



Surgery in Motion

Feasibility of Transvaginal NOTES-Assisted Laparoscopic Nephrectomy

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Abstract

Background: Recently, the feasibility of a transvaginal hybrid natural orifice transluminal endoscopic surgery (NOTES) nephrectomy was demonstrated in a 23-yr-old woman with a nonfunctional atrophic kidney.

Objective: To evaluate the feasibility and reproducibility of transvaginal NOTES-assisted laparoscopic nephrectomy in female patients with and without renal cancer.

Design, setting, and participants: Between March 2008 and June 2009, 14 female patients were submitted to transvaginal NOTES-assisted laparoscopic nephrectomy for T1–T3a NOM0 renal cancer ($n = 10$), lithiasis ($n = 2$), or renal atrophy ($n = 2$) at the Hospital Clinic of Barcelona, Spain.

Surgical procedure: Under general anaesthesia, female patients underwent laparoscopic nephrectomy by transvaginal NOTES using a deflectable camera by vaginal access and two additional 5- and 10-mm trocars in the abdomen. The renal artery and vein were dissected and taken separately between clips. The dissected kidney was removed via the vagina after enlarging the vaginal trocar incision.

Measurements: All data referring to patient demographics, surgery, pathology, and perioperative outcomes were recorded.

Results and limitations: The procedure was completed in all patients. The mean age of the women was 59.1 yr. The mean operative time was 132.9 min and the mean estimated blood loss was 111.2 ml. None of the patients required a blood transfusion and the use of analgesics was low. The mean hospital stay was 4 d. In one case, a major complication (a colon injury) occurred. The patient underwent surgery and a temporary colostomy was performed. The patient has already undergone reconstruction.

Conclusions: Transvaginal NOTES-assisted laparoscopic nephrectomy is feasible and reproducible and may be an alternative technique for treatment of women with renal cancer. Proper selection of patients is warranted for success of this new approach. However, longer follow-up in an increasing number of patients is needed to establish its role in the treatment of renal cancer.

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1. Introduction

The benefits of laparoscopic nephrectomy in comparison with open nephrectomy are well established. Retrieval of the kidney during laparoscopic nephrectomy has been completed by means of intact specimen removal through a small secondary incision in the abdominal wall. Currently, laparoscopic nephrectomy is considered the gold standard for treatment of T1b renal tumours. Although laparoscopic nephrectomy is a minimally invasive technique compared with open nephrectomy, laparoscopic dissection performed through a natural body orifice could possibly enhance cosmesis and further reduce postoperative recovery. Natural orifice transluminal endoscopic surgery (NOTES) is a surgical modality that uses empty organs as an access to the peritoneal cavity, avoiding skin incisions. However, available endoscopes have several limitations if used in the peritoneal cavity. If we combine NOTES with the conventional laparoscopic approach, a hybrid technique is obtained [1]. This new technique may increase safety and overcome the current technical problems, while maintaining most of the advantages of NOTES.

The vagina has been considered a viable route for kidney retrieval following laparoscopic nephrectomies [2]. While transvaginal hybrid NOTES nephrectomy has been previously described [3], this procedure has not yet been explored in women with renal cancer. Here, we present our early experience with transvaginal NOTES-assisted laparoscopic nephrectomy in female patients with T1–T3a N0M0 renal cancer.

2. Methods and patients

Between March 2008 and June 2009, 14 female patients were submitted to transvaginal NOTES-assisted laparoscopic nephrectomy for T1–T3a N0M0 renal cancer ($n = 10$), lithiasis ($n = 2$), or renal atrophy ($n = 2$) at the Hospital Clinic of Barcelona, Spain. The study protocol was authorised by the hospital's Ethics Committee. All data referring to patient demographics, surgery, pathology, and perioperative outcomes were recorded.

