal models have been used to demonstrate the possible applications of NOTES, including transgastric peritoneoscopy, tubal ligation, gastrojejunostomy, partial hysterectomy, oophorectomy, and transcolonic exploration, liver biopsy and cholecystectomy (12).

RATIONALE FOR NOTES

As we mentioned this revolutionary surgical approach that is being used for an increasing number of procedures, such as fallopian tube ligation, chole-

cystectomy, gastrojejunostomy, partial hysterectomy, oophorectomy and splenectomy essentially via the transgastric route. We need to state which would be the benefits or advantages of NOTES. First, there are no abdominal incisions and, therefore, abdominal wound infections and incisional hernias are avoided, this could translate into less pain and improved cosmesis. Second, there might be potential advantages of a more rapid recovery, fewer adhesions and less postoperative ileus. Third, the transluminal access to the peritoneal cavity will have definite advantages in situations whereby the transcutaneous path into the peritoneal cavity is not optimal, as in obese patients (13). And Fourth, consistent reduced levels of TNF-alpha in has been observed in experimental experiences with NOTES in animal, in the late postoperative period. The latter could suggest an immunomodulatory effect of the NOTES surgical technique not present in laparoscopy or laparotomy (14).

Early laboratory research has been focused on feasibility. More recently, experimental work aims to address the potential infectious and immunologic implications of NOTES and the development and refinement of the ideal instruments and techniques required to perform more complex procedures with this technique (1).

The field of NOTES should remain experimental and hard work in the laboratory should be bound simultaneous clinical trials in order to objectively verify the potential advantages of the novel technique. The rapid diffusion of NOTES should not be bound to high commercial interests, as this could take precedence over the welfare of the patient.

TRANSUMBILICAL NOTES

The approach to the peritoneal cavity through a hollow viscus has certain limitations. Furthermore, time is needed to develop technologies that would facilitate the procedure and to study the long-term consequences of the breach of a hollow viscus of the gastrointestinal or urinary tract. For this reason, researchers look back at the umbilicus. The umbilicus is an embryologically natural orifice and since the beginning laparoscopic surgeons have performed their procedures through the birth's natural scar. So, the umbilicus has not been only an important and essential aesthetic component of the abdomen but also a port of entry for surgical therapeutics. Transnatural orifice surgery can be safely performed through the umbilicus and laparoscopy has evolved from offering benefits of analgesic reduction, rapid postoperative recovery, and patient satisfaction using several small incisions, to offer the same byproducts but with the

use of a single access (15,16). Multiple definitions have been coined: Natural Orifice Trans Umbilical Surgery (NOTUS), Trans Umbilical Endoscopic Surgery (TUES), Trans Umbilical Laparoscopic Assisted (TULA), but the principle is to define the umbilicus as the port of entry in NOTES (17).

NOTES IN UROLOGY

Through studies using animal models and patient investigation, benefits of laparoscopy has been developed and redefined. In the field of urologic minimal access surgery in 2002, Gettman et al performed a complete transvaginal laparoscopic dissection and nephrectomy in a porcine model using a single, 5-mm abdominal port for visualization. They acknowledged the limitations imposed by both the porcine anatomy and available laparoscopic instruments at the time. This attempt to the transnatural orifice surgery did completely comply with the definition of NOTES because it did not require any abdominal incision to enter the peritoneal cavity. It is very interesting to observe how urologists have brought a great deal of thinking and novel ideas into the field of general access surgery, if one realizes that the experimental work by Gettman and colleagues was performed years in advanced of the "official" beginning of transnatural orifice surgery.

There has been also experience with experimental work in urological NOTES: Lima et al have presented several experiences in pig models where they have described transvesical access (18,19).

These investigators verified the feasibility of a transvesical endoscopic approach to the peritoneal cavity through a 5 mm port in a porcine model. They performed transvesical endoscopic peritoneoscopy 8 animals. A vesical entrance into the peritoneal cavity was created under cystoscopic guidance and a tube was placed into the cavity, through which they could progress an EndoEye™, which provided a view of all intra-abdominal viscera, and also a 9.8Fr ureteroscope, which allowed simple surgical procedures, such as liver biopsy and section of falciform ligament, without complications (18). Deployment of the same principles of transvesical access allowed Lima and colleagues to develop a surgical experience in transvesical transdiaphragmatic endoscopic thoracoscopy. They placed a transvesical and introduced a ureteroscope into the peritoneal cavity to subsequently perform a thoracoscopy and peripheral lung biopsy. There were neither no respiratory distress episodes nor surgical complications to report. Postmortem examination revealed complete healing of vesical and diaphragmatic holes, whereas no signs of infection

or adhesions were observed in the peritoneal or thoracic cavities (19).

