Laparoscopic and Robotic Urology



# Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report

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## OBJECTIVE

To report the initial clinical cases of scarless, single port, transumbilical nephrectomy and pyeloplasty.

## PATIENTS AND METHODS

One patient each underwent single port transumbilical nephrectomy and pyeloplasty using the R-Port (Advanced Surgical Concepts), inserted through a transumbilical incision in both cases. Novel, specialized instruments, curved at the shaft, were used in addition to standard laparoscopic instrumentation. During pyeloplasty, a 2-mm needle-port (MiniSite, USSC, Norfolk, CT, USA) was also inserted, with no skin incision, to facilitate suturing.

## RESULTS

Both procedures were technically successful with no extra-umbilical skin incisions. The total operative duration was 3.4 and 2.7 h, the estimated blood loss 100 and 50 mL, and the hospital stay was 1 and 2 days for the nephrectomy and pyeloplasty, respectively. There were no complications during or after surgery. The total analgesia requirement was 100 and 150 mg of keterolac, and visual analogue pain scores were 8/10 and 2/10 at 1 and 2 days after surgery, respectively.

## CONCLUSIONS

Transumbilical, single port nephrectomy and pyeloplasty are technically feasible. The first initial clinical experience of organ-ablative and reconstructive renal surgery with this approach is reported.

## KEYWORDS

scarless surgery, single port, laparoscopy, nephrectomy, pyeloplasty

## INTRODUCTION

Laparoscopic surgery is being increasingly used for a variety of ablative and reconstructive procedures of the urinary tract. Typically, major laparoscopic surgery involves the use of several (three to six), larger

(5 mm, 10/12 mm) ports inserted through commensurately sized skin incisions for tissue retraction, and the necessary triangulation of the surgeon's right- and left-hand instruments for the surgical dissection. Efforts are continuing to further reduce morbidity and improve the cosmetic outcome of laparoscopic surgery. These include the use of mini-laparoscopic 2 mm 'needle-ports' [1], use of natural orifices [2–5], and more recently, use of purpose-designed single port devices [6,7].

A novel single port device (R-Port, Advanced Surgical Concepts, Dublin, Ireland) was developed that allows the introduction of several (up to four), bent or curved laparoscopic instruments through one abdominal skin and fascial incision. To our knowledge, we report the initial clinical experience using this single port device inserted transumbilically for laparoscopic nephrectomy and pyeloplasty.

## PATIENTS AND METHODS

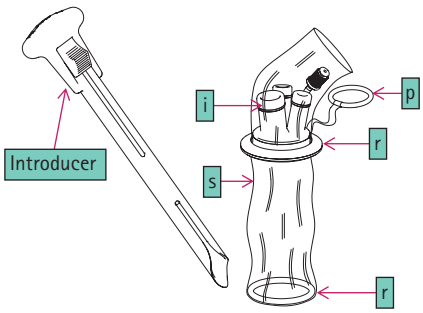
Both patients had surgery after obtaining institutional review board approval from the ethical committee of the local hospital, and informed patient consent.

The R-Port is a novel multichannel access system that allows simultaneous passage of several laparoscopic instruments through one incision. The device consists of a retractor and a valve (Fig. 1). The retractor consists of one internal ring and two external rings, and a doubled-over cylindrical plastic sleeve; the latter is attached to the inner of the two external rings and descends, circles the inner ring, and exits between the two outer rings. The valve component incorporates three or four inlets for introducing laparoscopic instruments and a separate port for insufflation. The valve contains a thermoplastic elastomer that allows the smooth introduction of instruments, including needles, with negligible air leak. The valve can be easily attached or removed from the retraction ring during specimen extraction. The three-inlet valve (Triport) has one inlet for a 12-mm instrument and two for 5 mm instruments. The larger version (Quadport) has two inlets for 12 mm and two inlets for 5 mm instruments.

