

Laparoendoscopic single site in pelvic surgery

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ABSTRACT

Laparoendoscopic single site (LESS) has recently gained momentum as feasible techniques for minimal access surgery. Our aim is to describe the current status of laparoendoscopic single site (LESS) in pelvic surgery. A comprehensive revision of the literature in LESS pelvic surgery was performed. References for this manuscript were obtained by performing a review of the available literature in PubMed from 01-01-01 to 30-11-11. References outside the search period were obtained selected manuscript's bibliography. Search terms included: pelvic anatomy, less in gynecology, single port colectomy, urological less, single port, single site, NOTES, LESS and single incision. 314 manuscripts were initially identified. Out of these, 46 manuscripts were selected based in their pelvic anatomy or surgical content; including experimental experience, clinical series and literature reviews. LESS drastically limit the surgeon's ability to perform in the operative field and the latter becomes hardened by the lack of space in anatomical location like the pelvis. Potential advantages of LESS are gained with the understanding that the surgical procedure is more technically challenging. Pelvic surgical procedures related to colorectal surgery, gynecology and urology have been performed with LESS technique and information available is mostly represented by case reports and short case series. Comparative series remain few. LESS pelvic surgery remain in its very beginning and due to the very specific anatomical conditions further development of LESS surgery in the mentioned area can be clearly be facilitated by using robotic technology. Standardization and reproducibility of techniques are mandatory to further develop LESS in the surgical arena..

Key words: Laparoendoscopic single site surgery in gynecology, LESS and single incision, natural orifice transluminal endoscopic surgery, pelvic anatomy, single port colectomy, single port, single site, urological LESS

INTRODUCTION

The pelvic cavity hosts a number of important organs that are suitable to receive surgical treatment for both benign and malignant diseases. Laparoscopic surgery is increasingly used as an alternative to laparotomy and more recently the evolution of surgery has brought up the concept of laparoendoscopic single site surgery (LESS).^[1] Patient selection for LESS surgery must be optimized by examining factors involved in both the choice of surgical approach, available instruments that are needed to perform the surgery, and the ultimate procedure performed.^[2,3]

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Pelvic anatomy: Roadmap for laparoendoscopic single site surgery

The surgical procedures performed in the pelvic cavity, from the sacral promontory to the insertion of the levator ani muscle, are challenging operations, where both experience and surgical skill play an important role. Experience in rectal oncological surgery has validated the relationship between the difficulty of surgical performance and pelvic space. Besides, in classic laparoscopy or LESS, there is a restriction imposed by the two-dimensional view of the endoscopic field. The presence of multiple factors such as a large prostate or uterus, narrow pelvis, and shallow sacral angle will definitively impact surgical therapeutics, as these will translate into lack of maneuvering space and inefficient count traction turns. Unsatisfactory surgical outcomes may naturally occur under such conditions.^[4,5]

In Urology these extreme conditions could become even more difficult because, as demonstrated by Targarona *et al.*,^[6] male patients tend to have deep, narrow, shallow pelvis angles. They reported males to have a significantly narrow bony pelvis compared to female patients, from various points of pelvic measurement. Counter traction is important for successful surgery, as adequate traction of the structures provides better visibility, with surgical exposure

of the anatomic structures involved in the operation, such as the so-called neurovascular bundle, in the case of radical prostatectomy. Another factor is surgical space. In a shallow concave sacrum or with a narrow intertuberous diameter it is very difficult to expose adequate planes and perhaps even more difficult to perform intracorporeal suturing, which is an essential part of reconstructive pelvic procedure. The latter explains the low percentage (7.8%) of pelvic LESS procedures, coined worldwide, between 2007 and 2010, as urological LESS.^[7] Pelvic LESS surgery is at its infancy and there is a lot of work pending in order to further develop the technique.

