Single port radical prostatectomy: current status

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Abstract The aim of this study is to analyze the current literature on single port radical prostatectomy (LESS-RP). Single port radical prostatectomy laparoendoscopic (LESS-RP) has established itself as a challenge for urological community, starting with the proposal of different approaches: extraperitoneal, transperitoneal and transvesical, initially described for laparoscopy and then laparoscopy robot-assisted. In order to improve the LESS-RP, new instruments, optical devices, trocars and retraction mechanisms have been developed. Advantages and disadvantages of LESS-RP are controversial, while some claim that it is a non-trustable approach, regarding the low cases number and technical difficulties, others acclaim that despite this facts some advantages have been shown and that previous described difficulties are being overcome, proving this is novel proposal of robotics platform, the Da Vinci SP, integrating the system into “Y”. The LESS-RP approach gives us a new horizon and opens the door for rapid standardization of this technique. The few studies and short series available can be result of a low interest in the application of LESS-RP in prostate, probably because of the technical complexity that it requires. The new robotic platform, the da Vinci SP, shows that it is clear that the long awaited evolution of robotic technologies for laparoscopy has begun, and we must not lose this momentum.

Keywords Single port radical prostatectomy · Single-site surgery · Robotic prostatectomy · Laparoscopic prostatectomy

Introduction

Radical prostatectomy (RP) is the most important standard for the treatment of organ-confined disease in patients with prostate cancer and it has useful life of 10 years more than higher. This therapy has changed exponentially with opening of minimally invasive techniques, is a milestone in the surgical treatment of prostate disease [1].

Techniques minimally invasive have experienced progress constant in time, beginning with standard, evolution mini-laparoscopic trocars and later development of laparoendoscopic single—site surgery (less). The aim was not only to improve the aesthetic result, but also to decrease the morbidity of the procedures, reducing the number and size of trocars [2].

Here, we present a comprehensive overview about development from this technique, which has been facing major challenges not only in the removal of the prostate gland but also in the reconstruction of the posterior urinary tract. A specific emphasis is urethrovesical anastomosis, that is one of the most difficult challenges to overcome due to the proximity of the laparoscopic instruments, which eliminates the principle of triangulation, increasing internal and external collision of instruments, restriction of movement (especially in intracorporeal suture) and hindering access to the structures, so it requires more surgical skills.
In addition, this report describes the current state of LESS-RP around the world, including existing techniques, constraints and proposals to overcome these limitations. We report the evolution of standard platforms through the arrival of new proposals for the robotic single-port procedures. Also we discuss the results in the literature, with a comparison of conventional and LESS-RP surgery techniques.

Techniques, access, instruments and visualization

Working time through a single port, the reduction of the workspace is immediately evident, as well the collision of instruments, limited freedom of movement and display of difficulties that inevitably lead to highly complex procedures and requirements higher surgical skills. Bearing these limitations in mind, the evolution of the strategy of a single-port should be considered in terms of four main aspects: trocars, instruments, mechanisms of contraction and display as strategies to overcome technical problems and improve the performance of the technique.

The first single-port used in radical prostatectomy was created with a rustic trocar, a single incision is made in the skin and fascia, which is defined as a ‘site’ surgery (incision in the skin only with a multi-port) [3].

Other devices of a single-port access developed several working channels (skin and fascia single-incision using a multiple port channels). The most commonly used are the TriPort/four ports (advanced surgical concepts, Bray, Ireland) and SILS™ (Covidien, Mansfield, MA, USA). Other devices offer the option of a single channel in which multiple trocars can be placed as shown in the GelPOINT device, others have required the additional use of one or two 2 or 5 mm accessory ports.

Four LESS-RP approaches have been described to date: transumbilical, extraperitoneal, intraperitoneal and transvesical. Whereas some groups use a single incision device, others have required the additional use of one or two 5 mm accessory ports.

Single-port laparoscopic radical prostatectomy (less-prl)

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Transumbilical approach (Fig. 1)

Kaouk et al. reported the first RP-LESS in 2008 [3] in a series of 4 low-risk prostate cancer cases. Used a transabdominal approach using the Uni-X (Pnavel systems,
Morganville, NJ, USA), that is a single port with three channels from 5 mm each and one additional channel of blow. In addition, used new tools such as a 5°, 0° flexible-tip mm endoscope (Olympus surgical, Orangeburg, NY, USA) and a variety of flexible instruments, curves and articulated (CambridgeEndo, Framingham, MA, USA; Pnavel; Surgical systems of Novare, Cupertino, CA, USA).