To deploy the R-Port (Figs 2,3), the inner ring is pre-loaded onto a special un-bladed introducer. The introducer with the loaded inner ring is introduced through an incision into the abdominal cavity using either an open or closed access technique. An adequate fascial incision is made before introducing the port. The size of the fascial incision determines the number and size of instruments that the port can accommodate and will vary depending on the specific operative indication. The inner ring is ejected from the introducer by pressing a button and the introducer is carefully removed, thus deploying the inner ring in the abdominal cavity. The plastic sleeve is then pulled outward to remove all slack and the external rings are cinched towards the abdominal wall. This incremental retraction of the sleeve and cinching down of the external rings draws the inner and outer rings together on either side of the abdominal wall, thereby creating a tension in the sleeve between the rings that retracts the edges of the abdominal wall apart. The securely approximated rings via the plastic sleeve also creates an effective seal preventing gas leakage.

The first patient had a laparoscopic nephrectomy, and was a 28-year-old man who had had a left (ipsilateral) open pyeloplasty 6 years earlier, and now presented with recurrent, symptomatic obstruction and episodes of upper tract infection. His serum creatinine level was 1.0 mg/dL. A diuretic renal scan confirmed left PUJ obstruction with 9% differential function, and a normally functioning unobstructed right kidney. The patient provided consent for a single port laparoscopic left nephrectomy. The patient was placed in a 45° flank position for transperitoneal surgery. After Veress needle pneumoperitoneum, a 2-cm vertical skin incision was concealed completely within the umbilicus, and deepened to the anterior rectus fascia, where a 2.5-cm fascial incision was made, the peritoneum was incised, and the R-Port was deployed (Fig. 4). A 5-mm rigid 30° video-laparoscope (EndoEye, Olympus Medical, Tokyo, Japan) was inserted through one of the access port inlets. The other two inlets in the R-Port were used to insert working instruments for dissection. No extra-umbilical skin incisions were used. The various operative steps were similar to standard laparoscopic nephrectomy. The colon was mobilized by incising the line of Toldt, using a combination of 5 mm harmonic scalpel (Ethicon Endosurgery, Cincinnati, OH, USA) and 5 mm monopolar scissors dissection (Table 1). A specially designed 5 mm grasping forceps, bent at mid-shaft, was used by the surgeon's subordinate (left) hand for

*FIG. 1. Diagrammatic illustration of the R-Port. The R-Port consists of the retractor part that contains the rings (r) and pulley sleeve (s), that provides an effective seal and retracts the edges of the abdominal incision; and b, the valve part that provides three or four inlets (i) for introducing instruments. The port for insufflation (p) and ribbon to facilitate removal are also shown.*




tissue retraction (Fig. 5). The ureter was dissected laterally off the aorta, exposing the psoas muscle. This dissection was carried cephalad up to the renal hilum. The renal vein and artery were individually dissected and clipped using 10 mm Hem-O-Lok clips (Teleflex Medical, Research Triangle Park, North Carolina, USA). The ureter was clipped and transected, and the kidney was circumferentially mobilized within Gerota's fascia. The valve of the Triport was disconnected, the ring was released, and the specimen was extracted through the umbilical incision, with no extension of the intraumbilical skin incision (Fig. 6). Laparoscopic exit was completed.

The second patient, a 29-year-old man diagnosed with right PUJ obstruction, had a laparoscopic pyeloplasty. A diuretic renal scan identified 34% function of the right kidney with a $T_{1/2}$ of 45 min. After consenting for single port laparoscopic right pyeloplasty, a 4.7 F 26 cm JJ ureteric stent was inserted cystoscopically before starting the laparoscopic procedure. The Triport was inserted through a 1-cm umbilical incision after creating pneumoperitoneum. The 5 mm 30° video-laparoscope and monopolar scissors were inserted through two of the access inlets; the liver was retracted as necessary by inserting a 5-mm grasper through the third inlet of the Triport. A 2-mm needlescopic port was inserted at the left subcostal area through a skin needle puncture, with no skin incision. A 1.9-mm

