NOTES: Transvaginal Endoscopic Cholecystectomy in Humans—Preliminary Report of a Case Series

Chinnusamy Palanivelu, MCh, FRCS, FACS[1], Pidigu Seshiyer Rajan, MS, DNB, FACS[1], Muthukumaran Rangarajan, MS, DipMIS, FACS[1], Mohan Prasad, MD, DM[1], Vijayan Kalyanakumari, MD[1], Ramakrishnan Parthasarathi, MBBS[1] and Palanisamy Senthilnathan, MS, DNB, MRCS[1]

OBJECTIVES: **Natural orifice translumenal endoscopic surgery (NOTES) represents an emerging technology, including under its umbrella a variety of approaches and combinations. The transvaginal approach to endoscopic cholecystectomy is one such technique, which we present here as a small series.**

METHODS: **From May to November 2007, a total of eight patients were scheduled to undergo transvaginal endoscopic cholecystectomy at our institute. Two patients were excluded as they were converted to laparoscopy due to technical difficulties.**

RESULTS: **Average age of the patients was 34.5 years, and mean body mass index was 27 kg/m^2. The mean operating time was 148.5 min. Patients were discharged in an average of four postoperative days. The major complication rate was 16% (1/6). The patient with a major complication had a subhepatic collection that was managed with ultrasonogram-guided aspiration followed by ERCP and stenting.**

CONCLUSIONS: **Since the first description of NOTES, there has been no standardized technique. In our technique, we used a single 3-mm trocar for visualizing the entry and exit of the endoscope, maintaining and measuring pneumoperitoneum, and retracting the gall bladder fundus. The instruments that were used were the conventional endoscopic ones. The transvaginal approach seems to be a viable alternative to the transgastric approach for cholecystectomy, as the transgastric approach has certain inherent problems like leakage from the gastrotomy site and poor ergonomy. The downside to the transvaginal approach is that it is possible only in women.**

Am J Gastroenterol 2009; 104:843–847; doi:10.1038/ajg.2009.1; published online 10 March 2009

INTRODUCTION

Two decades of experience with laparoscopic surgery coupled with major refinement in instrumentation has made it possible to perform more complex surgical procedures routinely. Just when we thought of laparoscopy as the holy grail of surgery, along came surgeries without skin incisions altogether in the form of NOTES (natural orifice translumenal endoscopic surgery). What now seems experimental, endoscopic surgery utilizing natural orifices, may in future become routine too. NOTES is an emerging experimental technique of surgery that eliminates abdominal incisions and has evolved from more than two centuries of technological innovations (1). To achieve this, commercially available flexible video endoscopes are being used. There are several approaches and techniques described in the literature, each with its own advantages (2). The transvaginal route for intra-abdominal procedures is one of the approaches reported for NOTES, though it is not a new concept, being described as early as the early 1900s—Klaften (3)presented colpolaparoscopy, and Decker and Cherry (4) reported culdoscopy. In this small series, we present the feasibility of the transvaginal approach to endoscopic cholecystectomy in human patients and to add to the existing literature.

METHODS

In our institute, from May to December 2007, we enrolled eight human patients with symptomatic cholelithiasis to undergo transvaginal cholecystectomy. Informed consent was obtained

[1]GEM Hospital & Postgraduate Institute, Coimbatore, India. **Correspondence:** Chinnusamy Palanivelu, MCh, FRCS, FACS, GEM Hospital & Postgraduate Institute, 45-A, Pankaja Mill Road, Ramnathapuram, Coimbatore 641045, India. E-mail: drcp@gemhospital.net
Presented at the 16th Asian Surgical Congress, Beijing, China, 2007.
Received 1 April 2008; accepted 16 October 2008