The most difficult step in his description was anastomosis ureterovesical, which could only be performed with extracorporeal interrupted suture knots. Only three interrupted suture knots were completed in the first patient, considering that six knots at the patient end completed, demonstrating the improvement through the perform. In one of the four patients, was carried out excision of pelvic lymph nodes, although he emphasized the extreme technical difficulty. In any case, the use of an additional port was necessary. As a unique complication, this series includes a patient who presented with a fistula urethrorectal (grade Clavien IIIb) [11], which was resolved by surgical treatment.

From the point of view of cancer, half of the patients had positive surgical margins with supervision limited of prostate-specific antigen (PSA) in the postoperative period. In this series, following the procedure of erectile function was not reported [3]. In subsequent series, such as Cáceres, 2012 (31 cases), preservation of the nerve was reported in 32.3 % of patients: as a result, 33 % of patients had an erectile function correct during the postoperative period [Sexual Health inventory for men (SHIM) score ≥21 points with or without medication]. It is noteworthy that an additional 3.5 mm port was used in this series, and preservation of the nerve was attempted only in patients with tumors of low risk (T1c–T2a) and shoes preoperative ≥21.

Most urologists who perform LESS-RP practice a transabdominal approach. However, Rabenalt et al. [12], who used extraperitoneal access using the TriPort device (Advanced Surgical Concepts, Bray, Ireland) and precurved instruments, reported achieving an anterograde dissection and six separate knots in the anastomosis in each case. In 2011, Gao Xin describes an extraperitoneal approach through two systems: the four-port multichannel (Olympus, Japan) and a device made with a surgical glove artisan multichannel. He also uses a flexible laparoscope with pre-curved and flexible instruments [13]. The most recent series was reported by 2013; Chun Jiang employed an extraperitoneal approach in 20 patients with a device made with a surgical glove art multi-channel using instruments straight and the curved (see Table 1).
Transvesical approach (Fig. 2)

Transvesical method has been widely known since 2009, when it was described by Desai and Sotelo for prostate adenomectomy [14]. This novel concept led to transvesical radical prostatectomy, reported in 2013 by Gao Xin. Xin completed the longest series of patients subjected to this technique: 20 patients at low risk confined prostate cancer (PSA = 10 ng/ml, Gleason <7 and clinical stage T1c or T2a). It was a dissection combined with initial retrograde dissection into the bladder neck followed by dissection anterograde of seminal vesicles and prostate. Finally, a urethrovesical anastomosis was created by inserting a graft of the foreskin with separate knots. No additional ports were used, and the neurovascular bundle was preserved in all patients. Reported results of the erectile function of 21 points or more in the IIEF-5 scale in 60 % of patients; 100 % was continent; and 0 % had positive surgical margins. The author reported 16 cases in which the anastomosis was launched using an innovative method in addition to previously described techniques. In this series, the author made three incisions near the bladder neck, and suture continuous anastomosis with sutures barbed was performed on each side [15] (see Table 1).

Robotic-assisted laparoscopic single-port radical prostatectomy

The wide range of movements that the surgical system da Vinci ® offers (surgical intuitive, Sunnydale, CA, USA) is widely known as one of its advantages, which in theory reduces internal and external instruments collision. However, this reputation is not entirely justified; the surgical system da Vinci ® is characterized by considerable size and volume, and initial platforms were not clearly developed for fewer procedures. Despite these factors, urologists have performed LESS-RP with the da Vinci® System and have demonstrated in the medical literature that it is feasible and safe despite the absence of standardization of the technique.

Transumbilical technique (Fig. 3)

The first two cases of LESS-RP were recorded by the Group of Montsouris in 2009. After performing the LESS-RP without robotic assistance in a cadaveric model, this group carries out robotic MOP-less in two patients and reported their findings in two separate publications [16, 17].

Single-port devices were not used in each study. A single umbilical incision was made with the subsequent independent trocar insertion. There was a 12 mm port to the camera and two robotic ports of 8 mm for instruments of work, with a separation of approximately 3.5 cm port. In the first case, an additional 5 mm trocar was placed in the right quadrant lower to allow suction and retraction in the header [16].

