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Research Article

Where Are We Now With Single-Port Robot-Assisted Radical Prostatectomy?

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Abstract

The US Food and Drug Administration authorized the da Vinci Single Port (SP) robotic system for use in urologic treatments in 2018. There aren't many research on the use of SP in prostate cancer surgery. Our study's objective is to compile the most recent data regarding the methods The results of surgeries involving SP robot-assisted radical prostatectomy (SP-RARLP). In January 2023, a narrative evaluation of the literature was conducted. According to preliminary findings, SP-RALP is both possible and safe, and it can produce results that are on par with those of the conventional multiport RALP.Given their reduced invasiveness, likely shorter duration of stay, and improved pain management, extraperitoneal and transvesical SP-RALP seem to be the two most promising strategies. Long-term, superior data are lacking, and additional verification through prospective research at several locations is necessary.

Keywords : *single port; radical prostatectomy; robotic surgery; extraperitoneal.*

INTRODUCTION

For males with localized prostate cancer, radical prostatectomy is the recommended course of treatment [1]. Robotic prostatectomy has emerged as the most popular procedure since the US Food and Drug Administration (FDA) approved da Vinci-assisted prostate surgery in 2001.robotic oncologic surgery that is frequently carried out in the United States [2]. The quick spread of surgical robots in urology is demonstrated by the fact that by 2013, 85% of all radical prostatectomies were carried out robotically [3]. In actuality, shorter hospital stays and less perioperative blood loss have been observed when robotic assistance is used during laparoscopic procedures [4]. Additionally, dubious and contentious research has indicated that robotic radical prostatectomy may have produced better rates of urine continence and enhanced erectile function after surgery as compared to alternative methods [5,6].

Over the past 20 years, several iterations of the da Vinci robotic platform have been introduced, all of which share a multi-arm architecture and a fixed laparoscopic camera. Natural orifice transluminal endoscopic surgery (NOTES) and laparoscopic single-site surgery (LESS) were intended to be the next wave of minimally invasive surgery, with the goal of reducing problems from incisions and postoperative discomfort [7]. However, despite the potential benefits of lowering surgical morbidity, improving cosmesis, and reducing pain, the widespread adoption of these single-site techniques was hindered by the rigid instrumentation, lengthy surgical times, significant instrument clashing challenges, and limited operative space [8].

The first clinical series using single-port (SP) robotic surgery with a specially designed robotic platform was published in 2014 [9]. The FDA authorized the da Vinci Single Port (SP) system for urologic surgery in 2018, a few years later. This innovative platform replaces the several trocars typically employed in multiport robotic surgeries.uses a single multichannel 2.5 cm port that is placed through a single skin incision to hold all of the robotic devices and camera.

The preferred surgical treatment for prostate cancer is robotic-assisted radical prostatectomy (RALP), which is typically carried out by a transperitoneal technique [2]. With the adoption of the Alternative strategies have been investigated in order to optimize the advantages that this new platform can provide for the SP robotic system [10]. Since Kaouk et al. [11] first described SP-RALP, numerous centers have reported various methods and results using this innovative process.

The current review's objectives are to outline the various methods and strategies for SP-RALP and to compile the results that have been published thus far.

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LITERATURE SEARCH

From the launch of the da Vinci SP platform in 2018 until December 2022, an electronic search of MEDLINE was conducted using a combination of MeSH terms and free text. "Single Port Robotic Radical Prostatectomy," "Single Port Prostatectomy," or "Single Port Robot Prostatectomy" were the research terms utilized. Additionally, every reference from important reviews on SP Radical Prostatectomy was checked. There were only articles written in English. Abstracts and titles were examined. Following this preliminary screening, a full-text review was carried out to verify the inclusion eligibility of the chosen articles. Book chapters, abstracts, commentary, and editorials were not included in the analysis.