Coined experience in laparoendoscopic single site pelvic surgery

Colorectal surgery

The field of colorectal surgery has slowly deployed LESS into their Operating Rooms. The technique has been received with a rather strong opposition from surgeons, considering that only a highly selected population of patients can actually benefit from it.^[8] The access technique was first described in 2007 for colorectal resection procedures and large series were few. Initially, case reports and series of LESS colectomy have reported feasibility and safety of this approach.^[9-14]

Geisler and Garret recently presented a series 102 patients who underwent LESS colorectal procedures. Procedures included total colectomies, segmental colectomies, and miscellaneous procedures. There was one conversion to open surgery and 18 patients required placement of additional ports during the operation. The authors reported an average operating time of 99 minutes, and the average blood loss was 140 ml. There was one postoperative death, and 39 patients experienced minor postoperative complications.^[15] Papaconstantinou and Thomas,^[16] presented a comparison of two groups of 26 patients undergoing LESS or classic laparoscopy colectomy for cancer. The series included eight sigmoid colectomies. Oncological resection was adequate and disease-free survival at one year was 92% for both groups. Van den Boezem and Sietses also reported the outcomes of their first 50 LESS colorectal operations, including 16 sigmoid resections, nine low anterior resections, and five total colectomies. The mean operative time was 130 minutes, and the median hospitalization period was six days. A minor complication included wound infections and incisional hernias.^[17]

Gynecology

Gynecological surgeons pioneered pelvic LESS surgery, as thousands of tubal ligations were performed using single-incision laparoscopes with an offset eyepiece.^[18] Also, a single incision hysterectomy with bilateral salpingo-oophorectomy was described by Pelosi and Pelosi.^[19] It is worth mentioning that hysterectomy is one of the procedures uniquely suited to LESS because of the possibility of manipulating the

uterus transvaginally, therefore, obviating the need for a retractor.^[20]

Adnexal surgery for benign disorders including salpingo-oophorectomy, adhesiolysis, endometriosis treatment, and ovarian cystectomy have been reported as feasible and adequate, but technically challenging, due to difficulty in achieving optimal traction-countertraction.^[21,22] Yim *et al.* have published a remarkable retrospective comparison of 52 LESS hysterectomies compared to 101 conventional procedures. The LESS arm showed a benefit in terms of blood loss, hospital stay, and pain scores.^[23] The LESS has been also used for the treatment of early-stage endometrial or ovarian cancer, pelvic masses, pelvic lymph node dissection, and precancerous gynecological conditions, with low perioperative complications (3.5%) and optimal results. Obesity has been described as a limiting factor for these procedures.^[24,25]

Urology

Laparoendoscopic Single Site Pelvic Surgery has gained popularity in Urology in the last few years and an important piece of information has been put together by Kaouk *et al.* in a large multi-institutional worldwide series.^[4] Looking at this timely manuscript, we verify that out of 1076 patients, only 85 cases (7.8%) belong to the LESS pelvic surgery. Furthermore, the period of a strong development for these procedures has been defined as being from 2009 to 2010. Sotelo *et al.*, described and demonstrated the technical feasibility of the surgical technique of LESS simple prostatectomy using a transperineal R-port through a 2.5-cm intraumbilical incision. The total operative time was 120 minutes and estimated blood loss was 200 ml, and no complications occurred [Figure 1a,b]. They extracted an adenoma of 95 g and at a three-month follow-up, the patient was completely continent and voiding spontaneously with a Q(max) of 85 ml / s. This initial experience was further expanded and reported, with adequate results.^[26,27]

Desai *et al.* reported that transvesical enucleation of the prostate was completed in all 34 cases with a mean operative time of 116 minutes and a blood loss of 460 ml. The authors reported two deaths in the series and complications such as, bowel injury, bleeding and epididymo-orchitis. Functional outcomes were reported as satisfactory.^[28] More recently, a combined approach featuring bipolar enucleation and LESS surgery was applied to surgically treat benign prostatic hyperplasia (BPH). Rao *et al.* treated five patients with prostates with an average weight of 114 g. The operative time ranged from 45 – 180 minutes^[29] [Figure 2]. An experimental robotic natural orifice transendoscopic surgery (R-NOTES) was also completed by Desai *et al.* on two human cadavers, utilizing a transvesical approach.^[30] Another interesting case is a NOTES radical prostatectomy (RP) performed transvesically on a cadaver model. The entire resection was performed with a laser. A rigid, offset 27 F nephroscope was

