Surgery Without Scars

Report of Transluminal Cholecystectomy in a Human Being

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Hypothesis: Natural orifice transluminal endoscopic surgery (NOTES) provides the potential for performance of incisionless operations. This would break the physical barrier between bodily trauma and surgery, representing an epical revolution in surgery. Our group at IRCAD-EITS (Institut de Recherche contre les Cancers de l’Appareil Digestif [Institute of Digestive Cancer Research]–European Institute of TeleSurgery) has been actively involved in the development of NOTES since 2004 with a dedicated project created to develop feasibility and survival studies and new endoscopic technology.

Design: NOTES cholecystectomy in a woman via a transvaginal approach.

Setting: University hospital.

Patient: The patient was a 30-year-old woman with symptomatic cholelithiasis.

Intervention: The procedure was carried out by a multidisciplinary team using a standard double-channel flexible videogastroscope and standard endoscopic instruments. The placement of a 2-mm needle port, mandatory to insufflate carbon dioxide and to monitor the pneumoperitoneum, was helpful for further retraction of the gallbladder. At no stage of the procedure was there need for laparoscopic assistance. All of the principles of cholecystectomy were strictly adhered to.

Results: The postoperative course was uneventful. The patient had no postoperative pain and no scars, and was discharged on the second postoperative day.

Conclusions: Transluminal surgery is feasible and safe. NOTES, a radical shift in the practice and philosophy of interventional treatment, is becoming established and is enormously advantageous to the patient. With its invisible mending and tremendous potential, NOTES might be the next surgical evolution.
tactical trocar and 2 other trocars. The world of general surgery was soon divided into a small group of enthusiastic surgeons convinced of the superiority of laparoscopic over conventional cholecystectomy and a second, large group of surgeons with varying opinions ranging from curiosity to frank condemnation of laparoscopic cholecystectomy.

The controversy was intense but short. In 1992, the National Institutes of Health Consensus Development Conference \(^4\) statement on gallstones and laparoscopic cholecystectomy concluded that, compared with open cholecystectomy, laparoscopic cholecystectomy was safe and effective in most patients and should be the treatment of choice. Even if surgeons were reluctant to acknowledge this shift in treatment, patients applauded the new minimally invasive surgery. Whenever it was possible, patients would ask for a surgical procedure that left no outer scarring and resulted in no postoperative pain. Patients, both male and female, independent of age and body shape, dislike scars, not only for cosmetic reasons but because scars indicate they have undergone treatment because of illness. This resulted in NOTES, with its general goal of minimizing the trauma of any interventional process by eliminating the incision through the abdominal wall and using natural orifices. To our knowledge, this is the first report of the use of NOTES to treat cholecystectomy in a human being via transvaginal access, performed at University Hospital in Strasbourg, France.

### METHODS

This first NOTES cholecystectomy in a human being was performed after extensive laboratory work in live pig models and human cadavers in the framework of a dedicated research program (Anubis Project) that includes surgeons, gastroenterologists, computer scientists, and robotic engineers. Institutional review board approval was obtained without further requirements because the transvaginal route is well-established as access to the peritoneal cavity.

Before this, the only experience in human beings was a series of hybrid, laparoscopic and transgastric appendectomies reported by Reddy and Rao.\(^5\) We report on our first NOTES cholecystectomy, carried out just a few days after the first laparoscopically assisted transvaginal cholecystectomy performed by the group at New York-Presbyterian/Columbia University Medical Center in New York City.

Our operation was performed via transvaginal access in a 30-year-old woman with symptomatic cholelithiasis by a multidisciplinary team that included a gynecologist (A.W.) experienced in transvaginal surgery who performed and closed the colpotomy. The potential risks and benefits of the operation were discussed with the patient, who gave informed consent. All of the principles of laparoscopic cholecystectomy were strictly adhered to.

The patient was placed in the lithotomy position (Figure 1). The peritoneal cavity was entered through an incision in the posterior vaginal cul de sac. Transvaginal access to the peritoneal cavity and introduction of a double-channel flexible videoscope (Karl Storz Endoskope GmbH, Tuttingen, Germany) were performed under laparoscopic guidance with a 2-mm needle scope. Placement of this 2-mm needle port was mandatory to insufflate carbon dioxide and to monitor for pneumoperitoneum, and was helpful for further retraction of the gallbladder (Figure 2). The quality of the operative view obtained with the endoscope was excellent, and complete identification of the structures of Calot’s triangle was achieved. The dissection was begun in close proximity to the gallbladder, at the junction between the infundibulum and the cystic duct. The peritoneum covering the cystic duct was incised anteriorly and posteriorly and was gently pushed aside with blunt dissection (Figure 3). Once sufficiently skeletonized, the cystic duct and artery were clipped twice on the patient side and once on the gallbladder side and divided with endoscopic scissors (Karl Storz Endoskope GmbH) (Figure 4). Using an endoscopic grasper and a unipolar round-tipped electrode (Karl Storz Endoskope GmbH), the gallbladder was dissected from the intrahepatic fossa and placed in a specimen retrieval bag (US Surgical/Tyco International Ltd, Norwalk, Connecticut) before removal via the vagina (Figure 5). The operative site was checked to ensure hemostasis and to rule out any inadvertent injury to the adjacent organs. The colpotomy was closed with interrupted 2-0 polyglactin 910 sutures (Vicryl; Johnson & Johnson Gateway LLC, Piscataway, New Jersey). No bleeding or bile leakage occurred during the procedure. The operative time was 3 hours.