*FIG. 2. Diagrammatic view of deployment of the R-Port. (a) The R-Port inner ring is pre-loaded into the introducer. The introducer is then inserted into the abdominal cavity through the umbilical incision. Note that the length of the fascial incision determines the number and size of instruments, as the plastic sleeve between the external and internal rings that constitutes the shaft of the 'port' is flexible. (b) Once within the abdominal cavity, the inner ring is released by pressing the trigger. (c) The abdominal seal and wound retraction is achieved by incrementally pulling on the sleeve in the outward direction and pushing the external ring in an inward direction until all slack on the plastic sleeve between the external and internal rings is removed.*

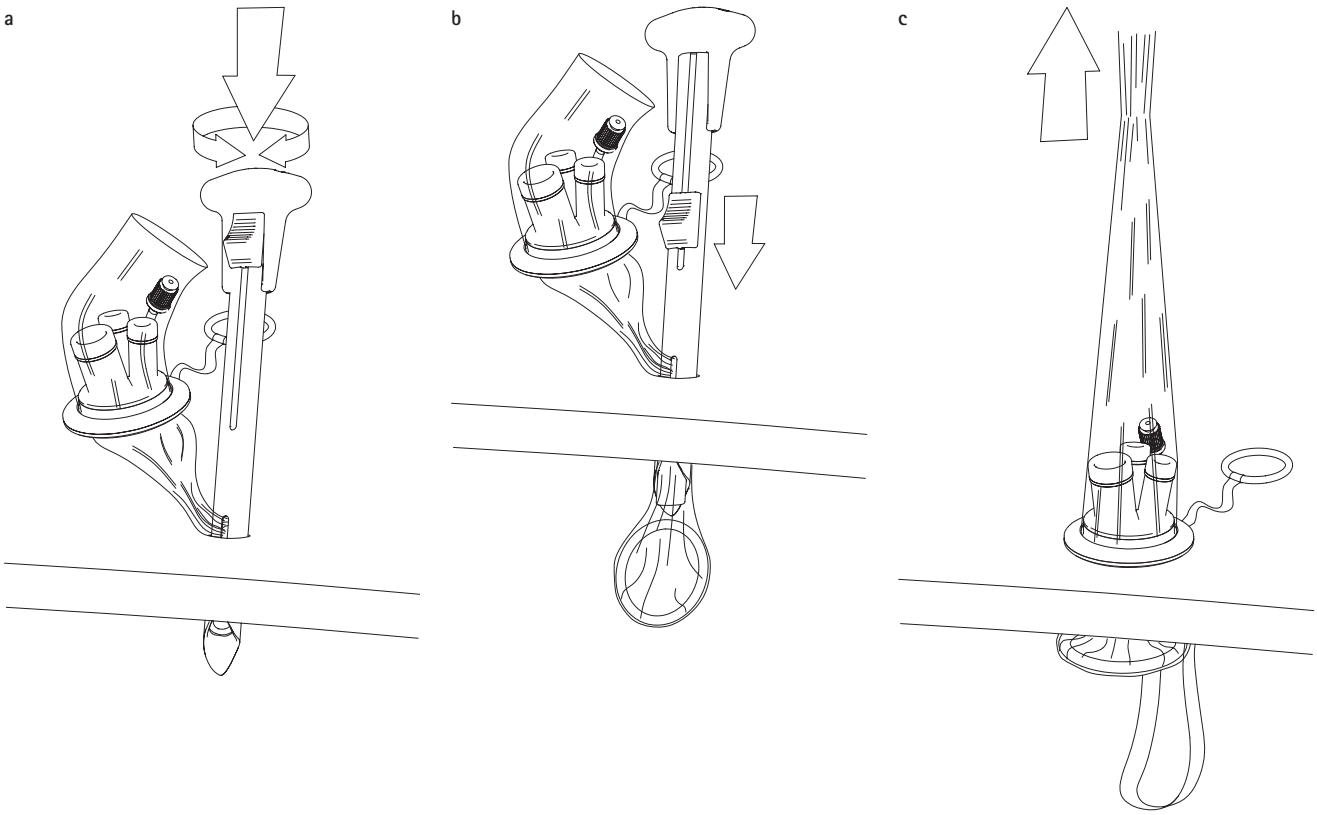



*TABLE 1 The instruments used*

| Procedure/instrument | Size, mm | Manufacturer |
|---|---|---|
| Laparoscopic nephrectomy | | |
| Triport | – | Advanced Medical Concepts |
| Curved instruments | 5 | Advanced Medical Concepts |
| Veress needle | 2 | USSC, Norfolk, CT |
| Harmonic scalpel | 5 | Ethicon Endosurgery |
| Grasper, monopolar hook | 5 | Karl Storz |
| Hem-O-Lok clips | 10 | Teleflex Medical |
| Laparoscopic pyeloplasty | | |
| Triport | – | Advanced Medical Concepts |
| Minisite port/Veress needle | 2 | USSC, Norfolk, CT |
| Harmonic scalpel | 5 | Ethicon Endosurgery |
| Grasper, monopolar hook | 5 | Karl Storz |
| Needle driver | 5 | Ethicon Endosurgery |
| Grasper | 2 | Microfrance |

