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Review

Single-port technique evolution and current practice in urologic procedures



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Received 20 December 2019; received in revised form 19 January 2020; accepted 21 April 2020

Available online 22 May 2020

KEYWORDS

da Vinci SP;
Single-port surgery;
Robotic surgery

Abstract Different groups described the single-port surgery since its first report in laparoscopic procedures. However, the acceptance of this technique among urologists, even after the robotic approach, was reduced in the past years. Therefore, to overcome the challenges related to the single-port surgery, a new robotic platform named da Vinci SP was created with exclusive single port technology. We performed a non-systematic literature review regarding the single port technique in urologic surgeries since the first laparoscopic report until the da Vinci SP robotic platform. Three different periods were described (laparoscopy, robotic, and da Vinci SP), and we focused in our experience with this new single port robot. We selected different articles and summarized the information regarding the use of single-site surgery in laparoscopic procedures and the challenges of this approach. We also reported the experience of different groups using the single port robotic technique and some recent reports of the da Vinci SP approach. In our experience with this new console, we described some critical points related to our radical prostatectomy technique and the lessons learned during the introduction of this novel platform. Previous single-site procedures described some common challenges that limited the technique expansion. However, our experience with the da Vinci SP described feasible and safe procedures with acceptable intraoperative outcomes. The introduction of this platform is recent in the market, and the literature still lacks a high level of evidence describing the long-term outcomes of this new technology.

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Peer review under responsibility of Second Military Medical University.

<https://doi.org/10.1016/j.ajur.2020.05.003>

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1. Introduction

The first use of single-site (SS) access in urology was performed in laparoscopic surgeries (1–5). The authors reported acceptable outcomes during procedures such as adrenalectomies, sacrocolpopexy, nephrectomies, cryotherapy, and kidney biopsy. However, the steep learning curve, technical challenges, limited number of cases reported, and lack of well-designed studies to establish the benefits led to low acceptance of SS among laparoscopic surgeons.

Nevertheless, some of these laparoscopic limitations were exceeded by the advent of robotic surgery, which enhanced the operative field magnification, instrument precision, and articulation (wrist-like). Therefore, the robotic single-port (SP) surgery had better acceptance because it enabled the procedures to be performed in smaller spaces with higher accuracy and ergonomics. However, this robotic approach also had some challenges in terms of the learning curve, lack of standard techniques, and a low number of cases described in the literature.

The advantages of the robotic approach, such as lower blood loss and shorter hospital stay, are established in the literature [25]. Therefore, all the efforts target the improvements of the current techniques and the creation of less invasive platforms. In this context, Intuitive Surgical recently introduced the first exclusive SP robot, the da Vinci SP.

This study aims to review the literature regarding SP surgery and to describe our experience with the da Vinci SP generation of robotic consoles.

2. Material and methods

We performed a literature review regarding the use of SP access in urologic procedures since the first laparoscopic case until the transition to an exclusive SP robot (da Vinci SP). In addition, we reported our experience with the implementation of this new platform describing our technique, learning curve, and lessons learned.

3. Urologic SS surgery

The evolution of SS surgery in urologic procedures occurred in three different periods during the history of minimally invasive surgery (laparoscopic, multiport robotic, and da Vinci SP).

3.1. Laparoscopic period

Initial reports of clinical experience with SS surgery were described in 2005 by laparoscopic surgeons [1–5]. Most procedures were nephrectomies, with the main site of access through the umbilicus. However, according to the authors, that initial experience with SS presented technical challenges such as internal clashing due to the improvised instrument triangulation.

In order to overcome those instrumental limitations, different laparoscopic tools with articulations and curvatures were created. However, the challenges remained,

and the steep learning curve added to the high laparoscopic expertise needed to perform the cases have limited the technique dissemination. Moreover, the lack of well-designed studies and the low number of cases reported discouraged surgeons to choose the laparoscopic SS as a first surgical option.

In fact, the laparoscopic SS challenges were higher than the technique dissemination. However, the SS access evolved during the robotic era, and different groups described procedures with a single incision reported as SP.