2.1. Surgical technique

Under general anaesthesia, the patient was placed in a semilumbotomy position with separated legs to allow vaginal access (Fig. 1). The pneumoperitoneum was achieved by a 12-mm trocar/port placed laterally 5 cm from the umbilicus under direct vision. The intra-abdominal pressure was maintained at 12 mm Hg. A normal laparoscopic optic of zero degrees was placed into the abdominal cavity under direct vision and an additional 5-mm trocar was placed in the flank (Fig. 1). Finally, an obese special port was placed through the vagina into the abdominal cavity, perforating the vaginal wall in the posterior cul-de-sac under direct vision. Through the 5-mm abdominal trocar, a conventional grasper was placed to retract the uterus and facilitate visualisation of the vaginal posterior wall to avoid sigmoid lesions. The trocar was guided through the vagina using a conventional vaginal valve. A deflectable optic (Deflectable-Tip EndoEYE, Olympus, Tokyo, Japan) was introduced into the peritoneal cavity (Fig. 2). Dissection was performed following the steps of a regular laparoscopic transabdominal nephrectomy using instruments placed in the abdominal trocars, under direct vision achieved by a deflectable camera, placed through the

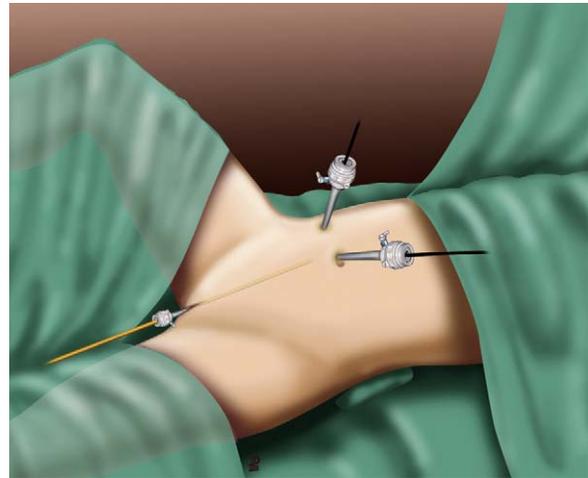


Fig. 1 – Scheme of the position and trocar placement.

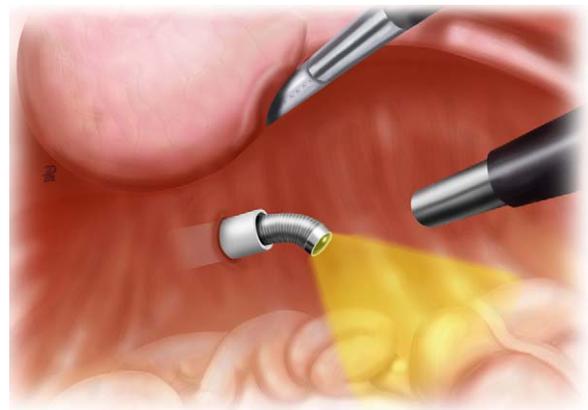


Fig. 2 – Laparoscopic visualisation of the peritoneal cavity. A grasper is lifting the uterus.

vaginal trocar. The line of Toldt was incised and the colon was mobilised until the psoas muscle became visible. The ureter was dissected and sectioned using the LigaSure device (Valleylab, Tyco Healthcare, Boulder, CO, USA). The renal hilum was reached by dissection of the lower pole through cranial direction (Fig. 3). The renal artery was ligated with Hem-o-lok clips (Weck Closure Systems, Research Triangle Park, NC, USA) and sectioned. Ligation of the renal vein was done by the same device.

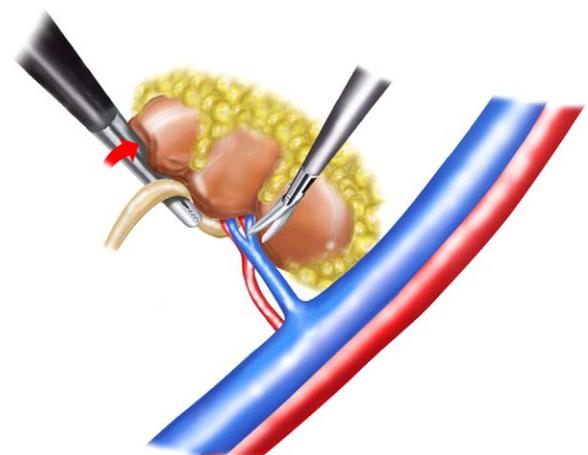


Fig. 3 – Caudal vision and dissection of renal hilum.