needlescopic grasper was used through the 2 mm port to aid in retraction and triangulation for pyeloplasty suturing. The right colon was mobilized and the PUJ dissected using monopolar scissors inserted through the Triport. A crossing artery and vein were identified and mobilized completely from the PUJ. The PUJ was dismembered, the ureter spatulated, and uretero-pelvic anastomosis made with 5 mm straight needle driver (Ethicon Endosurgery) using two sutures of 4–0 polyglactin, one each for the anterior and posterior wall, respectively. A perinephric Penrose drain was exteriorized through the umbilical incision, and laparoscopic exit completed.

## RESULTS

Both procedures were successfully completed with no need for open conversion or for any extra-umbilical skin incision in either patient. As noted, a 2-mm needlescopic grasper was inserted through a Minisite port via a skin puncture as the left-hand suturing instrument for the pyeloplasty. For the nephrectomy all dissecting manoeuvres were done via instruments inserted through the R-Port. The perioperative data are summarized in Table 2. The total operative duration was 3.4 and 2.7 h, estimated blood loss was 100 and 50 mL, analgesia requirements were 100

*FIG. 3. (a) Diagrammatic representation of the deployed device. Note the airtight seal and nice retraction of the incision. Also note that the deployed device has a single well-retracted inner opening and no internal profile whatsoever. (b) Deployed device during transperitoneal nephrectomy.*

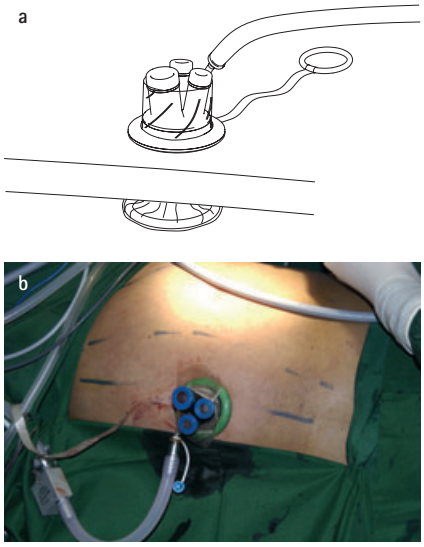



*FIG. 4. Intra-umbilical incision for the single port laparoscopic nephrectomy; the skin incision was 2 cm and the fascial incision was 2.5 cm.*