3.2. Robotic multiport use

Years after the laparoscopic reports regarding SS surgery, Kaouk et al. [6] published the first experience of SP in humans. The author described three different procedures using the da Vinci S robot. The instruments were placed through a multichannel SP (called R-port) to perform a radical nephrectomy, radical prostatectomy, and pyeloplasty.

In the following years, a higher percentage of authors, when compared to the laparoscopic era, reported different SP procedures with acceptable intra- and postoperative outcomes [7–19]. However, the SP also underwent a limited acceptance among robotic surgeons due to the improvised port access, lack of technique standardization, and a reduced number of cases described to establish the benefits of this access.

3.3. da Vinci SP clinical practice

In 2014, the literature had its first clinical report regarding a robot with an exclusive SP approach [20]. The new generation of intuitive robots, after the Food and Drug Administration approval, released in the market a single trocar platform, the da Vinci SP.

This robot has a 25 mm trocar, through which it is possible to work with three biarticulated instruments and one flexible scope with minimum clashing and maximum ergonomics. Following the first report, other groups also described the experience with da Vinci SP robot [21–24]. However, with a low number of centers working with this new platform, the limited amount of cases described, and positive margins ranging from 28% to 55% in prostatectomies, we still need more studies to establish the benefits of this new technology in our clinical practice. Searching for answers to fill these gaps in the literature, our group performed multiple studies with da Vinci SP and described our clinical experience with this new console.

3.4. Patient position and trocar placement

After general anesthesia and bilateral transversus abdominis plane block, the patient is positioned in dorsal decubitus with pads around all articulations and extremities. Also, a thoracic belt is placed to maintain patient security during the Trendelenburg position. The robotic trocar (25 mm) is placed on the midline above the umbilicus at least 20 cm from the pubic bone. In addition, we work with a 12 mm assistant trocar placed on the right lower quadrant.

3.5. da Vinci SP step-by-step technique

After a period of training and adaption with the different settings, instrument movements, and tool configuration, we established our radical prostatectomy technique using the da Vinci SP platform.

- We started the procedure with the Cadiere forceps at the 9 o'clock, bipolar at the 6 o'clock, and scissors at the 3 o'clock positions (Cadiere-bipolar-scissors). The first movement was performed with the relocation pedal that allows the whole system to move towards the umbilical ligaments to begin the bladder dropping. During this step, the vas deferens and the pubic bone are landmarks used to guide the Retzius space dissection. In this step, the scope should stay in a neutral position without deflection.
- After the prostate was exposed, anterior bladder neck access and posterior bladder wall dissection were performed with the same tool configuration (Cadiere-bipolar-scissors). During this step, the scope was deflected with downward angulation facing the prostate. To establish hemostatic control of the pedicles, we use the Hem-o-lock clips (purple).
- Afterward, seminal vesicle dissection is performed with the same instrument configuration (Cadiere-bipolar-scissors). The Cadiere applies traction towards the abdominal wall, while the bipolar and scissors dissect and present the vas deferens and seminal vesicles to the assistant for application of clips. In sequence, Denonvilliers fascia was then released with the scope deflected into upward angulation facing the prostate posterior neurovascular bundle. We spared the neurovascular bundle and the prostatic fascia bilaterally from the 5 o'clock and 7 o'clock positions to the 1 o'clock and 11 o'clock positions. On this step, the deflection was crucial to visualize the posterior dissection plan.
- Next, we opened the endopelvic fascia preserving the lateral prostatic fascia and performed the lateral neurovascular bundle retrograde dissection. The Cadiere in the left arm maintained the tissue traction while the dissection plan was performed with bipolar (located at 6 o'clock position) and scissors (in 3 o'clock position).
- Sequentially, we applied Hem-o-lock clips along the prostate vascular pedicles to achieve the hemostatic control.
- During the apical dissection, the Cadiere was essential to maintain the downward traction of the prostate (away from the pubis). We maximally preserved the anterior apical attachments to the prostate, performing a minimal apical dissection. The DVC was divided and sutured with 2-0 barbed running suture (Quill). For the suturing step, one needle drive was placed at the 9 o'clock position; the Cadiere was placed at the 6 o'clock to apply prostate traction, and the other needle drive was placed at the 3 o'clock position.
- Finally, the urethra was divided while preserving the maximum amount of urethral length and apical tissue. The bladder neck reconstruction was then performed with a 2-0 barbed suture (Quill). However, the Cadiere Forceps was removed since the bladder neck reconstruction until the end of anastomosis (needle driver, no instrument, needle driver). The posterior reconstruction was performed with a technique previously described [12]. The anastomosis was performed with a running bidirectional barbed suture as previously described [13].
- In cases that we performed a lymphadenectomy, the arms configuration followed the previously described position of bladder neck dissection (Cadiere-bipolar-scissors). In this step, the relocation pedal will target the robot to the operative site on both sides.
- The prostate and lymph nodes were placed in a specimen retrieval bag inserted through the 12 mm assistant port and removed through the midline incision after the robot undocking.
- The assistant port aponeurosis was closed with Carter-Thomason Laparoscopic port Closure System (Cooper Surgical, Inc., CT, USA), while in the midline incision we used Vicryl simple suture. No abdominal drain was placed. We closed the skin with Monocryl subcuticular suture.