EVIDENCE SYNTHESIS

A cutting-edge surgical system with several advancements is the da Vinci SP (Intuitive Surgical, Sunnyvale, CA, USA). Three articulating 6 mm instruments and an 8 mm articulating flexible camera can be introduced thanks to its single 27 mm port. The 25 mm The cannula can be positioned inside a GelPOINT® advanced access platform or straight into the 27 mm incision. A flexible camera that can rotate in all directions allows for the creation of various perspective angles while the instruments remain in a fixed position. This is one of the new peculiarities of the single-port system, despite the fact that it shares some characteristics with its predecessors, such as endodontist manipulators, three-dimensional visualization with magnification and scaled movement, and tremor reduction.Additionally, the entire platform may be rotated in any direction around its fulcrum thanks to a unique SP feature known as "relocation." Each gadget and the camera are placed in the 12.three, six, and nine o'clock locations inside the trocar. The port's location is adaptable and enables 360° robotic docking. Additionally, a new visual indicator known as the "Navigator" has been added, which enhances communication between the camera and the instruments.

All of the instruments can be tracked at once by doing this. Lastly, the "Cobra Mode" function, which basically positions the camera in a centered, ~30^{o} flexed position with the best instruments

visualization, aids the surgeon in determining the best location for the camera among the several tools at each stage of surgery.These novel features and improved instrument mechanics result in a number of technical modifications from the multiport method, such as more movements, altered alignment, and a reduction in instrument clashing while optimizing workspace within the patient. However, the surgical area is smaller and the instruments rotate, necessitating greater coordination and experience from the surgeon [12].A variety of strategies have been proposed for SP-RALP, each having pros and cons (Table 1).

Transperitoneal Approach

It is hardly unexpected that the transperitoneal technique was initially chosen with the SP platform's acceptance, given that it was the most well-known strategy for multiport RLP. The patient is positioned in the 25 Trendelenburg position in this instance, and an incision is created above the umbilicus, and the Hasson method is used to penetrate the peritoneum under direct eyesight. A GelPOINT Access Platform is fastened to an Alexis wound retractor that is inserted via the incision. The GelPOINT retractor or a separate fascial incision (using the same skin incision) can be used to insert a valveless Airseal® port.After that, the robotic instruments are presented and the SP robot is docked to the SP access port. The dissection is then performed using either an anterior or posterior approach, much like a multiport transperitoneal RAP.

Extraperitoneal Approach

The multiport system's extraperitoneal approach has been explained [13,14].Although it is possible, the limited working space and instrument clashes prevented this approach from being widely adopted. These restrictions can be overcome with the SP platform, increasing its viability and possibly attractiveness [15]. In this instance, the Trendelenburg position is not necessary because the patient can lie supine, which has a significant benefit for anesthesiology support. The Retzius space to the pubic bone is developed by blunt finger dissection following a single, horizontal infraumbilical incision.A wound retractor, an inflated plastic sphere that acts as a "floating" platform to give the robotic arms more room, and an SP robotic trocar make up the recently created unique SP access kit. Once the space of Retzius is made, the process is performed similarly to the transperitoneal method.

Extraperitoneal versus Transperitoneal Approach

There are just two studies that compare extraperitoneal and transperitoneal SP-RALP as of the publication date. The initial experience was reported by Kaouk et al. [16], who showed that the extraperitoneal cohort had a significantly shorter postoperative hospital stay, a lower need for postoperative opioids, and a quicker surgical duration. Subsequently, the first and biggest study comparing the two multi-institutional propensity scores methods were documented [17] (Table 2).

