SURGICAL TECHNIQUE

Laparoscopic radical cystectomy with orthotopic ileal neobladder through umbilical single port

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Abstract
Context: Radical cystectomy with orthotopic derivation is one of the most complex urological techniques, although laparoscopic surgery has made this procedure increasingly less invasive. Objective: To provide an updated review of the single port approach to carry out radical surgery due to bladder cancer.
Evidence acquisition: A comprehensive review of the literature was performed using Medline and Embase to discover the accumulated experience of the viability of carrying out laparoscopic radical cystectomy, pelvic lymphadenectomy and orthotopic neobladder using the LESS (laparoscopic single site surgery) approach. Our experience with this approach is also presented and the technique used with the reusable KeyPort® system developed by Richard Wolf is described.
Evidence synthesis: Radical treatment of bladder cancer is possible in men and women using a single port and even performance of ileal neobladder, as reconstructive procedure in these patients. The surgical technique, post-operative cares and result obtained in our center are described. The accumulated experience worldwide describes 25 cases of radical cystectomy performed using different single port systems, 14 of them with orthotopic intestinal neobladder.
Conclusion: The KeyPort® umbilical cystectomy constitutes in our setting the least possible invasive alternative to efficiently treat muscle-invasive bladder cancer, with excellent esthetic result, minimum post-operative pain and short hospital stay. The umbilical scar decreases the analgesic requirements and it ends up being practically invisible. This supposes an important step in the development of the minimally invasive surgery for bladder cancer.
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Introduction

Bladder cancer is the most common of all genitourinary malignancies. Spain is one of the territories of Western Europe which has the highest incidence for this disease, especially in men.1 Radical cystectomy remains the preferred therapeutic option to treat patients with muscle-invasive urothelial carcinoma of the bladder.2 Radical surgical removal of the bladder must be included, within the standard limits, and the thorough exeresis of pelvic lymph nodes as well.

Although the dilemma of which is the best form of urinary diversion is not closed, an orthotopic bladder substitute must also be offered, whenever possible.4 This requires that there is no tumor at the edge of the urethral resection.5 Complete removal of all possible extravesical tumor extension and of the terminal ureteral segment must also be carried out.

All studies support the simultaneous removal of pelvic lymph nodes. In fact, retrospective studies have demonstrated that extended lymphadenectomy is a therapeutic element that improves survival of the patients, and that the number of lymph nodes obtained means even a prognostic predictor.4,5 In this sense, pelvic lymphadenectomy performed through laparoscopic approach at the time of laparoscopic radical cystectomy has shown the same excisional benefit in terms of the number of nodes removed as conventional lymphadenectomy.6

Preservation of the anterior and membranous urethra, which includes the rhabdosphincter, makes the performance of an orthotopic neobladder possible. The preservation of sensory and autonomic pelvic nerves will improve surgical outcomes, in terms of both continence and power. The best nerve sparing is achieved by deliberately leaving the seminal vesicles, with or without the prostatic capsule. However, this decision must be properly balanced with the patient, and the oncologic risk needs to be considered in every case.2,7

Both laparoscopic radical cystectomy and laparoscopic robotic-assisted cystectomy are feasible alternatives.6,8,9 The current recommendation about their use remains in the hands of surgeons experienced in these techniques, also taking into account the patient's condition, the size of the tumor, and the type of diversion chosen. The possibility of performing laparoscopic or robotic intestinal neobladder is a difficult procedure of which few series are available.10,11 There really is important reluctance of academic centers to consider that laparoscopic and/or robotic surgery are the gold standard of care in this type of patients,12,13 although in recent years, this field is progressing significantly.

Possibly, the last of the advances is the performance of radical surgery for bladder cancer through single port systems, which can be coupled to the natural scar that is the navel (E-NOTES), the main embryonic natural orifice of our economy. The umbilical-approach scar is totally hidden from view, which in a few weeks makes a cosmetic impression of an "incisionless" scar.