Lima et al have also presented a very interesting combined approach in the experimental setting, in which they, under ureteroscope guidance, installed a transvesical tube into the peritoneal cavity and a flexible gastroscope was passed orally, also into the peritoneal cavity by a gastrotomy. They could perform 6 nephrectomies (right and left) nephrectomy with instruments introduced by both approaches to work in the renal hilum performing alternating dissection and retraction maneuvers. They experienced no complications with the transvesical and transgastric access and adequate dissection of both renal vessels and ureter. The transvesical port allowed them to employ ultrasonic scissors and clip appliers. Their initial cases presented mild hemorrhage after ultrasonic ligation (20).

More recently, a collaborative research group was formed to build a prototype system of magnetically anchored instruments for trocar-free laparoscopy. The mentioned prototype system was then evaluated in vivo in a porcine laparoscopic nephrectomy model with promising results (21).

Raman and colleagues presented single keyhole nephrectomy in a porcine model and three human patients. Laparoscopic nephrectomy was performed with either a novel single 25-mm port or using one 10-mm and two 5-mm adjacent trocars. Bent laparoscopic graspers were used for dissection. Indications for nephrectomy included chronic infection in a non-functioning kidney in 2 patients, and a 4.5-cm enhancing renal mass in the other patient. The procedure was successfully completed in all 3 human patients with mean operative time of 133 minutes (22).

The Cleveland Clinic Foundation (CCF) has presented their experience with the single port surgical approach. Desai et al presented the first initial clinical experience of organ-ablative and reconstructive renal surgery with single port. Transumbilical nephrectomy and pyeloplasty using the R-Port (Advanced Surgical Concepts) was performed. They employed articulated instruments in addition to standard laparoscopic instrumentation and also a 2-mm needle-port (MiniSite, USSC, Norfolk, CT, USA) to facilitate suturing. Procedures were successfully accomplished with no extra-umbilical skin incisions and adequate results (23).

Kaouk et al from CCF have presented a clinical series of ten patients operated by single-port technique for procedures like laparoscopic renal cryotherapy, wedge kidney biopsy, radical nephrectomy, and abdominal sacrocolpopexy (24). Their early

results show feasibility with good outcomes. Single trocar surgery for varicocelectomy has been also presented by Kaouk & Palmer, also from CCF group, in three adolescents patients (25).

The radical nephrectomy technique with single port surgery has been assessed by Ponsky and coworkers (26). This experience was undertaken in a patient with an enhancing renal tumor. The technique featured three trocars (12 mm, 10 mm, and 5 mm) through a Gel-Port device and the use of only standard laparoscopic instruments.

The main difficulty nowadays is to obtain any port device and articulated instruments which were commercially available. The latter has awakened the ideas of urologist worldwide to start their own experience with the concept of NOTES. In our experience, the deployment of the flexible cystoscope allowed for an adequate laparoscopic view and gathering of the ports at the umbilicus did not difficult the surgical performance. Preliminary experiences with NOTES might not exactly comply with the definition of transumbilical surgery, but innovation might imply variations on performance according to circumstances. Although, initiation on NOTES should be ideally accompanied by previous laparoscopic experience and a low threshold for conversion to either regular laparoscopy or open surgery.

FUTURE ENDEAVORS

Single port approach has arrived for good. Urology, as done in other areas of medical related technology, will play an important role in the development and refinement of the technique; the urologic teams around the world have already gathered to announce a consensus on the subject and solid outcomes will be provided by this association (27).

The responsibility is to objectively evaluate outcomes and beyond our personal hope verify the real benefits of the technique. Prompt availability of single port devices will provide expanding experiences with the technique. The preliminary experience in urological NOTES has been circumscribed to selected cases limited but patient selection will expand on time. Surgical technique have been well established and the aim would be to adapt in the beginning to the lack of mobility. The articulated instruments and the use of flexible scopes will play a crucial role in this aspect. Undoubtedly, follow-up, complications and morbidity will remain the parameters to precisely evaluate, in order to verify as facts the theoretical advantage and potential of NOTES.

CONCLUSIONS

Although the Natural Orifice Transluminal Endoscopic Surgery approach may hold tremendous potential, there are many issues that need to be addressed before this technique is introduced into an everyday clinical care. It is obvious that the skills needed to safely undertake the experience, will be a interesting mixture of laparoscopic and advanced flexible endoscopic skills. Once again, it is motivating to experience the potential of a novel surgical technique and the possible advantages that it could offer to clinical patient care. The essential is to keep in mind that there is still much work to do in basic research for NOTES. Instrument development remains an important issue in order to overcome the initial difficulties with the technique; deployment of off-axis optics and application of robotics would provide a great deal of advance to this novel approach.

