



Robotic Colorectal Surgery with the da Vinci SP

20

Dario Ribero, Diana Baldassarri, and Giuseppe Spinoglio

20.1 Introduction

Over the past few decades, multiport laparoscopy has become the standard surgical approach in the treatment of colorectal diseases. Several randomized trials have, in fact, proven a number of advantages of laparoscopy over open surgery in performing colonic or rectal resections [1].

By aiming to further minimize trauma to the abdominal wall and improve cosmetic outcomes, in the late 2000s, technological advances allowed pioneer surgeons to explore new techniques such as single-incision laparoscopic surgery (SILS) and natural orifice transluminal endoscopic surgery (NOTES), as less invasive alternatives to conventional laparoscopy. However, their widespread adoption has been limited due to intrinsic problems such as the lack of camera and instrument triangulation, limited range of motion with reduced dexterity, and instrument collision. Although some of these issues have been partially solved with a cross-handing technique, use of curved instruments and adoption of robotic platforms, these techniques remain only for skilled surgeons who have completed an adequate learning curve.

In 2018, Intuitive Surgical released for clinical application the da Vinci SP (dV SP), a unique platform specifically designed for single-incision surgery. This system utilizes a C-shaped arm connected to a 25-mm port with four channels to allow the parallel entry of an 8-mm flexible 3D camera and three 6-mm

D. Ribero (✉)

Division of General and Oncologic Surgery, Santa Croce e Carle Hospital, Cuneo, Italy
e-mail: ribero.d@ospedale.cuneo.it

D. Baldassarri

Division of General Surgery, San Gaudenzio Hospital, Novara, Italy
e-mail: dmc.baldassarri@gmail.com

G. Spinoglio

Faculty Colorectal Robotic Surgery, IRCAD, Strasbourg, France
e-mail: gspinoglio@icloud.com

instruments. All instruments are fully wristed with 7 degrees of movement and have an additional elbow flexion for proper triangulation around the target. A hologram located in the bottom center of the display tracks, in real-time, the spatial location of the camera and instruments, thus permitting minimization of internal collisions. In addition, the platform's boom can rotate 360° outside and inside the port's remote center. This facilitates multi-quadrant surgeries and the coordinated movement of the camera and robotic instruments as one unit, helping, for example, to visualize all four quadrants of the rectum. This maneuverability coupled with camera control represents a significant improvement over previous robotic platforms. Overall, it seems that the dV SP platform addresses many of the limitations of single-port transabdominal or transanal surgery. At present the dV SP is not yet available in Europe. Therefore, most of the experiences come from eastern countries and the USA.

The aim of this chapter is to analyze available data in the field of colorectal surgery and to present the authors' initial experience in a cadaveric model to highlight the pros and cons of this new platform.

20.2 Clinical Results of the da Vinci SP in Colorectal Surgery

Limited data still exist on the use of the dV SP in colorectal surgery. The first report was published in 2020 by Noh et al. [2], who described their initial experience with five right colectomies and two anterior resections with favorable short-term clinical outcomes and adequate pathologic results in terms of number of harvested lymph nodes, length of proximal and distal margins and quality of mesocolic or mesorectal fascias. Thereafter, few studies from both eastern [3–7] and western [8–10] institutions confirmed the technical feasibility of different types of colic (right and left colectomies, transverse colectomy) and transabdominal rectal resections, including intersphincteric and abdominoperineal resections. At the time of drafting the present chapter, the largest series of dV SP procedures has been reported by Choi et al. [11]. The authors analyzed 57 consecutive patients with rectal cancer who underwent 34 low anterior resections, 14 ultra-low anterior resections, 7 intersphincteric resections and 2 abdominoperineal resections, with satisfactory short-term outcomes. In fact, despite a 36% overall 30-day morbidity rate, only 2 patients (3.6%) suffered from major (Clavien IIIb–IV) complications, the most frequently recorded being intra-abdominal fluid collection and urinary retention (7 patients each). Final pathology confirmed the excellent performance of the dV SP in rectal resections, with a median number of harvested lymph nodes of 15.8 ± 6.1 and a positive circumferential resection margin rate of 5.3%. Interestingly, due to technical difficulties, 10 surgeries were completed with a single-port laparoscopic hybrid technique using the same robotic access without any additional trocar. Of note, most of the conversions to the laparoscopic approach happened during the first 16 cases. Analysis of the operative time, docking time and surgeon console time also permitted the authors to analyze the learning curve, showing an improvement in surgical performance after 21 cases.