Table 1 – Patient characteristics and study outcome measurements*

No. of patients	14
Mean age, yr (range)	59.1 (39–78)
Patients with ASA score 3, n (%)	4 (28)
Patients with T1b renal cancer, n (%)	10 (71.4)
Mean tumour size, cm (range)	5.0 (2.0–7.0)*
Median use of trocars (range)	2 (2–3)
Arteries dissected, median (range)	1 (1–2)
Veins dissected, median (range)	1 (1–2)
Mean operative time, min (range)	132.9 (65–270)
Mean estimated blood loss, ml (range)	111.2 (30–400)
Patients receiving blood transfusion, n (%)	0 (0)
Mean use of analgesics, h (range)	18 (0–72)
Mean hospital stay, d	4
Patients with major complications, n (%)	1 (7)

ASA = American Society of Anesthesiologists.

* Assessed in eight patients with renal tumours.

The posterior wall and the upper pole were dissected, preserving the adrenal gland. The surgical specimen was freed and an organ bag was introduced through the trocar placed at the vagina after retrieving the deflectable optic. The kidney was placed inside the organ bag and the specimen was removed under direct vision with an optic in the abdominal trocar through an extended incision at the posterior wall of the vagina. The vaginal wound was closed under direct vision using conventional instruments. A running 2-0 absorbable suture was used.

3. Results

The procedure was completed under general anaesthesia in all patients. The mean age of the women was 59.1 yr (range: 39–78 yr) (Table 1). Two out of 14 women had previously undergone hysterectomy. Most of the female patients (71.4%) had T1b renal cancer (Table 1). In two patients, the tumour was <4 cm and radical nephrectomy for special conditions was recommended. In one case, a computed tomography (CT) scan showed a 2-cm lesion, but an affected renal sinus and T3a stage renal cancer was confirmed after pathologic assessment. The second patient had a tumour of 2.8 cm and suffered from end-stage renal disease, so it was unnecessary to maintain the kidney. Two patients underwent surgery for lithiasis with a nonfunctioning kidney; one patient was operated for an atrophic kidney. The mean size of the removed tumours was 5.0 cm (range: 2.0–7.0 cm). Seven left and seven right nephrectomies were performed. In all patients two trocars were used; in one patient a 2-mm instrument was necessary, inserted by puncture with no trocar. A median number of one renal artery (range: 1–2) and one renal vein (range: 1–2) were dissected and taken separately between clips; two cases presented with two arteries. The mean operative time was 132.9 min (range: 65–270 min) and the mean estimated blood loss was 111.2 ml (range: 30–400 ml) (Table 1). None of the patients required a blood transfusion. For postoperative pain control, an intravenously administered combination of dexketoprofen and paracetamol was used during the first 24–48 h, except in two patients to whom a combination of ropivacaine and fentanyl through epidural catheter was applied. The analgesic choice was based on anaesthetists' preferences. The mean time of analgesics used was 18 h

(range: 0–72 h). In one patient who had a previous abdominal and pelvic surgery, a colon injury occurred. On the second day the patient experienced abdominal pain and fever. Colon injury was diagnosed and confirmed by CT scan. The patient underwent surgery and a temporary colostomy was performed. The patient has already undergone reconstruction. The mean hospital stay was 4 d (3 d if we exclude the patient with the major complication from the analysis).