© 2009 by the American College of Gastroenterology

from all the patients by explaining to them the potential benefits of this new approach. These benefits include less postoperative pain, better cosmesis due to the complete absence of scars, and shorter hospital stay. The possibility of temporary postoperative dysparunea was also explained to them. We successfully performed this procedure for six patients, as we had to convert the first two cases to conventional laparoscopic cholecystectomy due to technical difficulties. One patient had inflammatory adhesions that were difficult to dissect, and the other patient had a wide cystic duct that may not have completely occluded with an endoclip. The first successful procedure was performed at the end of July 2007. All the patients were worked up for surgery with routine blood and urine tests, liver function test, electrocardiogram, ultrasonogram (USG), and chest X-ray. Anesthetic fitness and gynecology consultation were obtained in all patients before the procedure. One vaginal povidone-iodine tablet was administered 12 h preoperatively for all the cases. The Ethics Committee approved the study, considering our extensive experience with the procedure in porcine models and our published study on transvaginal appendectomy in humans.

The inclusion criteria were age, 18–65 years, able to give informed consent, and symptomatic cholelithiasis.

The exclusion criteria were endometriosis, pelvic inflammatory disease, pregnancy, morbidly obese patients (body mass index>35), immunocompromised patients, severe medical comorbidities, acute cholecystitis with excess inflammation, gall bladder mass (phlegmon) or tumor, prior open abdominal or transvaginal surgery, and the presence of CBD stones.

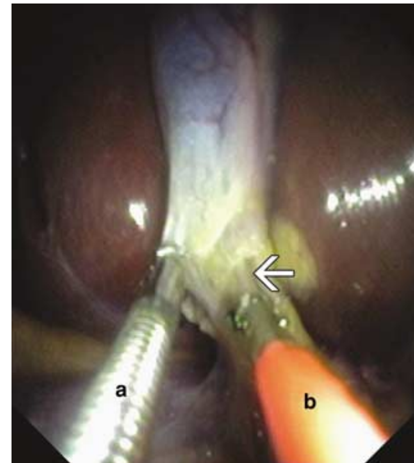

Figure 1. Dissection of peritoneum over Calot's triangle. (**a**) Rat-tooth grasper, (**b**) hot biopsy forceps. Arrow: cystic artery. 88×99 mm (300×300 DPI).

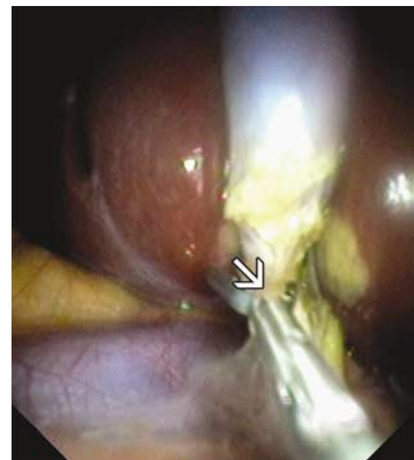

Figure 2. Applying an endoclip to the skeletonized cystic duct (arrow). 90×99 mm (300×300 DPI).

Procedure

The patients were placed in the lithotomy position, allowing the surgeon to sit between the legs of the patient. The endoscopy processor was placed on the left side of the patient, so that the endoscopist could stand on the left of the surgeon and the scrub nurse stands on the right side of the surgeon at the foot end of the patient. The scrub nurse holds and operates the accessories that were used for the procedure. The laparoscopic monitor was positioned on the right side of the patient and endoscopic monitor was at the head end of the patient. A double-channel endoscope with the required endoscopic accessories was kept ready by the nurse. The patient was anesthetized and pneumoperitoneum was created with a Veress needle introduced through a 2-mm incision at the umbilicus. At this stage, the patient's head end was lowered by 25°. The gynecologist, who was a valuable member of the team, incised the posterior fornix by giving traction to the posterior lip of the cervix to facilitate entry of the double-channel endoscope. Next, a 3-mm trocar was introduced at the umbilicus for a 3-mm telescope that was used to guide the entry of the endoscope from the vagina to the subhepatic area. Once the scope reached the gall bladder area, the 3-mm telescope was exchanged with a 3-mm toothed grasper to hold the fundus of the gall bladder for cranial traction. Through the left working channel of the double-channel endoscope, a rat-tooth biopsy forceps was introduced to hold the infundibulum. A hot biopsy forceps with diathermy was introduced through the right working channel for dissection. The dissection was commenced by opening the peritoneum covering Calot's triangle, taking care to stay close to the gall bladder at all times (**Figure 1**). As a precautionary measure, electrocautery was used only in short bursts during the entire procedure. Once the cystic duct was skeletonized, two endoclips were applied and the duct divided in between them with an endoscissor (**Figures 2** and **3**). Next, the cystic artery was dissected out and skeletonized. In four patients, the artery was clipped and divided with endoscissors, and in two cases the artery was thin and was coagulated and cut without any clips. The gall bladder was separated from the liver bed gradually by applying hot biopsy forceps dividing the meso-gall bladder (**Figure 4**). An endosnare was applied to the infundibulum to provide lateral traction. After completely separating the gall bladder from the liver, the endosnare was repositioned to fully