In the second case, the ports had a configuration of diamond that allows the auxiliary port to be placed behind the camera port, avoiding an additional incision [17]. Surgical time was 150 min, the dorsal venous complex was linked with a knot, and settled with six separate knots urethrovesical anastomosis. The main difficulty, according to surgeons was external collision of robotic arms, that subsequently limited movement and to interfere with the proper progression of the procedure of the robotic arms. This French technique and rhomboid configuration of the port have been replicated by other groups, who have demonstrated that it is feasible and successful.

To date, the largest series of LESS-RP using the transumbilical technique was reported by White et al. [18], that describes the results of 20 patients who underwent LESS-RP between 2008 and 2010.

Their approach used two robotic 8-mm ports, one placed caudal and the other cephalad to a 2-cm umbilical incision. Puerto SILS ® was placed in the center of the incision between the two ports of 8 mm thickness. The robotic laparoscope was settled through a 12 mm working channel. The surgical technique included an anterograde approach and had followed the conventional robot-assisted radical prostatectomy technique. The maneuver puppet was used to open the field of work and pull the neck of the bladder or urethral catheter forward during dissection of the neck of the bladder. With continuous sutures urethrovesical anastomosis was performed, and conventionally pelvic lymphadenectomy.

The authors reported satisfactory results: average operating time was less than 200 min. Only 4 of the 20 patients experienced complications, including urosepsis with a fatality. Intraoperative complications were not disclosed. Oncological results revealed positive surgical margins in 24 % of evaluable patients (4/17). Dissection nodal in 60 % of patients, but with a low average of four nodes was carried out per box. All patients had undetectable PSA levels after surgery; However, there has been follow-up reports.

Recently, results by 11 patients it shows that included the use of a new port robotic platform, da Vinci SP, which introduces the camera and instruments through a single port (Fig. 5). In general, patients were young and not obese, with medium sized prostates and low risk of prostate cancer. The authors reported a conversion rate of 0 % and complications that were mostly minor. The average surgical time was 239 min; 18.2 % of patients had positive margins; and continence rates and the recovery of erectile function at 30 days were 55 and 63.3 %, respectively [9].
Transvesical technique (Fig. 4)

The first robotic LESS-RP was developed in 2008 by Desai and Sotelo, using two cadaveric models [19]. In the first model, the approach was developed through a horizontal suprapubic incision (mini-Pfannestiel) and meant the inclusion of multiple trocars in the fascia through the bladder. For the second corpse, four ports system was used, which had an advantage over conventional trocars due to the use of a single incision when four-port system was later used in humans, surgeons reported great difficulty to perform by Pneumovesicum urethrovesical anastomosis,

| Table 1 Radical prostatectomy single-site surgery procedures: clinical series |
|---|---|---|---|---|---|
| N° patients/approach | Additional ports | Type port | Conversion + (%) | Function erectil\(^b\) | Continence\(^a\) | Positivity Margin (\%) |
| Kaouk et al. [3] | n = 4 Laparoscopic Transumbilical | No | Uni-X\(^\circ\) | 0 | N/R | 100 % | 50 % | 25 |
| Bachiller et al. [22] | n = 4 Laparoscopic Transumbilical | Yes 2 × 5 mm | SILS\(^\circ\) | 25 | N/R | N/R | N/R | 25 |
| Ferrara et al. [23] | n = 10 Laparoscopic Transumbilical | Yes 1 × 5 mm | Tridport\(^\circ\) | 0 | N/R | N/R | 20 % | 0 |
| White [18] | n = 20 Robotic Transumbilical | Yes 1 × 8 mm | SILS\(^\circ\) daVinci S da Vinci Si | 5 | 100 % | 25 % | 20 % | 20 |
| Wen et al. [13] | n = 6 Laparoscopic Transumbilical | No | Quadport\(^\circ\) Homemade | 0 | 50 % | 100 % | 0 % | 0 |
| Gaboardi et al. [24] | n = 5 Laparoscopic Transumbilical | No | Tridport\(^\circ\) | 0 | 20 % | 60 % | 0 % | 0 |
| Gao et al. [25] | n = 8 Laparoscopic Transumbilical | Yes 1 × 5 mm | Normal trocars (single site) | 0 | N/R | 75 % | 12.5 % | 0 |
| Cáreres et al. [4] | n = 31 Laparoscopic Transumbilical | Yes 1 × 3.5 mm | KeyPort\(^\circ\) | 0 | 33.3 % | 33.3 % (20 months) | 16.1 % | 19.4 |
| Zhu et al. [26] | n = 6 Laparoscopic Transumbilical | No | Quadport\(^\circ\) | 0 | N/R | 100 % (12 months) | 0 % | 33.3 |
| Gao et al. [15] | n = 16 Laparoscopic Transvesical | No | Quadport\(^\circ\) | 0 | 75 % | 100 % (3 months) | 0 % | 31.2 |
| Jiang et al. [5] | n = 6 Laparoscopic Transvesical | Yes (1 pt) 1 × 5 mm | Homemade | 0 | 60 % | 100 % (3 years) | 5 % | 20 |
| Kaouk et al. [9] | n = 11 Robotic Transvesical | Yes 1 × 5 mm | daVinci SP | 0 | 0 % | 100 % (3 years) | 18.2 % | 45.5 |