In recent years, an increasing number of total mesorectal excisions (TME) have been made from bottom to up transanally (TaTME), either laparoscopically [12] or robotically (rTaTME) [13]. After the demonstration, in a preclinical cadaveric model [14], that the dV SP can be a viable option to safely and proficiently realize the transanal phase of TaTME, Marks et al. [15] reported the first clinical experience of dV SP rTaTME in two patients who underwent proctosigmoidectomy with hand-sewn coloanal anastomosis. In both patients the authors completed the TME phase transanally; interestingly, while in one patient, the abdominal phase of the operation was completed through an abdominal single-incision with robot re-docking, in the second patient the operation was entirely performed transanally as a pure NOTES procedure.

Over the last decade, the transanal minimally invasive surgery (TAMIS) technique has been increasingly used in the treatment of rectal benign lesions and low-risk T1 adenocarcinomas. Several studies have shown that this approach has several benefits over traditional transanal surgery. However, it remains a challenging procedure due to several shortcomings, such as the lack of a stable platform, the limited space for the surgeon and assistant between the patient's legs, the difficulty of tissue dissection and suturing due to the poor ergonomics and antagonism of contralateral instruments, a limited reach and a long learning curve [16]. The new dV SP has the potential to surpass all the technical challenges of conventional TAMIS. After exploring in a cadaveric study the potential of the dV SP in performing TAMIS procedures [17], Marks et al. evaluated, in a phase II trial on 26 patients, the feasibility and safety of a dV SP rTAMIS [18]. They documented excellent outcomes including no piecemeal extractions and 100% negative margins on final pathology with no mortality and a 15.8% morbidity rate. Although two patients were converted to TME, the authors showed the potential of this new platform in this type of surgery.

20.3 Authors' Experience in Cadaveric Models

In March 2018, we had the opportunity to use the dV SP on cadavers. Access to the robotic platform, laboratory time and cadavers were provided by Intuitive Surgical, Inc. After 3 hours of training lab with the dV SP platform to familiarize with control of the flexible endoscope and instruments and use of the holographic navigation aid, two different operations were performed: a rTaTME and a transvaginal right colectomy with complete mesocolic excision (CME) and D3 lymphadenectomy.

20.3.1 Robotic Transanal Total Mesorectal Excision with the da Vinci SP

The cadavers were placed in the modified lithotomy position in Allen stirrups. A slight Trendelenburg ($\sim 10^\circ$) position was adopted. The patient-side cart was placed at a 90° angle to the left of the body with the vision cart over the left shoulder.

Two different scenarios were imagined, simulating a distance of the tumor's inferior margin to the anorectal junction of 1 cm in one cadaver and 4 cm in the other.

The first case initiated by manually creating a purse-string closure of the rectal lumen, at the level of the dentate line. Then, a partial intersphincteric resection was performed robotically and the dissection was continued cephalad until the levator ani plane was reached, allowing introduction of the GelPOINT Path Transanal Access Platform (Applied Medical, Inc.). This part of the operation was done positioning the remote center of the robotic trocar approximately 15 cm from the anus. The setup of the instruments and camera was as follows: the camera was inserted through the camera port, a Cadieere forceps, monopolar curved scissors, and a fenestrated bipolar forceps were inserted through ports 1, 2 and 3, respectively. The second case began with the introduction of the transanal platform. The robotic trocar was positioned at 12 o'clock of the gelatinous membrane of the device, and a 10-mm port was inserted in the inferior part of the GelSeal cap. After docking the dV SP, the instruments were set up as in the other case. A 15-mmHg pneumorectum was established and closure of the rectum with a full thickness purse-string was constructed and tightened with the robotic instruments (needle driver in arm 2). After circumferentially marking the site of rectotomy, a full thickness and perpendicular transection of the rectal wall was performed with monopolar scissors. Then, the initial dissection was conducted until the posterior avascular presacral plane was encountered. The mesorectal dissection proceeded in the posterior quadrants first, followed by dissection of the distal anterior plane. Then, the lateral sides were approached. Thereafter, dissection following the TME plane proceeded cephalad in a cylindrical fashion until the abdominal cavity was entered by opening the peritoneum of the Douglas pouch. The specimen was extracted to evaluate the quality of TME which was graded as "complete" with an intact mesorectum in both cases.