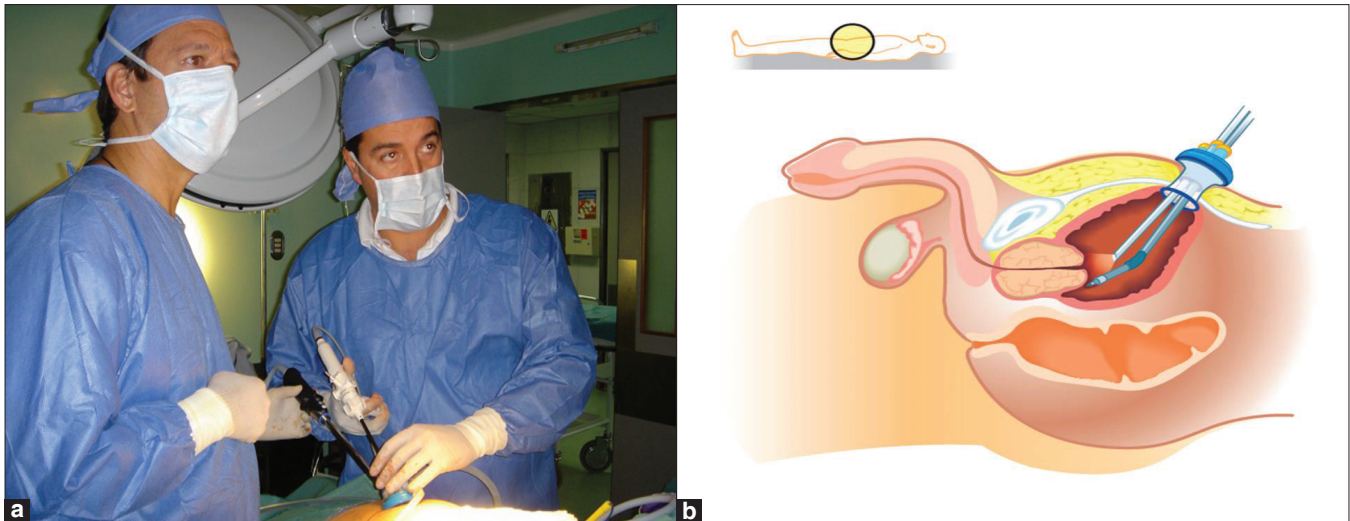


Figure 1: (a) Transvesical LESS adenectomy, surgical performance. Source: CIMI, Instituto Médico La Floresta, (b) Transvesical LESS adenectomy, Schema showing the inside vision of the procedure. Source: CIMI, Instituto Médico La Floresta

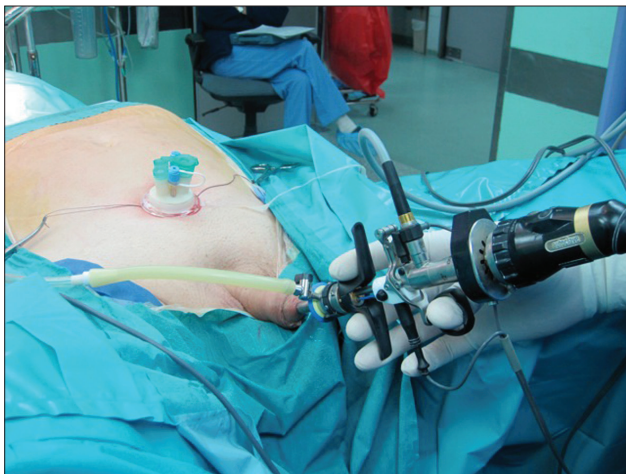


Figure 2: Hybrid adenectomy, LESS and endoscopic surgery combined. Source: CIMI, Instituto Médico La Floresta

then used to perform vesicourethral anastomosis using a laparoscopic suture device and knot pusher, in an interrupted fashion.^[31] Barret *et al.* then described a LESS-RP completed on a cadaveric model. The technique was then transitioned to a human patient using the robotic interface. R-LESS-RP was performed on a patient with a T1c prostate tumor. The procedure was performed with the daVinci® Standard interface and normal robotic trocars and instruments. The total operative time was 210 minutes, with an estimated blood loss was 300 mL, and negative surgical margins. No perioperative complications were observed.^[32]