N/R not realized

\(^a\) Use 0–1 security PADS + conversion open or more 2 ports
\(^b\) SHIM ≥ 21
\(^c\) Intra and extra operative
Fig. 2  a Lateral view, b umbilical Quadport, c mucosa-muscle incisions between 2 and 4 o’clock, 5 and 7 o’clock, and 8 and 10 o’clock, marked as “X”, ease uretro-bladder anastomosis (U-B), d continuos closure U-B anastomosis and enlargement of the mucosa-muscle incisions

Fig. 3  a Lateral view, b DaVinci SP docking, c systems elements entry, d system components deployment, “Y” principle is observed
**Fig. 4**  
(a) Lateral view.  
(b) DaVinci-Si docking.  
(c) Intravesical dissection of the prostate and seminal vesicles.  
(d) Urethral-bladder anastomosis with anterior plication.
which pulled the bladder cephalad and limited his approach to the urethra.

Future directions

The challenges of the LESS platform in the surgical management of urological diseases are clear. It is also very important to provide minimally invasive surgery that achieves the best aesthetic results without compromising security or the expectations of the patient. Therefore, the development of tools and techniques is necessary to achieve these objectives.

Based on this “Y” platform concept of the second robotic single-site platform, a new robotic single-port prototype called a “plate spring mechanism” has been developed. This system consists of a plate spring unit that allows power transmission and improves workspace volume (Fig. 5).

A very interesting option developed for a minimally invasive approach is the use of natural orifice transluminal endoscopic surgery (NOTES). This surgical approach uses an existing natural orifice (typically transoral or transvaginal). This technique does not require the use of ports through the skin and subcutaneous tissues to enter a body cavity and approach the organ of interest.

In 2012, Nagele reported the first case of NOTES in a 77-year-old man; a 26 Fr resectoscope (Karl Storz GmbH, Tuttlingen, Germany) and a 550-m WBER laser fiber with a thulium: YAG laser fiber (Revolix® 120 W laser surgical, LISA laser products, Katlenburg, Germany) were used to perform a complete intrafascial prostate dissection. The urethrovaginal anastomosis was performed with urethrovesical probe approximation, and organ extraction was performed through a Pfannenstiel incision [20].

An innovative for radical prostatectomy approach is to be newly developed robotic approach to perenial with a single site system GelPort demonstrates the feasibility and possibility of other insurance and cash less focus to radical prostatectomy [21].

These events clearly demonstrate the speed in which surgical approaches are evolving in increasingly less forms invasive, with the aim of achieving optimal results.

Conclusions

The surgery LESS-RP is a technique that it allows access by decreasing the number of trocars. This technique has given rise to a new concept of minimally invasive surgical approach and the concomitant expansion of new instrumentation, technology, ports, optics and mechanisms of contraction. To date, the RP less benefits have not been endorsed definitively; only small series have been reported, and the results have not been fully evaluated.

On the other hand, this technique has not become popular, we have explored different surgical approaches: transperitoneal, retroperitoneal, transvesical, laparoscopic and robotic even with changes to the platform. The current environment may not be unbeatable for the widespread acceptance of this technique; however, its popularity could increase when one achieves the full development of a robotic platform.

This overview demonstrates the great progress in the clinical application of prostate surgery less. Continuous development is expected to lead to wide acceptance of this technique by the urology’s community next years. It is clear that the expected evolution of robotic technologies for laparoscopy has started, and we must not lose this conjuncture time.

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Compliance with ethical standards

Conflict of interest

The authors Oscar Darío Martín, Raed A. Azhar, Rafael Clavijo, Camilo Gidelman, Luis Medina, Nelson Ramirez Troche, Leonardo Brunacci, René Sotelo declare that they have no conflict of interest.

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