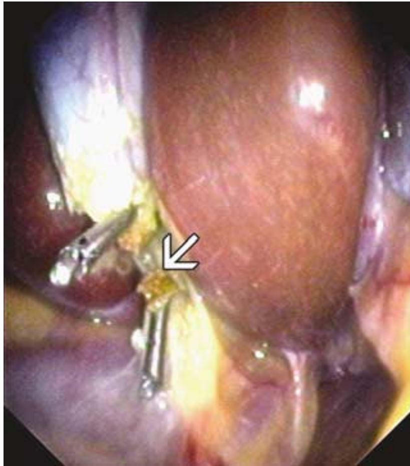

Figure 3. Cystic duct (arrow) divided between the two endoclips. 87×99 mm (300×300 DPI).

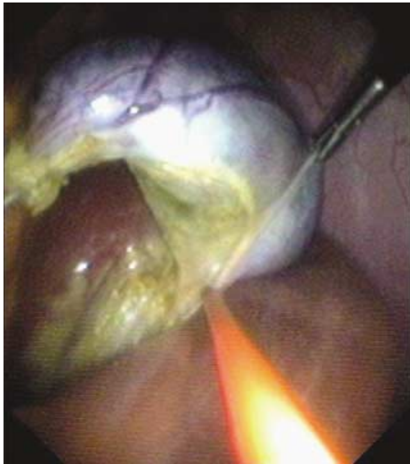

Figure 4. Hot biopsy forceps used to dissect gall bladder off the liver bed. 88×99 mm (300×300 DPI).

hold the body of the gall bladder. The entire specimen was pulled out through the vagina with the endosnare, along with the endoscope (**Figure 5**). Hemostasis was confirmed before closing the incision in the posterior fornix with 1.0 polyglactin 910. A sterile vaginal pack dressing was applied in all the patients. The operative field was not drained in any case. The 3-mm wound was closed with 3.0 polyglactin 910 and dressed.

RESULTS

The total number of patients in the series was eight (women). The average age of the patients was 34.5 years (range, 25–44), and their mean body mass index was 27 kg/m^2 (range, 25–29). The mean operating time was 148.5 min (range, 115–182).

Postoperatively, one dose of pre-emptive parenteral analgesic was administered, and thereafter oral analgesics for 1 day were necessary for three patients. The average hospital stay was

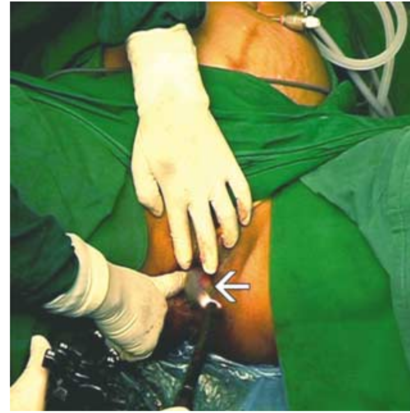

Figure 5. Intact specimen (arrow) being delivered through the vagina. 99×99 mm (300×300 DPI).