Except for the operative duration, which was longer in the extraperitoneal group (median 206 vs. 155 min, $p < 0.001$), the results mostly confirmed those of the earlier trial. This conclusion was supported by the authors' various more common cases of lymph node dissection in the extraperitoneal group, the experience of the surgeon, and the extra time needed for surgery to create the extraperitoneal area [17]. In conclusion, the extraperitoneal technique seems to be less intrusive, which could lead to a shorter recovery period and fewer hospital days, with the majority of cases potentially concluding in same-day release (SDD). The ability to avoid the peritoneum, which prevents postoperative ileus and peritoneal irritation, also makes it possible to treat instances withsubstantial prior abdominal surgery, as well as to reduce the amount of painkillers used after surgery.Additionally, a lack of pneumoperitoneum and steep Trendelenburg may speed up recovery after surgery and make anesthesia easier. The length of hospital stays may be shortened by all of these factors [13, 18]. However, the extraperitoneal method may be linked to higher absorption of CO2, which could lead to hypercapnia and possibly systemic acidosis [19]. Despite the fact that these issues seem uncommon, surgeons must Recognize this issue and maintain lower pneumopressure levels than are often employed in transperitoneal situations. Since adhesions and scar fibrosis would restrict access to the retropubic space, a history of previous laparoscopic extraperitoneal mesh herniorrhaphy or kidney transplantation may also be a relative contraindication to the extraperitoneal technique.The transperitoneal method might be more practical in this situation [13]. Due to limited workspace, the learning curve for extraperitoneal radical prostatectomy (EPRP) may be severe, therefore younger or less experienced To gain greater confidence and dexterity with the single-port platform, surgeons might want to begin with the transperitoneal technique. There don't seem to be any notable variations between the two strategies in terms of oncological and functional results. At three and six months, the rate of stress incontinence was similar, and positive surgical margins were comparable [14,20].

Perineal Approach

For nearly 70 years, the most popular surgical procedure for treating prostate cancer was perineal radical prostatectomy, which Young first described in 1905. However, because of its limited operational space and technical complexity, this technology lost appeal.Despite certain technological difficulties, robotic-assisted perineal radical prostatectomy was demonstrated to be possible. Nevertheless, there are currently few clinical series [21].The sole clinical series on SP robotics was recently reported by the Cleveland Clinic group. radical prostatectomy in the perineum [22]. To put it briefly, a 4–5 cm perineal incision is done while the patient is in the lithotomy position. The external sphincter muscle is retracted superiorly following the division of the central tendon and the dissection of the subcutaneous tissue. After that, the robot is docked and the GelPOINT device is positioned.The development of the posterior prostatic area, the splitting of levator ani fibers along the prostate's lateral aspects, and the opening of the Denonvilliers fascia to reveal the plane of seminal vesicles and vasa deferens;The prostatic apex and urethra are dissected after the bilateral vascular pedicles have been located and tied. The bladder neck is then located, opened, and vesicourethral anastomosis is carried out using the standard procedure. When a lymphadenectomy is necessary, the same incision is used to access both pelvic lymph nodes; unlike previously reported, no additional access is needed.The obturator fossa and the inferior margin of the external iliac vein are now exposed through the inferior lateral perivesical gap, which was first created following the division of the levator ani muscle. As an example, The obturator structures will be reached before the external iliac vein since the anatomy is inverted from the usual retropubic approach. The same surgeon who did the regular multiport transperitoneal RALP at the start of the SP experience also performed the SP transperineal radical prostectomy, according to Kaouk et al.At 12 months, the study's functional and oncological results were comparable overall, but the SP group experienced a greater rate of complications and a higher detection of positive surgical margins (38.5% vs. 7.7%, $p < 0.01$) [22].To sum up, robotic SP perineal radical prostatectomy is a viable yet difficult operation. Its use is restricted to a small number of instances and facilities with the necessary skills to carry out this process.

Transvescical Approach

Kaouk et al. first published a clinical experience for SP transvescical radical prostatectomy after outlining the single-port transvescical technique for easy prostatectomy [23, 24].The functional and oncological results were similar to those of previous methods, although There was a cap on the sample size [25]. A GelPOINT trocar is percutaneously put into the bladder after the patient has been positioned in a supine posture and an incision is made 4 cm above the pubic symphysis. The multichannel SP cannula is then inserted through the GelPOINT GelSeal cap. After that, the robot docks the pneumo-vesicum and creates it using carbon dioxide insufflation.By cutting the neck of the bladder distal to the ureteral and trigone orifices, one can obtain access to the prostate and see the prostate's periphery clearly right away. The dissection proceeds in the direction of The infratrigonal intravesical incision is then prolonged circumferentially to complete the bladder neck dissection; the anterior plane of the prostate is then prepared, and anastomosis is finished after identifying the apex and then the plane of seminal vesicles. This method has the advantage of preventing needless bladder dissection and mobilization, bowel mobilization, adhesion lysis in patients who have had prior surgery, and Trendelenburg positioning [25].Furthermore, patients with substantial cardiac comorbidities may benefit more from epidural anesthetic than general anesthesia since CO2 is not well absorbed. However, this approach's shortcomings are mostly connected toto disorders of the bladder, including trabeculation, diverticula, and increased bladder capacity. Most importantly, a big prostate volume may make this treatment more difficult [25].