20.3.2 Robotic Transvaginal Right Colectomy with the da Vinci SP

Cadaver, patient-side cart and vision cart were placed as during the dV SP rTaTME, adding a 10° left rotation of the cadaver. The operation started with performing a posterior colpotomy through which an Alexis Wound Protector-Retractor (Applied Medical, Inc.) was inserted. Then the robotic trocar was placed transvaginally with the tip of the cannula in the abdominal cavity. The plastic sheath of the Alexis was closed around the trocar with an umbilical tape before establishing a 12-mmHg pneumoperitoneum. A 12-mm trocar was placed 5 cm above the left iliac spine. After docking the dV SP, a fenestrated bipolar forceps, monopolar curved scissors and a Cadieere forceps were placed in ports 1, 2 and 3. After positioning the small bowel in the left upper quadrant, a bottom-to-up right colectomy procedure with CME and D3 lymphadenectomy was performed, as previously described with the da Vinci Xi (dV Xi) [19]. Of note, the anastomosis was performed mechanically with a linear stapler introduced through the assistant trocar. The ileocolic anastomosis was mechanical, side-to-side, isoperistaltic with the enterotomies closed with a

manual continuous barbed suture. The specimen was extracted transvaginally and inspected to evaluate the quality of the mesocolic dissection, which was graded C.

20.3.3 Technical Considerations

In the authors' experience performing rTaTME with the dV SP facilitated all critical steps of the procedure as compared to standard TaTME or rTaTME with the dV Xi. First, it solved issues related to the limited space for the surgeon and assistant between the patient's legs while providing a stable surgical field with an enhanced 3D vision. Second, since all three instruments and endoscope are oriented parallel, external collisions between the arms or with the patient's thigh were avoided. Third, the instruments' articulation facilitated the initial posterior dissection which must be performed at a markedly caudal and posterior angle to enter the proper plane. In addition, improved ambidexterity and ergonomics enhanced the ease of performing the lateral dissection, a critical step for the risk of pelvic nerve injuries. This ease of dissection was further improved by the possibility to rotate the boom with coordinated instrument and camera movements to optimize the instruments' angle of approach throughout the procedure. Overall, all steps were simplified by the possibility of utilizing a third arm for traction/exposure. This represents a major advance compared to the da Vinci Si/Xi rTaTME or laparoscopic TaTME, where only two arms/instruments are available. In fact, a proper exposure has the potential to improve preservation of the integrity of the mesorectal envelope. All of these advantages might translate to a reduction of the surgeon's fatigue, stress and discomfort, resulting in an increased surgical performance.

In right colectomy, while no major differences in terms of instrument maneuverability, precise tissue handling, and meticulous dissection were observed compared to the dV Xi platform, the specific design for single-port surgery permitted us to explore a new surgical access. Although no objective data are available comparing the mechanical force of the dV SP and dV Xi instruments, we felt that in some steps the mechanical force was a little weak. In addition, compared to the multiport system, we noted a limited range in third arm traction, which in some circumstances might be a partial obstacle. An additional limitation is represented by the lack of a suction, stapling, and, more importantly, vessel sealing device.

In all our surgeries, the dV SP demonstrated to be straightforward to set up, easy to use and precise in dissection and suturing.

20.4 Conclusions

The available data and the authors' personal experience indicate that in colorectal surgery there is significant potential for the use of the dV SP, which might become competitive with the dV Xi. Many questions remain to be answered in the coming years. In particular, future studies will have to define the clinical role of this technology and establish which patients will benefit the most from its application.