4. da Vinci SP console adaption and learning curve

Before we performed the first surgery with the new console, the whole team underwent an intense period of study and training. The dry lab, animal, and cadaveric practices with an SP trainer were essential during this learning period.

The differences between the previous (Xi) and the new console (SP) in terms of trocar placement, arm movements, and instrument configurations demand a learning curve for the whole team. Also, the scope deflection during key steps such as nerve-sparing and apical dissection requires a period of training and adaptations. An important factor influencing these differences was the addition of an extra trocar in the left lower quadrant in the first cases, through which we placed a laparoscopic scope to record the procedure on a different angle. Therefore, we had feedback in terms of arm movements and scope position. Also, these videos were used for study purposes to improve the technique in the following cases.

Another crucial factor during this adaption period was the learning curve selection criteria. The candidates for the procedure were patients with prostate size lower than 80 g, body index less than 35 kg/m², no previous primary treatment (salvage), and no extraprostatic extension on the magnetic resonance imaging (MRI) exam.

5. Lessons learned during the transition from Xi to da Vinci SP

The delicate instruments and blunt tip scissors challenge the surgeon while reproducing the conventional radical prostatectomy technique performed on the Xi console. Due to limited tissue traction and strength dissection, some steps such as apical dissection and nerve-sparing require an extra effort. The working distance is also another challenge during the learning curve. While on the Xi console, the

instruments and scope act very close to the operative site, on the SP, due to the space needed to triangulate the arms, the working distance is far from the prostate and needs to be readjusted with the relocation pedal. Another crucial factor is the camera control while performing different surgical steps. During the bladder dropping, bladder neck opening, and nerve-sparing, we described three different angulations that are essential to improve the anatomy visualization during the dissection.

The current literature and our experience with this new platform revealed that clinical practice is safe and feasible. However, most centers are performing surgeries in particular cases, and further studies are needed to evaluate the benefits of this robot on large prostates, salvage prostatectomy, and extraprostatic tumor extension.

6. Summary

The literature regarding SP surgery is scarce and lacks well-designed studies to establish the benefits of this technique comparing different types of robotic approaches to open surgery. Also, we need additional time to describe with accuracy the oncologic and functional outcomes of this new da Vinci SP platform. However, our experience with this new robot describes that the RARP is feasible, safe, and requires a new learning curve in terms of adaptations with the scope angles and instrument settings.

7. Conclusion

The SP surgery has undergone some adaptations and modifications in the past years. However, the technologic improvements, novel types of robots, and the increasing number of surgeons adopting minimally invasive techniques are encouraging factors to believe that the number of surgeries with fewer portals and incisions will increase in the next years.

Author contributions

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Conflicts of interest

The authors declare no financial interests, or funding related to this manuscript production. Dr Patel is consultant for Exact Sciences/Genomic Health, Decipher/Genomic DX, Active Surgical, and AVRA.

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