4. Discussion

Urology is a surgical speciality that can be considered the pioneer in using minimally invasive techniques (eg, transurethral resection of the prostate, ureterorenoscopy). The development of minimally invasive surgeries over the past 20 yr has led to the near extinction of several traditional open procedures. Laparoscopy is a minimally invasive surgery associated with many advantages, including smaller incisions of the abdomen, less postoperative pain, and faster recovery compared with open surgery. One of the newest innovations into this field has been the development of NOTES, a surgical modality that uses empty organs (eg, vagina, gastrointestinal tract) as an access to the peritoneal cavity, thereby avoiding skin incisions. Although there seems to be a wide variation in the terminology and use of acronyms for NOTES, it should be designated as the common term to define this new procedure in urology [4]. With regard to this technique, a first experimental study using the gastrointestinal tract for NOTES was published in 2004 [5]. Following this report, other investigators have shown the feasibility of transgastric ligation of fallopian tubes [6], cholecystectomy and cholecystogastric anastomosis [7], gastrojejunostomy [8], and splenectomy [9]. All these NOTES techniques were based on experimental porcine models. At the 2006 Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Conference in Dallas, Texas, USA, the first transgastric NOTES appendectomy performed in humans was reported [10]. Three yr later, Marescaux et al [11] described the first cholecystectomy performed by transvaginal NOTES in humans; it was called the “Anubis Project.” A transvaginal NOTES cholecystectomy with a flexible endoscope coupled with a 2-mm needle port for gas instillation and abdominal pressure monitoring was performed. At none of the stages of the procedure was laparoscopic assistance needed.

The NOTES procedure may provide additional benefits when compared with current minimally invasive procedures. Potential advantages includes lack of skin incisions, improved cosmetic results, reduced postoperative pain, diminished risks of postoperative hernias, and earlier recovery [12]. However, “pure” NOTES instruments have been criticised because of their flexibility, the impossibility to retract big organs such as the kidney, the incongruence of the flexible material to be used in the abdominal cavity, and the limited port access to use good haemostatic devices. The combination of both a flexible laparoscope through a natural orifice with the use of a minimum number of necessary abdominal trocars (ie, hybrid NOTES approach)

may overcome these limitations, increase safety, and decrease invasiveness of conventional laparoscopic surgery [1].

In accordance with the philosophy of NOTES, the vagina has been considered a viable route for retrieval of specimens after laparoscopic nephrectomy. In 2002, Gill et al [13] published a series of 10 successful standard laparoscopic nephrectomies with transvaginal extraction of the specimen, an important step towards NOTES. In the same year, Gettman et al [2] described an attempt to assess the feasibility of laparoscopic nephrectomy completed entirely via the vagina in a porcine model. However, in five of six renal units, a single 5-mm transabdominal trocar for the laparoscope was required to facilitate visualisation. More recently, Branco et al [3] performed the first nephrectomy by transvaginal hybrid NOTES in a 23-yr-old woman with a nonfunctional right kidney. Vaginal access was used for specimen retrieval and as a working port, assisted by two additional 5-mm trocars placed into the abdomen.

In March 2008, we performed the first transvaginal NOTES-assisted laparoscopic nephrectomy for renal cancer [14]. So far, 14 procedures have been completed. We used a vaginal access for a deflectable camera and the assistance of two additional abdominal trocars. The caudal vision of the kidney and the hilum is different than with conventional laparoscopy; but the use of a transvaginal deflectable camera allows a much more reliable and comfortable procedure. Although it requires a learning curve, the technique using vaginal access for working and vision seems to be exportable and considered reliable by other surgical teams. If necessary, the number of abdominal trocars can be increased with no need for conversion to open surgery. In fact, when a hybrid NOTES procedure requires more than two trocars, we are converting to conventional laparoscopic procedure that still is considered minimally invasive. The additional use of needle instruments is also an alternative. The main advantage of hybrid NOTES is that it allows the use of conventional laparoscopic devices and overcomes the limitations with pure NOTES. Moreover, hybrid NOTES preserves the main advantage of pure NOTES, which is the lack of abdominal incision for retrieving the organ.