Retzius-Sparing Approach

Bocciardi's team in Milan was the first to outline a Retzius-sparing strategy [26].This technique's primary objective is to preserve the bladder's natural anatomical position while preserving the endopelvic fascia, puboprostatic ligaments, Santorini's plexus, and other anterior compartment features that have been linked to robotic radical prostatectomy. significantly higher rates of urine continence when compared to earlier methods [27–29]. In fact, up to 92% of patients have been reported to have early continence after catheter removal [30]. The extra or transperitoneal method is equivalent to patient positioning.The peritoneum is used to make a 2.5 cm vertical incision above the umbilicus. After that, the GelPOINT® Advanced Access Platform is put together. After that, a prostateectomy is carried out as previously explained by Galfano and associates [26]. The SP platform facilitates a number of significant changes in surgical practice. First, the interfascial or intrafascial plane between the prostatic and Denonvilliers' fascia is developed by lifting the bladder with the Cadiere forceps at the 12 o'clock position.As explained in the multiport approach, the "Cobra" mode camera enables access to the apices without the need for suspension sutures through the abdominal wall.The flexible scope allows for greater degrees of camera articulation, which facilitates the dissection of the gland's ventral surface.In the last three years, a few series of patients have undergone SP Retzius-sparing radical prostatectomy (SP-rsRALP), which was first described using a cadaveric model [31–34]. Balasubramanian S. exhibited the largest SP-rsRALP cohort.et al., who contrasted this strategy with transperitoneal and extraperitoneal methods. With comparable perioperative, oncologic, and postoperative pain management outcomes, the three SPRALP techniques seem safe and workableThis method was linked to quicker and better erection and continence returns [31]. However, there is a significant learning curve and some risks associated with this surgical treatment whenin contrast to alternative accesses [33]. Furthermore, a number of papers [35] state that doing SP-rsRALP on bigger glands is technically difficult due to the limited operating room. Indeed, according to recent research, rsRALP provides a greater positive surgical margin than conventional RALP, with a 53% rate, particularly for anterior tumors [36].A lack of a lateral aiming point when dissecting the prostate's lateral pedicles and inadequate view of the bladder neck during dissection, which affects the location of the ureteric orifices, are possible additional restrictions.

Oncological and Functional Outcomes

Although the SP robotic system is still in its early phases of deployment, SP surgery is quickly becoming more and more well-liked globally and attracting the attention of skilled robotic surgeons. Although there aren't many excellent comparative studies, preliminary research hasproduced perioperative results that were acceptable and on par with those of conventional multiport robotic surgery.In relation to SP-RALP, around 30 series with about 1000 patients enrolled have been published in the previous three years. Overall, the process proved to be safe and feasible. Six trials with 107 participants were examined by Checcucci et al. in systematic review on the topic [20]. Total operation time, blood loss estimate, hospital stay,
and the duration of catheterization were 190.55 minutes, 198.4 milliliters, 1.86 days, and 8.21 days, in that order.According to oncological results, a pooled positive surgical margin rate of 33% and a pooled mean number of lymph nodes excised were around 8.33.At 12 weeks, the percentages of poor continence and potency were 55% and 42%, respectively, in terms of functional outcomes. There was just one significant complication overall and only 15% of mild issues were noted [20]. In spite of theAccording to the authors, functional and oncological outcomes appeared to be promising despite the exceedingly short follow-up and small sample size. However, a significant source of bias may have been the doctors' disparate surgical techniques. Despite these drawbacks, the findings are consistent with those of multi-port radical prostatectomy (MP RALP) that have been previously published [37–39].Three other systematic evaluations have more recently evaluated the comparative results of SP versus MP RALP (Table 3). In their separate analyses, Gonzalez et al. [40], Fahmy et al. [41], and Li et al. [42] examined 1068, 666, and 1239 patients. Li et al. alone carried out asubgroup analysis depending on the various surgical techniques; in fact, they take into account perineal access, while the other two studies solely considered more conventional techniques (extraperitoneal and transperitoneal) [42].