4 (range, 2–6) postoperative days (PODs). Four patients were discharged on the first POD, one case on the second POD (due to ileus), whereas one patient had a minor bile leak and had to stay in the hospital for 6 days. The major complication rate was 12.5% (1/8) and conversion rate was 25% (2/8). All the patients underwent USG in the postoperative period, which was normal for all except in one patient. This case had a subhepatic collection measuring 60 ml on the second POD. A USG-guided aspiration was performed for her on the same day. The next day, USG revealed a similar collection, so she underwent another aspiration followed by endoscopic retrograde cholangiopancreatogram (ERCP) and stenting. The source of the leak was a partially slipped endoclip on the cystic duct, as identified by the ERCP. She was discharged on the sixth POD and reviewed after 14 days for liver function tests and USG, and found to be symptom free. After 6 weeks, the patient was reviewed again for liver function tests, USG, and total blood counts, which were normal. So the stent was removed, following which the patient had no further problems. A complete sexual abstinence lasting 4 weeks was advised for all cases. One patient complained of dyspareunia on the fourth week of follow-up. Vaginal examination revealed inflammation, so she was started on a full course of antibiotics, following which she recovered. The other five patients had an uneventful postoperative period. Follow-up was scheduled at 1 week, 1, 2, and 3 months. Two patients completed their 3-month follow-up, whereas two patients completed their 2-month follow-up and one case was followed up for 1 month.

Overall, on questioning the patients, five out of six patients were totally satisfied with their surgery. The patient with the bile leak stated that she would have preferred laparoscopic cholecystectomy if she had to undergo the surgery again.

DISCUSSION

In the first published description of NOTES, Kalloo *et al.* (5) demonstrated the feasibility and safety of a per oral transgastric endoscopic approach to the peritoneal cavity with long-term survival in a porcine model. Since then, numerous

© 2009 by the American College of Gastroenterology

reports have been published describing different techniques and approaches in animals and, now, in humans (6). In 2007, Swanstrom (7) reported the first human transgastric cholecystectomy. In March 2007, the NOTES Research Group in Brazil performed the first ever series of transvaginal endoscopic cholecystectomies in four human patients, assisted by instruments other than the ones used through the endoscope (8). Later on in the same month, Bessler *et al.* (9) was successful in performing transvaginal cholecystectomy with the help of three abdominal ports. Marescaux *et al.* (10), from France, performed the first "pure" NOTES cholecystectomy in a patient in early April 2007 using only a Veress needle as the only abdominal port. Ours is only the fourth series in published literature describing transvaginal cholecystectomy in humans.

The major concern with the transgastric procedures described is the integrity of the gastrotomy closure, which may leak and cause peritonitis. If transgastric NOTES is to reach human trials, a 100% reliable means of gastric closure must be developed. Several accessories are used and these include endoscopic clippings, suturing, tissue fasteners, and NDO plicators (11,12). Among these techniques, there is no evidence that one is superior to the other, although endoclips are the most commonly used. The current leak rate of 1–2% is not acceptable, given the safety of other minimally invasive approaches to cholecystectomy (13). It is therefore crucial to reduce the leak rate to almost zero, if the transgastric approach is to be successful. The potential for complications is higher when two or more instruments are passed at different sites through the gastric wall due to the development of shearing forces during active dissection. In the transgastric approach, the endoscope occupies most of the esophagus and stomach, so the length of the scope actually available outside the mouth for manipulation is only a few centimeters long. Also, the original image of the target organ obtained through the endoscope is always inverted. Usually, it is reverted by torquing the scope, but here it may be impossible due to the short length available for manipulation. This is not a problem with the transvaginal approach.