Evidence acquisition

An extensive review of the literature was performed using Medline and Embase from 1993 to 2011. The questions

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concerning the search were bladder cancer and laparoendoscopic surgery through single port (LESS), including radical cystectomy, pelvic lymphadenectomy, and orthotopic ileal neobladder. Year 1993 was chosen because it was the time when the first vaginal removal of an intact kidney after laparoscopic radical nephrectomy was described, this being the major milestone of the development of transluminal endoscopic surgery through natural orifices. In 1999, laparoscopic cholecystectomy was systematized without any incision outside the umbilicus. In 2007, a laparoendoscopic approach was first used in Urology through the placement of a single port on the side to perform nephrectomy of a non-functioning atrophic kidney.

The search focused on identifying all the procedures related to pelvic surgery, and more specifically, to the urinary bladder surgery, performed through LESS approach. Only 7 articles specifically refer to this type of surgical approach for patients with bladder cancer, none of them in Spanish. Our group has extensive experience in the laparoscopic approach of bladder cancer. We have recently carried out radical cystoprostatectomy with lymphadenectomy through the navel using the Keyport system and extracorporeal ileal neobladder in a patient with muscle-invasive bladder cancer with excellent results. The updated global experience with this type of approach is, thus, described.

Evidence synthesis

Experience in the literature

The first mention in the literature of patients treated by LESS radical cystectomy is the analysis of the first 100 cases of laparoendoscopic surgery performed at the Cleveland Clinic, which was published by White et al. in 2009. This description consists in carrying out a record of surgeries that can be performed successfully by LESS. Radical cystectomy represents 3% of the total indications and less than 9% of all pelvic surgeries. Other procedures performed were sacrocolpopexy, radical prostatectomy, varicocoelectomy, and ureteral reimplantation. The authors noted that this type of surgery was feasible and that the complication rate did not appear increased. A better cosmetic result and less postoperative pain were the main findings of the global series.

The same three patients were described by Kaouk et al. in 2010 as a specific series of LESS radical cystectomy and bilateral pelvic lymphadenectomy. They were 2 men and 1 woman. The system used was the Uni-X single port (Pnavel Systems, Brooklyn, NY) consisting of a three-light valve system that accommodates three 5-mm laparoscopic instruments, along with an insufflation port. Through this port, instruments like flexible monopolar scissors (CambridgeEndo, Framingham, MA), and a 5-mm flexible laparoscope (Olympus Surgical, Orangeburg, NY) were used. The authors stated that in no case was there locally advanced disease, and patients with previous abdominal surgery and/or radiotherapy, and patients who wanted orthotopic bladder substitution were also excluded. All the procedures were carried out using pure LESS, without need for additional port. Extraction of the specimen and performance of the ileal conduit were performed by extending the umbilical port incision to 5 cm and the use of a wound protector. The mean blood loss was minimal and no patient required transfusion. The mean surgical time was 315 ± 40 min. A mean of 16 ± 3 nodes was removed per patient. The visual analog scale for pain was 0–1 (out of 10) in the three patients. All were discharged within 1 week. Histopathological examination of the specimen revealed a stage pT2pN0 (2 patients; one with incidental prostate adenocarcinoma Gleason 3 + 4) and pT0pN0 (1 patient). All the patients were free of disease with a follow-up of 24–26 months. This preliminary experience heralded that the procedure was feasible in selected cases; however, none of the patients received an orthotopic neobladder (Table 1).

The global record of urological LESS published by Kaouk et al. in 2011 includes the three cases that were conducted in the period 2007–2008 and other three cases performed in 2009–2010. No data are provided on the type of urinary diversion, or the operating parameters or complications obtained in the latter three cases. Indirect experience shows that the indication for LESS radical cystectomy has not grown among the authors in this contributor group. In fact, this surgery is only 0.5% of the published record and it has not shown a tendency to grow over time (p = 0.83). From a global perspective, it has even been a detriment, since it was performed in 1.28% of the patients operated in 2007–2008 and in 0.35% of those operated in 2009–2010.