### RESULTS

All of the advantages of laparoscopy, namely, minimal postoperative pain and abdominal scarring, seemed to be enhanced with the NOTES approach. The patient recov-
erred promptly after surgery, with no postoperative pain and no scars. Although she was feeling well on the evening of the surgery, we elected to discharge her on postoperative day 2 because this was our first case. At the follow-up visit 10 days after surgery, the patient had completely resumed full activity, with no discharge or bleeding and no discomfort at the perineal access site.

COMMENT

In 2004, Kalloo et al6 demonstrated the feasibility and safety of an oral transgastric endoscopic approach to the peritoneal cavity with long-term survival in a porcine model. Since then, exciting creativity and research have followed at a stunning rate. The experience of Kalloo and colleagues was soon followed by other transgastric peritoneal procedures in the porcine model, including tubal ligation, cholecystectomy, gastrojejunostomy, splenectomy, and oophorectomy with tubectomy.7-11 Other procedures using natural orifice access to the peritoneal cavity (eg, transcolonic, transvaginal, and transvesical) have also been described, even in combination.12,13

Our group at IRCAD-EITS (Institut de Recherche contre les Cancers de l’Appareil Digestif [Institute of Digestive Cancer Research]–European Institute of TeleSurgery) has been actively involved in the development of NOTES since 2004. A dedicated project, Anubis, was created to develop feasibility and survival studies, as well as new endoscopic technology. Between 2004 and 2007, more than 170 NOTES procedures have been performed in pigs, including cholecystectomy, distal pancreatectomy, splenectomy, adrenalectomy, bowel resection, and gastrointestinal anastomosis.

Although transgastric access to the abdominal cavity seems to be the route that will dominate NOTES in the future, there are still some challenging issues, such as risk of infection or leakage and the method of gastric closure, that will need to be addressed before this technique is introduced into clinical practice. In contrast, transvaginal access is well established and accepted. It has been used for years by gynecologists for diagnostic and therapeutic purposes (eg, hysterectomy, myomectomy, adnexectomy, and fertiloscopy). In addition, surgeons have used this route to extract large specimens after laparoscopic procedures involving the gallbladder, colon, spleen, and kidney.14

It is exciting to contemplate the potential for NOTES in improving patient care. A surgical intervention that eradicates the need for any incision, avoiding bodily trauma, is attractive to patients and also has an aura that surgeons find hard to resist.

The concept of NOTES has several consequences that need to be addressed by the medical and ancillary professions. NOTES has the potential for fundamental changes in surgical treatment, but the benefits of such changes must be supported by well-audited studies, which should report results comparable to the currently accepted standard criterion. A radical shift in the practice and philosophy of interventional treatment is being established that will be enormously advantageous to patients.

Such evolution calls for fundamental revision in surgical training, which should include flexible endoscopy to ensure that surgeons have the skills required to perform NOTES procedures. Ultimately, it will not matter
whether the operators are surgeons or gastroenterologists but that they are adequately trained to perform NOTES safely and responsibly.

The current constraints on visual feedback and dexterity may limit the scope of NOTES procedures. The future of natural orifice surgery lies in the application of computer and robotic technologies with the vision of a fully autonomous endoscopic platform, optimal visual feedback, and full computer-assisted guidance of the endoscopic instruments. The strategy for success is to create a multidisciplinary approach that combines instrument manufacturers, robotic engineers, and computer scientists.

CONCLUSION

With the successful performance of the first transluminal cholecystectomy, we witnessed the introduction of NOTES into clinical practice with mixed feelings of excitement and caution. Even if the advantages of NOTES in this first clinical case are apparent, transvaginal cholecystectomy is time consuming and difficult. Will NOTES generate a major paradigm shift in surgical care? We know that laparoscopic surgery is just the beginning of the minimally invasive evolution of surgery. We have come to an even more critical juncture in the history of surgery. With its invisible mending and tremendous potential for improving patient care and well-being, NOTES might represent the next greatest surgical evolution.

Accepted for Publication: May 14, 2007.

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Study supervision: Marescaux, Dallemagne, Perretta, and Mutter.

Financial Disclosure: None reported.

REFERENCES


Invited Critique

Surgery, gaining much from the general advance of knowledge, will be rendered both knifeless and bloodless.


After 2 centuries of progress in maximally invasive surgery, it seems that much progress toward Hunter’s prophecy of “rendering surgery both knifeless and bloodless” has been made in the last 2 decades. In Georgian England, the achievement of such a goal more concerned the elimination of incisional pain than worry its cosmetic consequences, as Hunter’s work preceded general anesthesia by more than 80 years. Nevertheless, incisionless, painless, scarless surgery has become the Holy Grail of modern surgical minimalists. Transvaginal cholecystectomy is a step in that direction. Or is it? Does this article by Marescaux et al merely record a triumph of technology and surgical panache such as landing a man on the moon, or does it represent another step toward truly noninvasive surgery? To answer this question, one must dissect further, to examine the measurable benefits of such an approach.

First and foremost we must look at safety. With only 2 successful NOTES cholecystectomies performed, one in New York City and one in Strasbourg, France, a discussion of safety can only be guesswork. Laparoscopic cholecystectomy sacrificed tactile sensation for better visualization of right upper quadrant anatomy, yet the unfamiliar image and unfamiliar equipment resulted in many