*TABLE 2 The demographics and perioperative data*

| Variable | Laparoscopic Nephrectomy | Laparoscopic Pyeloplasty |
|---|---|---|
| Age, years | 28 | 29 |
| Side | Left | Right |
| Body mass index, kg/m$^2$ | 28 | 25 |
| Indication | Nonfunctioning hydronephrotic kidney | Primary PUJ obstruction |
| Previous surgery | Open pyeloplasty | None |
| Incision site | Umbilicus | Umbilicus |
| Incision size, cm | 2 | 1 |
| Method of access | Open | Closed (Veress) |
| Ports | Triport, 2 mm Minisite port | Triport, 2 mm Minisite port |
| Operative time, min | 220 | 160 |
| Estimated blood loss, mL | 100 | 50 |
| Hospital stay, days | 1 | 2 |
| Analgesia requirements (mg ketorolac) | 100 | 150 |
| Visual analogue pain scale after surgery | | |
| 1 day | 8/10 | 8/10 |
| Discharge | 2/10 | 2/10 |

*FIG. 5. External view during transumbilical nephrectomy. The working instruments and digital videoscope are seen entering the R-Port.*

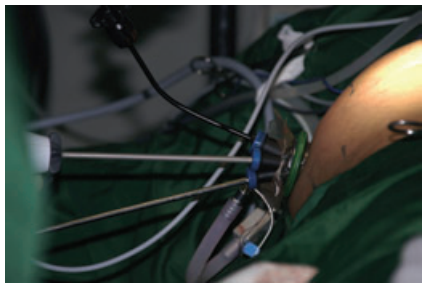
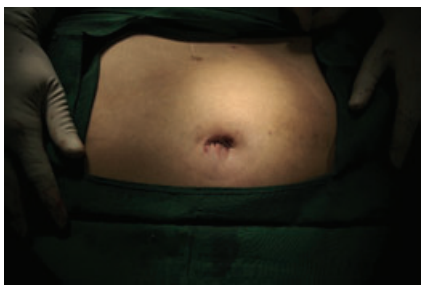


*FIG. 6. The completed transumbilical nephrectomy.*



and 150 mg ketorolac, and the hospital stay was 1 and 2 days for the laparoscopic nephrectomy and pyeloplasty, respectively. The operative duration for pyeloplasty included the time for cystoscopy and JJ stenting before the laparoscopic procedure. The visual analogue pain scales were 8/10 and 8/10 at 1 day after surgery, and 2/10 and 1/10 at discharge for the nephrectomy and pyeloplasty, respectively. There were no complications during or after surgery. Some air-leak occurred in the first patient in whom a 2.5-cm fascial incision was made. This problem was resolved by narrowing the incision with a suture in the first patient and by creating a smaller 1-cm umbilical incision in the second patient.

## DISCUSSION

In the last two decades there has been a change in surgical practice, with the increasing incorporation of minimally invasive laparoscopic/robotic procedures. Minimally invasive surgery aims to provide effective treatment of surgical diseases inside a body cavity, while decreasing access-related morbidity. The advantages of excellent visualization, decreased blood loss, less postoperative pain, quicker recovery, and superior cosmesis, coupled with oncological outcomes comparable to the open counterpart, have now been repeatedly reported for a wide array of minimally invasive procedures across many surgical specialities.

With increasing levels of comfort in the laparoscopic environment, there have been continuing attempts to further decrease access-related morbidity. This includes the incorporation of needlescopic instruments [1], natural orifice transluminal endoscopic surgery (NOTES), [2–5] and single port laparoscopy (SPL) [6,7] (Table 3).

