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Implementation and early outcomes of Da Vinci SP® Robot-Assisted partial nephrectomy via supine anterior retroperitoneal access: Italian single centre experience

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Introduction The da Vinci SP® Surgical System, approved by the FDA in 2018 for urological procedures and by the European Union in 2024, is now being adopted across Europe. This report presents the first Italian experience with single-port robot-assisted partial nephrectomy (RAPN) using the SP system.

Material and methods From May 8 and May 31, 2024, ten consecutive male patients underwent single-port RAPN via a Lower Anterior retroperitoneal Access (LAA) at a single institution. Perioperative and early postoperative variables were prospectively collected and analyzed.

Results All 10 procedures were completed without conversion to multiport or open surgery. One case was converted to radical nephrectomy for oncologic reasons. Eight procedures were performed on the right kidney and 2 on the left. Median patient age was 72 years (IQR 64–72), median BMI was 28.0 kg/m² (IQR 24.9–34), and median Charlson Comorbidity Index was 5 (IQR 4–6). Sixty percent had an ASA score of 3. Median RENAL and PADUA scores were 8 (IQR 7–9) and 7 (IQR 7–8), respectively. Tumours were <4 cm. Median warm ischaemia time was 21.5 minutes (IQR 15.25–26.5), operative time was 120 minutes (IQR 100–180), and blood loss was 60 ml (IQR 50–80). Pre- and postoperative eGFR medians were 84.9 and 84.2, respectively. Patients were discharged on postoperative day one with a median pain score of 1.3/10. No major (Clavien-Dindo ≥ III) complications occurred. One patient had a positive surgical margin.

Conclusions Single-port RAPN with the da Vinci SP® system is safe and feasible, with promising short-term outcomes.

Key Words: partial nephrectomy ‹› SP® surgical system ‹› supine anterior retroperitoneal access ‹› single-site surgery

INTRODUCTION

Over the past decade, robot-assisted partial nephrectomy (RAPN) has become the preferred surgical procedure for the management of localized kidney tumours [1–3]. One of the principal advantages of robotic surgery lies in its ability to simplify the reconstruction process, enabling enhanced nephron preservation and facilitating the treatment of more complex renal masses [4–6].

The da Vinci Single Port™ system, cleared by the FDA in 2018, has ushered in a new era in robotic surgery, offering the capability to perform complex procedures through a single abdominal incision. This advanced technology has demonstrated safety and feasibility in a range of urological procedures,

including partial nephrectomies [7–9]. After much expectation [10], this new robotic platform recently received the CE mark approval and entered the European market in 2024. Therefore, a few selected centres in Europe started implementing SP robotic surgery in their daily practice.
In this study, we present the first Italian experience with the da Vinci Single Port™ system in performing RAPN and provide a comprehensive analysis of its implementation, alongside a discussion of its future perspectives.

MATERIAL AND METHODS

Study design and analysis

This is a retrospective analysis of the first 10 cases performed at our tertiary care center in May 2024. All patients consented to undergo single-port (SP) RAPN for a cT1a (<4 cm) single renal mass. These procedures represented the initial single-port surgical experience of the operating surgeon, who, despite being new to the SP platform, had over 10 years of experience across all previous generations of robotic systems. All surgeries were performed by a dedicated team with extensive expertise in multiport robotic surgery, all of whom had completed specific preclinical training on the SP system.
Key perioperative data, including operative time, warm ischaemia time, estimated blood loss (EBL), length of hospitalization, and complications, were recorded and analyzed. Tumour complexity was assessed using the RENAL [11] and PADUA [12] scores. The prediction of adherent perinephric fat (APF) was calculated using the MAP score [13]. Conversion was defined as a change from the planned single-port approach to a multiport robotic, traditional laparoscopic, or open surgical technique. Clavien-Dindo classification was employed to categorize postoperative complications. The Trifecta rate (warm ischaemia <25 minutes, no perioperative complications Clavien-Dindo, and negative surgical margins) served as a key surrogate for surgical quality [14]. Renal function was assessed by using eGFR. Postoperative pain was evaluated at 24 hours after surgery by using a Numeric Rating Scale (NRS) from 0 to 10. Pathological data included pathological stage, histology, and surgical margin status.