Kaouk *et al.*^[33] presented a series of single-port laparoscopic RP in four patients diagnosed with prostate cancer. They treated patients with localized disease, no previous pelvic surgery, and a body mass index < 35 kg / m². All the cases were completed without conversion to a standard laparoscopic approach. The mean operative time for prostate excision and urethrovesical anastomosis was 3.25 hours

and 1.1 hours, respectively. The mean blood loss was 288 ml, and no patient required a blood transfusion. Kaouk *et al.*^[34] also presented a previous experience of R-LESS-RP, using the R-port with adequate results. Gaboardi *et al.* have presented their initial experience with LESS RP using a periumbilical multichannel port with an additional port. All cases were completed successfully with a mean operative time of 225 minutes, mean blood loss under 100 ml, and no intraoperative complications.^[35] Bachiller-Burgos *et al.* reported their initial experience in LESS RP using two lateral 5 mm trocars for triangulation. The operative time was 210 minutes with a blood loss of 200 ml.^[36] Leewansangtong *et al.* performed R-LESS-RP on a 71-year-old man with the da Vinci® S robotic system. They reported an operative time of 335 minutes, with an estimated blood loss of 250 ml and no intraoperative or postoperative complications.^[37]

White *et al.* described their surgical technique and reported their early outcomes. They operated on 20 patients, with a mean age of 60 years. Single-port access was accomplished through a multichannel port. The da Vinci® S and da Vinci® Si surgical platforms were used, with pediatric and standard instruments. They reported a mean operative time of 189.5 minutes and mean estimated blood loss of 142.0 ml.^[38]

A series of radical cystectomies were also presented by Kaouk *et al.*^[39] All procedures were performed transumbilically, with extracorporeal diversion. Mean operative time was 315 minutes with a blood loss of 217 ml. The oncological outcomes have been verified as adequate, at 2 years of follow-up.

The pelvic region as the zone of entry for Laparoendoscopic Single Site – Natural Orifice Transluminal Endoscopic surgery