We earlier reported partial incorporation of 1.9-mm needlescopic instrumentation in laparoscopic urological surgery [1]. These instruments can be passed through 2 mm needlescopic Veress needle ports that are about the diameter of a 16 G angiocath needle. The 2-mm trocars can be inserted with no need for a skin incision, do not require

*TABLE 3 The chronology of clinical reports on scarless surgery; NOTES and SPL*

| Year | Study | Category | Procedure | *n* | Comments |
|---|---|---|---|---|---|
| 2000 | [2] | NOTES | Pancreatic necrosectomy | 3 | Transgastric |
| 2004 | [3] | NOTES | Appendectomy | – | Hybrid transgastric with laparoscopic assistance |
| 2007 | [4] | NOTES | Cholecystectomy | 1 | Transvaginal. Used additional 2-mm needleport and needlescope |
| 2007 | [5] | NOTES | Cholecystectomy | 1 | Hybrid transvaginal with laparoscopic assistance |
| 2007 | [6] | SPL | Appendectomy* | 38 | Children. Single umbilical port. Separate percutaneously placed suture to 'sling' the appendix. Pedicle control with diathermy only |
| 2007 | [7] | SPL | Nephrectomy, 1†<br>Ureterolithotomy, 1<br>Orchidopexy, 1 | 3 | Use of R-Port |
| 2007 | Present | SPL | Pyeloplasty, 1<br>Nephrectomy, 1 | 2 | Trans-umbilical single port, 2 mm needlescopic instrument for pyeloplasty suturing |

**SPL with no use of a specialized device; †The nephrectomy was done through a 2-cm extra-umbilical incision positioned at the lateral border of the rectus abdominis, midway between the umbilicus and costal margin, using the R-Port.*

formal closure, and are associated with negligible scarring or pain.

There has been a recent interest in the use of NOTES for nephrectomy in an animal model; NOTES completely avoids abdominal wall incisions and attendant scarring. Therefore, the abdominal wall remains unviolated; however, intra-abdominal scarring is expected to be the same, as it depends on mobilization of the target organ, its adjacent viscera and parieties. In addition, NOTES is associated with the unique issue of achieving reliable closure of the iatrogenically created, controlled opening in the hollow organ of access, i.e. stomach, colon, vagina. As such, water-tight repair of the viscus of access is mandatory.

SPL involves the introduction of special multichannel access devices that allow laparoscopic surgery through one incision. By contrast with NOTES, a single port of laparoscopic entry into the abdomen is created, which can be cosmetically concealed, when appropriate, within the umbilicus. The R-Port is one such unique single-access device that is an offshoot of the design for hand-assist laparoscopic surgery. A few features of the R-Port design make it particularly suitable for SPL. The R-port uses a pulley and ring system that tightly cinches the abdominal wall in a self-retaining fashion, and creates an effective self-retaining seal for insufflation with no need for tacking sutures. The entire mechanism is flexible and therefore allows the passage of instruments with an exaggerated curve that cannot be inserted through conventional rigid laparoscopic ports. There is no internal profile, thereby allowing greater freedom of instruments. This feature is critical with SPL, as all instruments are closely 'packed' together, and the ability to constantly realign instruments relative to each other is of paramount importance. Purpose-designed curved, bent and/or articulating instruments are inserted through the two to four inlets of this single port device to perform the laparoscopic procedure. By contrast with NOTES, no deliberate viscerotomy is created, eliminating the need for this often difficult visceral closure, and potential complications thereof, such as leakage from a gastrotomy or colotomy. Also, locating the single port within the umbilicus eliminates any visible scarring. Advocates of NOTES and SPL also argue that the potential for intra-abdominal adhesions will be decreased. However, this remains unconfirmed and to us, doubtful.

Thus we report, to our knowledge, the first clinical report of a totally 'scarless' nephrectomy and pyeloplasty with the incision completely concealed within the umbilicus, using a single-access trocar with no extra-umbilical incisions. The procedures were technically successful, albeit taking longer than expected for their traditional laparoscopic counterparts.