Nevertheless, female patients should be selected with caution. Selection criteria are not easily established based on this preliminary experience. However, a conservative approach should be undertaken with new procedures under development. Among the indications for simple or radical nephrectomy in female patients, we have to exclude any patient with vaginal narrowing. Patients with no history of sexual intercourse and those with no history of deliveries should be evaluated carefully. Obesity, especially in the case of a radical nephrectomy in which we expect a voluminous surgical specimen, can be a contraindication for transvaginal surgery.

In our series, one patient had a colon injury. This major complication was not due to the transvaginal hybrid procedure as such, but was related to an inadequate patient selection due to multiple intestinal adhesions to the abdominal wall after open gynaecological surgery. Important difficulties in the procedures, specifically in retrieving the organ, were found in case 3 with a body mass index (BMI)

of 32 and case 10 with a BMI of 31 and no history of sexual intercourse. These difficulties were mainly due to the high volume of the radical nephrectomy specimens, including the perinephric fat.

Sexual dysfunction may be a matter of concern after vaginal incision. The wide literature reported about vaginal surgery, mainly in the gynaecological field, suggests that sexual dysfunction is a rare event after vaginal surgery [15]. Since specific data regarding the impact of the vaginal incision are not available, data comparing abdominal versus transvaginal hysterectomy show that deterioration of sexual function occurred more frequently after abdominal than after vaginal hysterectomy [16]. Nevertheless, as gynaecologic surgery may have an impact on sexual condition, we have started assessing sexual function in our patients in a prospective manner using a validated questionnaire.

The transvaginal procedure allows better cosmesis, diminished analgesia requirement, and shorter hospital stay. Other modalities of minimally invasive “scarless” surgery are under development and preliminary data in animal models and humans are available. The single port surgery (SPS), or laparoendoscopic single-site surgery (LESS), is accepted as a promising procedure. This single-access technique could significantly enhance the applicability of NOTES approaches and accomplish the ultimate goal of minimally invasive, incision-free intra-abdominal surgery [17].

Based on porcine models, some procedures have been reported that indicate the feasibility of this approach [18–21]. In clinical practice there are several publications on the application of LESS. All the published studies include only a few cases, but in all series the feasibility of the approach has been demonstrated. Urologic procedures reported by single-access surgery in humans include nephrectomy [22,23], live-donor nephrectomy for transplantation [24], renal cryotherapy, kidney biopsy, and sacrocolpopexy [25], adrenalectomy [26], and radical prostatectomy [27]. Overall, minimally invasive scarless surgery is a challenging technique, which may improve quality of life and offers an advantage over conventional laparoscopy.

5. Conclusions

Transvaginal NOTES-assisted laparoscopic nephrectomy appears to be a feasible and reproducible surgical technique. It may be considered an alternative procedure for treatment of female patients with renal cancer. However, proper selection of patients to undergo this new approach is warranted for success. Furthermore, longer follow-up is needed to establish its role in the treatment of renal cancer.

Author contributions: Antonio Alcaraz had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Alcaraz, Ribal.

Acquisition of data: Alcaraz, Peri, Ribal, Molina.

Analysis and interpretation of data: Izquierdo, Goicoechea.

Drafting of the manuscript: Alcaraz, Ribal, Peri.

Critical revision of the manuscript for important intellectual content: Alcaraz, Ribal, Garcia.

Statistical analysis: Izquierdo, Goicoechea.

Obtaining funding: None.

Administrative, technical, or material support: Izquierdo, Goicoechea, Molina.

Supervision: Alcaraz, Ribal.

Other (specify): None.

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Appendix A. Supplementary data

The Surgery in Motion video accompanying this article can be found in the online version at [doi:10.1016/j.eururo.2009.09.025](https://doi.org/10.1016/j.eururo.2009.09.025) and via www.europeanurology.com. Subscribers to the printed journal will find the Surgery in Motion DVD enclosed.

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