References

1. Jayne DG, Thorpe HC, Copeland J, et al. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. *Br J Surg*. 2010;97(11):1638–45.
2. Noh GT, Oh BY, Han M, et al. Initial clinical experience of single-incision robotic colorectal surgery with da Vinci SP platform. *Int J Med Robot*. 2020;16(3):e2091.
3. Kim HJ, Choi GS, Song SH, et al. An initial experience with a novel technique of single-port robotic resection for rectal cancer. *Tech Coloproctol*. 2021;25(7):857–64.
4. Piozzi GN, Kim JS, Choo JM, et al. Da Vinci SP robotic approach to colorectal surgery: two specific indications and short-term results. *Tech Coloproctol*. 2022;26(6):461–70.
5. Noh GT, Chung SS, Lee RA, et al. Robotic single-incision right hemicolectomy with extended lymphadenectomy using the da Vinci SP surgical platform. *J Minim Invasive Surg*. 2021;24(2):109–12.
6. Piozzi GN, Lee DY, Kim JS, Kim SH. Da Vinci single-port (SP) robotic transverse colectomy for mid-transverse colon cancer. *Tech Coloproctol*. 2022;26(8):681–2.
7. Song SH, Kim HJ, Choi GS, et al. Initial experience with a suprapubic single-port robotic right hemicolectomy in patients with colon cancer. *Tech Coloproctol*. 2021;25(9):1065–71.
8. Marks JH, Kunkel E, Salem J, et al. rSILS: initial clinical experience with single-port robotic (SPr) right colectomy. *Tech Coloproctol*. 2020;24(8):817–22.
9. Marks JH, Salem JF, Anderson BK, et al. Single-port robotic left colectomy: first clinical experience using the SP robot (rSILS). *Tech Coloproctol*. 2020;24(1):57–63.
10. Salem JF, Agarwal S, Schoonyoung H, et al. Initial clinical experience with single-port robotic (SP r) left colectomy using the SP surgical system: description of the technique. *Surg Endosc*. 2021;35(7):4022–7.
11. Choi MS, Yun SH, Oh CK, et al. Learning curve for single-port robot-assisted rectal cancer surgery. *Ann Surg Treat Res*. 2022;102(3):159–66.
12. Sylla P, Rattner DW, Delgado S, Lacy AM. NOTES transanal rectal cancer resection using transanal endoscopic microsurgery and laparoscopic assistance. *Surg Endosc*. 2010;24(5):1205–10.
13. Hu JM, Chu CH, Jiang JK, et al. Robotic transanal total mesorectal excision assisted by laparoscopic transabdominal approach: a preliminary twenty-case series report. *Asian J Surg*. 2020;43(1):330–8.
14. Kneist W, Stein H, Rheinwald M. Da Vinci single-port robot-assisted transanal mesorectal excision: a promising preclinical experience. *Surg Endosc*. 2020;34(7):3232–5.
15. Marks JH, Salem JF, Adams P, et al. SP rTaTME: initial clinical experience with single-port robotic transanal total mesorectal excision (SP rTaTME). *Tech Coloproctol*. 2021;25(6):721–6.
16. Lee L, Kelly J, Nassif GJ, et al. Establishing the learning curve of transanal minimally invasive surgery for local excision of rectal neoplasms. *Surg Endosc*. 2018;32(3):1368–76.
17. Marks JH, Ng S, Mak T. Robotic transanal surgery (RTAS) with utilization of a next-generation single-port system: a cadaveric feasibility study. *Tech Coloproctol*. 2017;21(7):541–5.
18. Marks JH, Kunkel E, Salem JF, et al. First clinical experience with single-port robotic transanal minimally invasive surgery: phase II trial of the initial 26 cases. *Dis Colon Rectum*. 2021;64(8):1003–13.
19. Petz W, Ribero D, Bertani E, et al. Suprapubic approach for robotic complete mesocolic excision in right colectomy: oncologic safety and short-term outcomes of an original technique. *Eur J Surg Oncol*. 2017;43(11):2060–6.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits any noncommercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if you modified the licensed material. You do not have permission under this license to share adapted material derived from this chapter or parts of it.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