Certain technical caveats of SPL require consideration. The parallel and close lie of the right- and left-hand instrument shafts tends to result in 'crowding' of the laparoscope and instruments. Although this problem is partly offset by the prototype instruments that have varying curvatures or bends in the shaft, dissection through a single port is more difficult than in conventional multi-port laparoscopy. To overcome this, the instrument shafts are frequently crossed at the point of entry into the valve, such that the external right-hand instrument becomes the left instrument internally, and vice-versa. As such, intraoperative dissection might sometimes be done with the left hand, requiring ambidexterity on the part of the surgeon. For right-sided renal surgery, we were able to achieve necessary retraction of the liver by selective use of a 5-mm grasper inserted through the third inlet of the Triport, and maintained in place by the first assistant. Fixed tissue retraction of the kidney and peri-renal fat was achieved by retention sutures anchored to the lateral parietal peritoneum. Absence of a separate venting channel for intra-abdominal smoke slows the procedure somewhat.

Selective use of 2 mm needlescopic instruments facilitates SPL, especially intracorporeal suturing, which is otherwise hampered by the loss of triangulation. This 2 mm Minisite port does not require a skin incision for introduction, and thus requires no formal closure. We previously reported that use of needlescopic ports has no cosmetic sequelae and does not increase the morbidity.

Currently single port procedures are somewhat cumbersome, and additional work remains before these techniques achieve the level of standardization that is now established for conventional laparoscopy.

Robust flexible articulating instruments and high-illumination, high-magnification flexible endoscopes, as well as free-standing insertable retractors, will need to be developed. Combining the two methods of NOTES and SPL, such that a tri-lumen single port can be used through a natural orifice (vagina), could maximize the benefits of the two techniques. Introducing robotically controlled flexible instruments inserted through the single port might be the ultimate answer to facilitate technical performance.

Is there any substantial advantage of SPL or NOTES over conventional laparoscopy and robotics? There might be an apparent psychological and cosmetic benefit, and decreased postoperative pain, but much work remains to address these issues and determine their true role in minimally invasive surgery.

In conclusion, we report the initial experience of organ-ablative and reconstructive renal surgery using a single transumbilical port. No extra-umbilical incisions were used; both procedures were completed successfully within a reasonable time, with no complications, and the patients recovered quickly. We think that continuing advances in single port technology will improve in the near-term.

## CONFLICT OF INTEREST

Pradeep P. Rao is a Study Investigator funded by the Sponsor. Devices were provided free of charge by Advanced Surgical Innovations Inc.

## REFERENCES


1 **Soble JJ, Gill IS.** Needlescopic urology: incorporating 2 mm instrumentation in laparoscopic surgery. *Urology* 1998; **52**: 187–94

2 **Seifert H, Wehrmann T, Schmitt T *et al.*** Retroperitoneal endoscopic debridement for infected peripancreatic necrosis. *Lancet* 2000; **356**: 653–5

3 **Reddy N, Rao P.** Per oral transgastric endoscopic appendectomy in human. *Presented at the 45th Annual Conference of the Society of Gastrointestinal Endoscopy of India*;February 28–29, 2004; Jaipur, India

4 **Marescaux J, Dallemagne B, Perretta S, Wattiez A, Mutter D, Coumaros D.** Surgery without scars: report of transluminal cholecystectomy in a human being. *Arch Surg* 2007; **142**: 823–6

5 **Bessler M, Stevens PD, Milone L, Parikh M, Fowler D.** Transvaginal laparoscopically assisted endoscopic cholecystectomy: a hybrid approach to natural orifice surgery. *Gastrointest Endosc* 2007; [Epub ahead of print]

6 **Ates O, Hakguder G, Olguner M, Akgur FM.** Single port laparoscopic appendectomy conducted intracorporeally with the aid of a transabdominal sling suture. *J Pediatr Surg* 2007; **42**: 1071–4

7 **Rane A, Rao PP, Rao SP, Bonadio F, Rao PP.** Clinical evaluation of a novel laparoscopic port (R-Port™) in urology and evolution of the single laparoscopic port procedure (SLAPP). *J Endourol* 2007; Abstract BR6-01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Abbreviations: **NOTES**, natural orifice transluminal endoscopic surgery; **SPL**, single port laparoscopy.