Very recently, several very interesting experiences from Chinese authors, who are generating renewed interest in the issue, have entered this stage of LESS radical cystectomy. It is the experience of the centers Zhujiang Hospital (Southern Medical University, Guangzhou), Memorial Hospital (Sun Yat-sen University, Guangzhou), and Peking University Third Hospital (Beijing). These authors have published the description of a total of 18 new cases. The urinary derivation used was varied: cutaneous ureterostomy (2 cases), ileal conduit (3 cases), sigmoid neobladder (1 case), and ileal neobladder (12 cases) (Table 1). In 4 of the 12 cases described by Lin et al., nerve sparing, which was successful in two patients (one spontaneously and another one with the aid of PDE-5 inhibitors), was conducted.

The experience of the institutions in Guangzhou has opted for the preparation of orthotopic bladder reservoirs, mostly using an ileal segment that is performed extracorporeally. The Beijing experience, however, prefers incontinent derivations (ureterostomy or ileal loop). In these cases, the operative time is reduced significantly. The system used by all the Chinese authors has been a home-made system performed with a latex glove size 7½ and two compressible rings, or an inverted conical polycarbonate. These glove systems allow for a multichannel approach with three or four independent elements, since the fingers of the gloves are cut and fixed to the trocars (two 12 mm and one 5 mm, respectively) using a knotted suture. Thus, a 10-mm and 30° lens, along with conventional laparoscopic instruments, is used. Valves with plastic closure to allow passage of instruments through the glove fingers can also be performed. CO₂ insufflation creates a tension which enables the device to be secure.
### Experience at our center

We present the case of a 64-year-old male with high-grade muscle-invasive urothelial carcinoma. Radical cystectomy with orthotopic derivatization was carried out through a single-port Keyport system placed in the navel with a 2.5-cm incision in the transverse direction (Fig. 1). We performed other surgeries at our center with this system quite satisfactorily. They all achieved an excellent esthetic result, and the postoperative pain was significantly lower than that of open surgery and even that of conventional laparoscopy. The transumbilical use of this system hides the surgical scar in the navel, giving the final appearance of a scar-free surgery. An auxiliary 10-mm port is placed in the right iliac fossa to facilitate the neovesicourethral anastomosis and for placement of a peritoneal drainage and bilateral urinary derivation (urinary derivation catheters) that are externalized through the same trocar.

The patient is placed in the Trendelenburg position. The surgeon takes the curved work instruments with dual rotating system (scissors in the right hand, and grasper in the left hand) while the assistant carries the camera with his left hand and the accessory trocar with his right hand (Fig. 2). Surgery begins with the opening of the parietal peritoneum. Then, the ureters are identified and dissected. The opening of the pouch of Douglas and dissection of the seminal case are performed. We show the dissection of the right side in detail (Fig. 3A).

Hem-o-lok ligation and right ureter section are performed. The superior vesical pedicle and vas deferens are also identified and ligated with Hem-o-lok. Hemostatic control of the seminal pedicle with 10-mm Ligasure is carried out. The same maneuver is repeated on the other side to, then, develop the space of Retzius to the prostatic apex, and hemostasis of the plexus of Santorini is performed. Finally, the urethra and the urethral rectus muscle are sectioned on the posterior plane.

We proceed to perform obturator and pelvic to common iliac lymphadenectomy, showing ilioinguinal nerve. It again shows an image corresponding to the dissection of the right side (Fig. 3B). The lymphadenectomy specimen is removed.