REFERENCES AND RECOMENDED READINGS

(*of special interest, **of outstanding interest)

1. Pearl JP, Ponsky JL. Natural orifice transluminal endoscopic surgery: A critical review. *J Gastrointest Surg.* 2008; 12:1293-300.
2. Piskun G, Rajpal S. Transumbilical laparoscopic cholecystectomy utilizes no incisions outside the umbilicus. *J Laparoendosc Adv Surg Tech A* 1999; 9:361-64.
3. Marescaux J, Dallemagne B, Perretta S, et al. Surgery without scars: report of transluminal cholecystectomy in a human being. *Arch Surg.* 2007; 142:823-26.
4. Esposito C. One-trocar appendectomy in pediatric surgery. *Surg Endosc* 1998; 12:177-78.
5. Kalloo AN. Is STAT (self-approximating transluminal access technique) the first step for NOTES? *Gastrointest Endosc.* 2007; 66:979-80.
6. Zhu JF. Scarless endoscopic surgery: NOTES or TUES. *Surg Endosc* 2007; 21:1898-99.
7. Schafer M, Lauper M, Krahenbuhl L. Trocar and Veress needle injuries during laparoscopy. *Surg Endosc* 2001; 15:275-80.
8. Tooher R, Swindle P, Woo H, et al. Laparoscopic radical prostatectomy for localized prostate cancer: a systematic review of comparative studies. *J Urol.* 2006;175:2011-17.
9. Gumbs AA, Gagner M. Laparoscopic adrenalectomy. *Best Pract Res Clin Endocrinol Metab.* 2006; 20:483-84.

10. Eden CG. Minimally invasive treatment of ureteropelvic junction obstruction: a critical analysis of results. *Eur Urol* 2007; 52:983-89.
11. Castillo OA, Sánchez-Salas R. Laparoscopic principles of robotic surgery. *Arch Esp Urol* 2007; 60:357-62.
12. Wagh MS, Thompson CC. Surgery insight: natural orifice transluminal endoscopic surgery--an analysis of work to date. *Nat Clin Pract Gastroenterol Hepatol* 2007; 4:386-92.
13. Giday SA, Kantsevov SV, Kalloo AN. Current status of natural orifice transluminal surgery. *Gastrointest Endosc Clin N Am* 2007; 17:595-604.
14. McGee MF, Schomisch SJ, Marks JM, et al. Late phase TNF-alpha depression in natural orifice transluminal endoscopic surgery (NOTES) peritoneoscopy. *Surgery* 2008; 143:318-28.
15. Cuesta MA, Berends F, Veenhof AA. The "invisible cholecystectomy": A transumbilical laparoscopic operation without a scar. *Surg Endosc* 2007. [Epub ahead of print]
16. Pappalepore N, Tursini S, Marino N, et al. Transumbilical laparoscopic-assisted appendectomy (TULAA): a safe and useful alternative for uncomplicated appendicitis. *Eur J Pediatr Surg* 2002; 12:383-86.
17. Lima E, Rolanda C, Pêgo JM, et al. Transvesical endoscopic peritoneoscopy: a novel 5 mm port for intra-abdominal scarless surgery. *J Urol* 2006; 176:802-05.
18. Lima E, Rolanda C, Pêgo JM, et al. Third-generation nephrectomy by natural orifice transluminal endoscopic surgery. *J Urol* 2007; 178:2648-54.
19. Lima E, Henriques-Coelho T, Rolanda C, et al. Transvesical thoracoscopy: a natural orifice transluminal endoscopic approach for thoracic surgery. *Surg Endosc* 2007; 21:854-58.
20. Zeltser IS, Bergs R, Fernandez R, et al. Single trocar laparoscopic nephrectomy using magnetic anchoring and guidance system in the porcine model. *J Urol* 2007; 178:288-91. Epub 2007 May 17.
21. Raman JD, Bensalah K, Bagrodia A, et al. Laboratory and clinical development of single keyhole umbilical nephrectomy. *Urology* 2007; 70:1039-42.
22. Desai MM, Rao PP, Aron M, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. *BJU Int* 2008; 101:83-8.
23. Kaouk JH, Haber GP, Goel RK, et al. Single-port laparoscopic surgery in urology: initial experience. *Urology* 2008; 71:3-6.
24. Kaouk JH, Palmer JS. Single-port laparoscopic surgery: initial experience in children for varicocelelectomy. *BJU Int* 2008; 102:97-9.
25. Ponsky LE, Cherullo EE, Sawyer M, et al. Single access site laparoscopic radical nephrectomy: Initial clinical experience. *J Endourol* 2008; 22:663-6
26. Gettman MT, Box G, Averch T, et al. Consensus statement on natural orifice transluminal endoscopic surgery and single-incision laparoscopic surgery: Heralding a new era in urology? *Eur Urol* 2008; 53:1117-20.