Closely related to LESS, NOTES involves the intentional

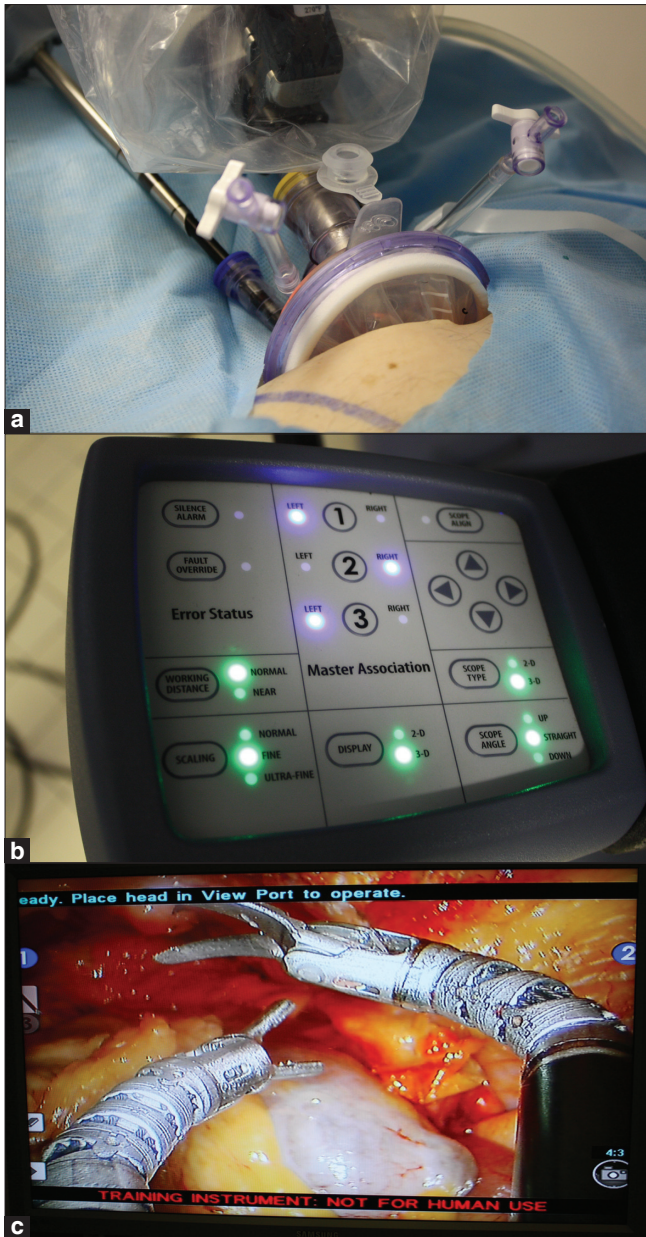


Figure 3: (a) Experimental cadaveric experience with Quadriport+ (Olympus Europe, Hamburg) ducked to the da Vinci S (Intuitive systems, Sunnyvale, Cal, USA). Source: Institut Montsouris and Ecole Europeen de Chirurgie, (b) Inversion of the robotic arms control from the robotic console. Da Vinci S (Intuitive systems, Sunnyvale, Cal, USA). Source: Institut Montsouris and Ecole Europeen de Chirurgie, (c) Inside view of the alignment of robotic instruments, when ducked for pelvic LESS surgery in the Quadriport+ (Olympus Europe, Hamburg). Source: Institut Montsouris and Ecole Europeen de Chirurgie

penetration of hollow viscera with an endoscope, in order to access the abdominal cavity and perform an intra-abdominal operation.^[40] In 2002, Gettman reported the first experience with NOTES, performing transvaginal nephrectomies in pigs.^[41] The initial clinical experience in NOTES was performed by Antony Kalloo, in a transgastric surgery, in 2004.^[42] The pelvic region is not the site of surgery, but it has also been explored as the point of access for LESS surgery aimed to be performed outside the

pelvic boundaries. Procedures like cholecystectomy are performed with transvaginal access with excellent results and the benefit of outstanding cosmesis.^[43] Lima *et al.* have also presented a combined approach in an experimental setting, in which they installed a transvesical tube into the peritoneal cavity under cystoscopic guidance; and a flexible gastroscope was passed orally into the peritoneal cavity via gastrotomy.^[44] Crouzet *et al.* described a transvaginal renal cryoablation in a porcine model, accomplished without complications.^[45] Clayman *et al.* also reported a transvaginal NOTES nephrectomy in a porcine model, utilizing a TransPort™ flexible platform with four working channels that could be locked into a rigid position. This was a hybrid NOTES procedure, as a 12-mm port was placed at the umbilicus for endoscopic stapling of the hilar vessels.^[46] Isariyawongse *et al.* completed a porcine transvaginal NOTES nephrectomy, utilizing endoscopic stapling through a vaginal trocar, with triangulated vision and retraction provided by a transgastric endoscope.^[47] More recently, Haber *et al.* presented their experience with four nephrectomies in the porcine model, using the pure NOTES transvaginal technique. The procedure was verified as feasible and the authors stated the need for further development of instrumentation.^[48] Perhaps the most developed surgical procedure performed using the NOTES technique was nephrectomy; Alcaraz *et al.* from Spain,^[49-51] have coined an interesting experience that should be highlighted, because this is how NOTES surgery was initially explored. Horgan *et al.* recently presented an interesting experience with transvaginal cholecystectomies and appendectomy, with excellent results.^[17]

Robotic technology: overcoming space limitation with dexterity and tridimension

The conflict in LESS surgery is defined by the loss of instrument triangulation and instrument clashing. This problem is even more difficult to overcome in an unfavorable surgical field like the male pelvis. For those operations one would need to have instruments with an augmented mobility and improved vision of the surgical field, thus making the surgeon work in a comfortable environment, without struggling to complete the procedure. Technical challenges of LESS that may limit its widespread acceptance can be addressed by using robotic technology. Da Vinci® endo-wrist technology and further refinement of robotic instruments for use with LESS may render obsolete the long-held laparoscopic principle of triangulation. Modifications to the current da Vinci® Si surgical platform and software for robotic LESS have been utilized to perform renal surgery in a porcine model.^[52] Robotic LESS is the path to overcome surgical difficulties in a limited space, however, more experience should be coined with the robotic device in the experimental setting. We could say that LESS pelvic can be easily tackled with the robot. Improved ergonomics and vision define robotics as the ideal allies to further develop LESS, not only in the pelvic area, but in the whole surgical field [Figures 3a-c].

CONCLUSION

Laparoendoscopic single site surgery drastically raises difficulties to surgically perform in anatomical locations like the pelvis. The LESS pelvic surgery is more technically challenging. Pelvic surgical procedures related to colorectal surgery, gynecology, and urology have been performed with the LESS technique, and the information available is mostly represented by case reports and short case series. The comparative series remain few. The LESS pelvic surgery remains in its infancy and further development can be facilitated with robotic technology.

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