Given the limitations of the transgastric approach, it seems worthwhile to explore other natural orifices like the vagina for NOTES. Natural orifices, such as the anus or vagina, also allow access to the peritoneal cavity and were experimented extensively in pigs. Tsin *et al.* (14) have had extensive experience in this approach, in which they used conventional laparoscopic instruments combined with endoscopy through the transvaginal route and have reported their results. Another difference between the two approaches is the placement of equipment to maintain ergonomy. In the transvaginal technique, the surgeon, the target organ, and monitor lie in a straight line, whereas in the transgastric approach, the scope has to be torqued at a right angle, once the stomach is breached, to reach the target organ. In our experience with transvaginal endoscopic appendectomies, we found that this approach gave us the much-needed dexterity, as endoscopic instruments are quite cumbersome to dissect with (15). Currently, a transvaginal access to NOTES seems to be safe and feasible for clinical application in humans. Compared with the transgastric access with its inherent morbidity associated with gastrotomy, the transvaginal approach seems to serve the same purpose with the only morbidity of dysparunea. However, it must be said that the transvaginal approach has the disadvantage of being possible only in women. The upside to this is that cholelithiasis is more common in women, so cholecystectomy is more likely to be performed in women anyway. Whereas the transgastric approach is ideal for cholecystectomy in male patients, the transvaginal approach is probably a better option in women.

Other than the conventional endoscopy and its accessories, we have used a single 3-mm trocar placed at the umbilicus. During the initial incision of posterior vaginal wall and introduction of the endoscope, a 3-mm telescope in the umbilical port was used to visualize the entry through the vaginal wall. This prevents bowel injury. Subsequently, a controlled pneumoperitoneum was maintained and measured through this port. Also, a toothed grasper was placed in this port to provide traction by lifting up the fundus of the gall bladder. Some of the other authors who reported transvaginal cholecystectomy have used two or three trocars in the abdominal wall, along with the endoscopic procedure. In our opinion, this technique resembles conventional laparoscopy, and thus may not confer the desired benefit of "scarless" surgery to the patient. As experience is gained, the number of these extra ports can be reduced or avoided, and the entire procedure could be completed endoscopically. Initially, the operating times were obviously longer though later we were able to reduce it. The initial hospital stay was similar to that of our patients who undergo conventional laparoscopic cholecystectomy. Four patients were discharged on the first POD and were instructed to visit the outpatient department in case they had any symptoms of abdominal pain, right shoulder pain, fever, or jaundice. The patient who had a leak was managed successfully by ERCP and the patient who had dyspareunia was managed conservatively. The bile leak was most likely operator dependant, due to a misplaced clip. More experience is needed to evaluate the safety of other methods of securing the cystic duct, such as the poly-loop. This goes to show that NOTES has its share of difficulties and a learning curve as well. We hope that as we gain experience, we can definitely reduce operator-based complications.

Recently, the transvesical and the transcolonic approaches have been advocated by some researchers as being more suited to access upper abdominal structures that are often more difficult to work with using a transgastric approach (16). A novel modification was described in which transvaginal cholecystectomy was performed using magnetically anchored instruments (17).

No doubt, NOTES is here to stay. Although the promise of adventure is exciting to surgeons and endoscopists alike, patient benefits and safety are paramount and we should work toward it. Different approaches and techniques have to be assessed thoroughly in the form of randomized trials to identify the ideal procedure for NOTES. On the basis of our small series of patients, transvaginal endoscopic cholecystectomy seems to be an effective approach to NOTES. In spite of the dangers of bile leak that can be minimized with experience, this and other

similar series should stimulate surgeons to adopt it into routine practice in the near future.

CONFLICT OF INTEREST

Guarantor of the article: Chinnusamy Palanivelu, MCh, FRCS, FACS.
Specific author contributions: Chinnusamy Palanivelu: assisted in the procedures and critically reviewed the paper; Pidigu Seshiyer Rajan: performed the procedures (chief surgeon); Muthukumaran Rangarajan: created the draft and wrote the paper; Mohan Prasad: assisted in the procedures (endoscopist); Vijayan Kalyanakumari: performed the colpotomies (gynecologist); Ramakrishnan Parthasarathi: recorded the procedures and edited the article; and Palanisamy Senthilnathan: collected data for the article.
Financial support: None.
Potential competing interests: None.

Study Highlights

WHAT IS CURRENT KNOWLEDGE

- ✓ The current gold standard in the management of symptomatic cholelithiasis is laparoscopic cholecystectomy.
- ✓ Natural orifice surgery has been described in animal models.
- ✓ Very few reports are available on human patients.
- ✓ The transgastric approach is the most common technique described currently, but it is fraught with the danger of gastrotomy leak.
- ✓ Only one case report of "pure" transvaginal cholecystectomy in humans is available (Marescaux *et al.* (10)).