The intestinal loop is marked with a reference point 15 cm from the ileocecal valve, which will help at the time of selection of the intestinal segment. We proceed to bagging the cystectomy specimen, which is extracted with cross-shaped minimal enlargement of the hole performed in the rectus muscle (Fig. 4A). Then, the umbilical hole is also slightly extended, making a small perpendicular midline incision and disposable disc is placed to facilitate exposure of the ureters and bowel outside the navel (Fig. 4B). The intestinal segment that will serve to perform the neobladder is identified. The intestine is cut and we proceed to the ileo-ileal anastomosis with mechanical sutures (Fig. 4C). Later, the intestine is detubularized and the reservoir is constructed with straight needle absorbable suture (Fig. 4D). The ureters are anastomosed to the effenter loop in isoperistaltic direction and closure of the neobladder, which acquires spherical shape leaving a distal hole that will anastomose to the urethral end, is completed.

The neobladder is introduced into the pelvic cavity to then re-enter the Keyport system, which now requires adaptation to the extended closure by means of a circular suture.

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#### Table 1

<table>
<thead>
<tr>
<th>Author (reference)</th>
<th>Year</th>
<th>n</th>
<th>pT (n/%)</th>
<th>Surgical T (min)</th>
<th>Bleeding (cm³)</th>
<th>Stay (days)</th>
<th>Type of urinary diversion</th>
<th>Complications</th>
<th>Follow-up (months)</th>
</tr>
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<tr>
<td>White et al. (2009)</td>
<td>3</td>
<td>γT3(2)</td>
<td>2.7</td>
<td>15</td>
<td>NA</td>
<td>NA</td>
<td>Ileal conduit (3)</td>
<td>Transfusion (1)</td>
<td>2-26</td>
</tr>
<tr>
<td>Koop et al. (2010)</td>
<td>3</td>
<td>NA</td>
<td>600</td>
<td>12</td>
<td>270</td>
<td>NA</td>
<td>NA</td>
<td>Transfusion (1)</td>
<td>2-26</td>
</tr>
<tr>
<td>Hurac et al. (2010)</td>
<td>12</td>
<td>pT4(1)</td>
<td>383</td>
<td>15</td>
<td>19.5</td>
<td>NA</td>
<td>Ileal conduit (3)</td>
<td>Transfusion (1)</td>
<td>2-26</td>
</tr>
<tr>
<td>Hurac et al. (2010)</td>
<td>2011</td>
<td>pT4(1)</td>
<td>208</td>
<td>480</td>
<td>6</td>
<td>NA</td>
<td>Ileal neobladder (1)</td>
<td>Cattex-ureterostomy (2)</td>
<td>4-8</td>
</tr>
<tr>
<td>Kim et al. (2012)</td>
<td>5</td>
<td>pT1(1)</td>
<td>280</td>
<td>480</td>
<td>6</td>
<td>NA</td>
<td>Ileal neobladder (1)</td>
<td>Hemi-lok(2)</td>
<td>1-26</td>
</tr>
<tr>
<td>Na et al. (2014)</td>
<td>25</td>
<td>pT1(1)</td>
<td>150-600</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Ileal conduit (3)</td>
<td>NA</td>
<td>2-26</td>
</tr>
</tbody>
</table>

**Note:** a. 2 patients were pT1; b. The not available (NA) were discounted of the total to calculate the overall percentage.
Neovesicourethral anastomosis with barbed suture V-lock is carried out (Fig. 5). Once the anastomosis is completed, urethropexy with suture fixation to the pubic bone and traction by Hem-o-lok is performed. A drainage is placed through the accessory port, and through the same hole, both urinary derivation catheters are removed. Finally, the single port is removed and the umbilical wound is closed with Vicryl rapid 3/0 (Fig. 6). The umbilical scar significantly reduces analgesic requirements. The visual analog pain scale on day 2 was 1/10. A few weeks later, the wound is almost invisible, thus, fulfilling the paradigm of ‘incision-less’ surgery. The histopathological examination showed no residual tumor in the specimen and 26 lymph nodes negative for tumor. The patient has daytime continence at three months of follow-up and training their neobladder to avoid the occasional night escape that they suffer. Additional material that illustrates the surgical technique step by step is attached.