Operative time, blood loss, rates of continence and potency, complication rate, positive surgical margin, and biochemical recurrence all showed comparable outcomes. Conversely, all three investigations found that the SP groups needed less opioids and had shorter hospital stays [40–42]. Additionally, cosmetic outcome was undoubtedly mentioned as a significant benefit of SP surgery, particularly for certain patient types [43]. Only Li et al. had looked into catheterization time; they found that the SP-RALP group required less time to catheterize than the MPRALP group (WMD-1.51 days, p = 0.007) [42].Once more, a shorter catheterization duration was linked to less invasiveness; nevertheless, prior research has shown that the majority of patients who had SP-RALP or MP

RALP required 5–7 days of catheterization after surgery.[44] series. The costs of SP RALP were found to be greater in the one study that conducted a cost analysis.

The expenses of SP-RALP and MP RALP prostatectomy may be similar, nevertheless, as the shorter hospital stay may offset the increased cost of surgical supplies [45]. Numerous studies indicate that SP-RALP plays a significant part in an outpatient context [15–17]. Reduced use of opiates and analgesics will undoubtedly improve hospital stays and make outpatient treatments easier.It was found that switching from MP to SP procedures can be accomplished fast in terms of the learning curve of SP surgery; however, it should be mentioned that all of the papers included in these analyses are from high-volume facilities, where skilled surgeons had been performing traditional RALP for many years.

In conclusion, there aren't enough comparison studies that support SP-RALP's non-inferior peri-operative, functional, and oncological outcomes, shorter hospital stays, and lower need for pain management. brief follow-up, potential bias in selection due to rigid inclusion criteria, or alternative methods or strategies used—like the employment of auxiliary Comparing the platforms in terms of functional or oncologic results is limited by a number of circumstances, such as ports during procedures or different surgical experiences between centers. Actually, the majority of the publications that are now accessible on the SP interface are written by a small number of industry experts, whose backgrounds and accomplishments may not accurately reflect those of the typical urologic surgeon.Furthermore, some of the included trials include the first time a surgeon used the platform, which introduces additional biases into the study due to differential familiarity and experience. But the distinctive features of the new purpose-builtA single-port platform may benefit the multiarm robotic system in a number of ways. As previously stated, the preliminary study demonstrated encouraging outcomes in advancing the field of single-site/single-port surgery by providing the strength of traction, EndoWrist technology, and triangulation preservation through a single keyhole incision. Only skilled surgeons who have already finished the learning curve for multiple-port robotic prostatectomy may consider single-port radical prostatectomy as a future procedure. Valid research into the true advantages of the single-port system requires randomized studies with long-term follow-up.Future developments are continuing in terms of platforms and new applicability. For the treatment of localized low- and intermediate-risk prostate cancer, for instance, SP partial prostatectomy has been proposed as a substitute for focused therapy [46]. Organic A specialized robotic platform is required for orifice transluminal endoscopic surgery (NOTES), which was intended to be the advancement of the robotic platform and a fully "scarless" procedure [47].

CONCLUSIONS

The most recent technological advancement in robotically assisted surgery is represented by the da Vinci SP platform. This platform is quickly becoming well-liked in robotic centers of excellence in the United States. With promising results, numerous skilled surgeons have adopted the SP-RALP technique despite the currently scant evidence. The RALP processBy eliminating the need to enter the peritoneal cavity, the SP robotic system reduces the invasiveness of surgery and has been shown to be safe and practical in skilled hands.Although there aren't many high-caliber comparative trials, early findings from busy institutions show encouraging outcomes for oncology, function, and perioperative care.

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Conflicts of Interest
No conflicts of interest are disclosed by the writers.

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