WHAT IS NEW HERE

- ✓ Groups from the United States and Brazil reported transvaginal cholecystectomy in humans, though they used two or more laparoscopic ports to assist.
- ✓ We report a small series of transvaginal cholecystectomy in humans using just one 3-mm laparoscopic port for assistance.
- ✓ Even though it is possible only in female patients, the transvaginal approach is safe, and only randomized trials will prove the superiority of one technique over another.

REFERENCES

1. McGee MF, Rosen MJ, Marks J *et al.* A primer on Natural Orifice Transluminal Endoscopic Surgery: building a new paradigm. Surg Inn 2006;13:86–93.
2. de la Fuente SG, DeMaria EJ, Reynolds JD *et al.* New developments in surgery—Natural Orifice Transluminal Endoscopic Surgery (NOTES). Arch Surg 2007;142:295–7.
3. Klaften E. Culdoscopy [letter to the editor]. Am J Obstet Gynecol 1948;55:1071–2.
4. Decker A, Cherry T. Culdoscopy, a new method in diagnosis of pelvic disease. Am J Surg 1944;64:40–4.
5. Kalloo AN, Singh VK, Jagannath SB *et al.* Flexible transgastric peritoneoscopy: a novel approach to diagnostic and therapeutic interventions in the peritoneal cavity. Gastrointest Endosc 2004;60: 114–7.
6. Wagh MS, Merrifield BF, Thompson CC. Endoscopic transgastric abdominal exploration and organ resection: initial experience in a porcine model. Clin Gastroenterol Hepatol 2005;3:892–6.
7. Swanstrom LL. Beyond endoluminal therapeutic endoscopy. Gastrointest Endosc 2007;66:121–2.
8. Zorron R, Maggioni LC, Pombo L *et al.* NOTES transvaginal cholecystectomy: preliminary clinical application. Surg Endosc 2008;22:542–7.
9. Bessler M, Stevens P, Milone L *et al.* Transvaginal cholecystectomy laparoscopically assisted for gallstones: a human case (ET017). Proceedings of the annual meeting of the Society of American Gastrointestinal Endoscopy Surgeons, 2007, Las Vegas, Nevada. Las Vegas: The Society; 2007:318.
10. Marescaux J, Dallemagne B, Perretta S *et al.* Surgery without scars: report of transluminal cholecystectomy in a human being. Arch Surg 2007;142: 823–6; discussion 826–7.
11. Sumiyama K, Gostout CJ, Rajan E *et al.* Endoscopic full-thickness closure of large gastric perforations by use of tissue anchors. Gastrointest Endosc 2007;65:134–9.
12. McGee MF, Marks JM, Onders RP *et al.* Complete endoscopic closure of gastrotomy after natural orifice translumenal endoscopic surgery using the NDO plicator. Surg Endosc 2008;22:214–20.
13. Zornig C, Emmermann A, von Waldenfels HA *et al.* Laparoscopic cholecystectomy without visible scar: combined transvaginal and transumbilical approach. Endoscopy 2007;39:913–5.
14. Tsin DA, Colombero LT, Mahmood D *et al.* Operative culdolaparoscopy: a new approach combining operative culdoscopy and minilaparoscopy. J Am Assoc Gynecol Laparosc 2001;8:438–41.
15. Palanivelu C, Rajan PS, Rangarajan M *et al.* Transvaginal endoscopic appendectomy in humans: a unique approach to NOTES—world's first report. Surg Endosc 2008;22:1343–7.
16. Pai RD, Fong DG, Bundga ME *et al.* Transcolonic endoscopic cholecystectomy: a NOTES survival study in a porcine model. Gastrointest Endosc 2006;64:428–34.
17. Scott DJ, Tang SJ, Fernandez R *et al.* Completely transvaginal NOTES cholecystectomy using magnetically anchored instruments. Surg Endosc 2007;21:2308–16.

© 2009 by the American College of Gastroenterology