**Discussion**

Single-port surgery is the progressive result of small steps based on minor adjustments of previous techniques, the same as the tuning of an instrument is carried out with minor adjustments whose real value is difficult to define. The result is that from the sum of all these small adjustments, exquisite tuning is achieved, with no breaks or discontinuity solution in the evolutionary development of the technique.
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Figure 3  Start (A) and course (B) of pelvic lymphadenectomy.

The initial impetus to promote minimally invasive surgery focused on avoiding the morbidity of laparotomy. Improvements regarding less pain, less bleeding, better recovery of intestinal motility, and decreased need for analgesics are the main achievements of the laparoscopic approach\textsuperscript{26,27} without sacrificing the results for oncological safety.\textsuperscript{28}

The laparoendoscopic approach through the navel to perform radical cystectomy is the latest technical development in the field of minimally invasive surgery, because it reduces the placement of extraumbilical trocars and, most times, it allows for the final removal of the specimens, leaving a wound with significant cosmetic benefits. Furthermore, it is also possible to carry out the urinary derivation taking advantage of this approach, and

Figure 4  Removal of the cystectomy specimen (A), exposure of the ureters (B), intestinal anastomosis (C), and construction of the detubularized ileal reservoir (D).

Figure 5  Insertion of the neobladder through the umbilical incision (A) and neovesicourethral anastomosis with V-lock barbed suture (B).
even to practice orthotopic neobladder extracorporeally in a reasonable range of time.

But the most important fact is that some parameters concerning the quality of the procedure such as tumor margins, the number of nodes obtained in the pelvic lymphadenectomy, and the possibility of conducting continent reservoirs are today an entirely feasible reality using a laparoendoscopic approach. If the only advantage of the procedure resided in cosmetic surgery, it might not be enough to apply this concept to the radical treatment of bladder cancer. However, the stay reduced to 6 days in a patient with orthotopic neobladder, who was discharged without any Clavien-Dindo complications, not even in the administration of analgesia, is frankly astonishing. A visual analog scale of postoperative pain 1/10 on day 2, the absence of ileus in the postoperative period, and the great satisfaction with the procedure by the patient are well worth an extended operative time of 480 min.

We think this type of approach is ideal for selected patients and that if these impressive results are consolidated, it will constitute an indisputable future advance in the treatment of muscle invasive bladder cancer. The reusable nature of the material used is also a strong argument in terms of hospital efficiency.

There is no doubt that the experience in this type of patients is still very limited even worldwide and that more casuistry will have to be accumulated in order to acknowledge the benefits of this procedure. Today, the experience described seems comparable to the laparoscopic approach, which surely entails a high oncological efficacy. However, a closer follow-up is needed with regard to functional results and late complications.

Different procedures are being developed at present with this type of single-port devices, although in many surgeries, placement of 3.5 mm-gauge thin accessory ports (even less if the instrument is placed directly without the trocar) is necessary. There is no doubt that single-port surgery means a challenge of retooling, still under development. The first descriptions of its application in Urology were flank incision nephrectomy and transumbilical ureterolithectomy.16,29 Then, transumbilical nephrectomy and pyeloplasty were described.30,31 Gradually, most urological procedures have been developed using single port: adrenalectomy, nephroureterectomy, living donor nephrectomy, ureteral replacement, ureteral reimplantation, and augmentation enterocystoplasty.20,32–35 Radical prostatectomy and radical cystoprostatectomy through umbilical approach are also feasible19,36 and will soon see their indication grow.

The advent of new systems with improvements provided by the applied research from the field of engineering and optics will be the key elements that will contribute to this increase. The Keyport system is an example of this development, because it incorporates dual rotation curved elements which involve greater precision, and it also prevents the external shock of the instruments thanks to the crossing inside them, which involves a mirror image. It is therefore necessary to carry out a progressive learning to compensate for the laterality change.37 The use of accessory trocars as hybrid LESS is an excellent option that also facilitates the use of this system.23,38

Conflict of interest
The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data
Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.acuroe.2012.03.009.

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