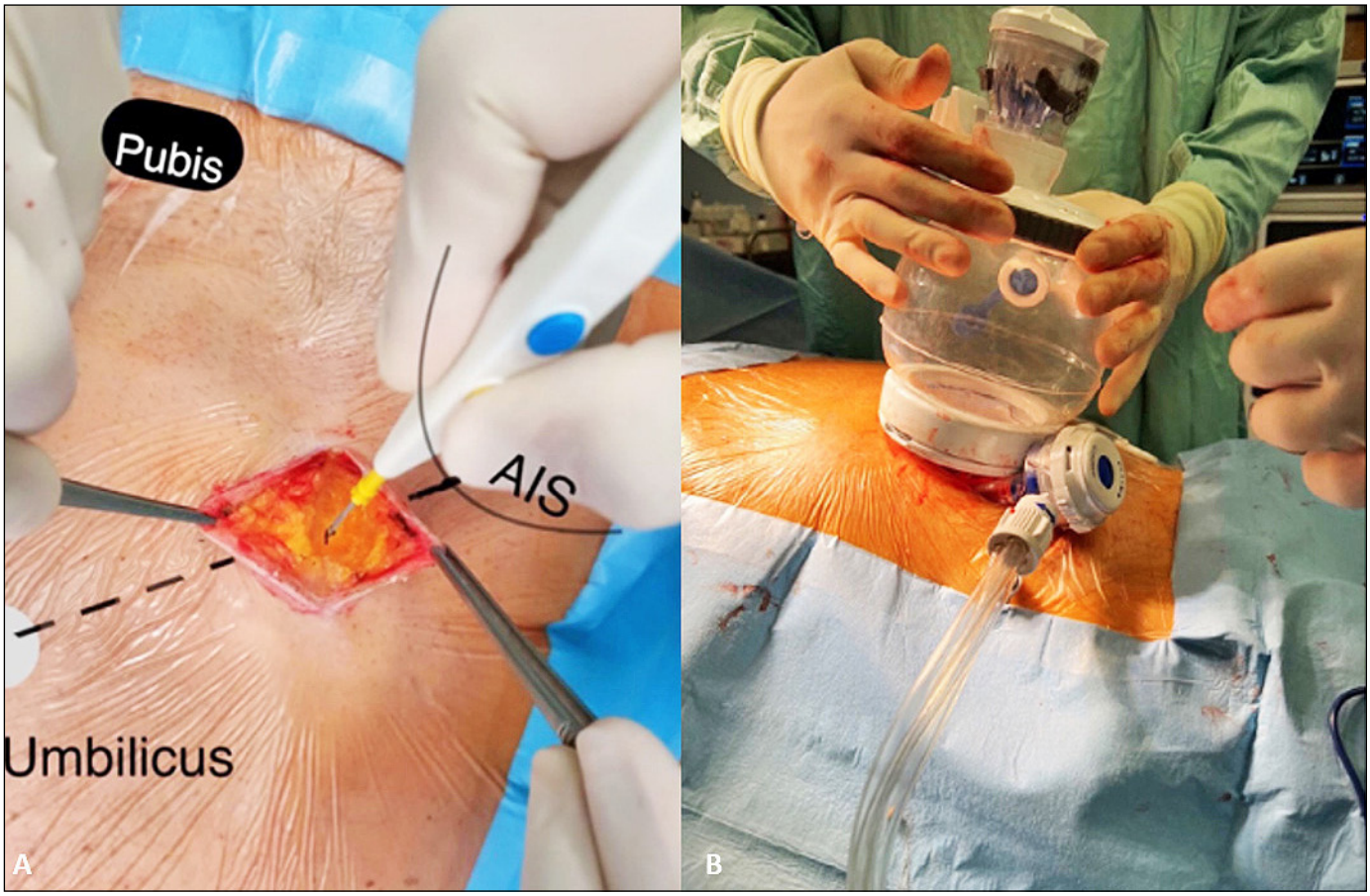

Figure 1. A) *Skin incision at the McBurney point.* **B)** *The SP "Access-Port" and "Side-car" positioned AirSeal trocar.*

Descriptive analysis was used for data reporting. Categorical variables were presented as frequencies and percentages, while continuous variables were reported as median with interquartile range (IQR).

Surgical technique

The main features of the da Vinci SP system have been described elsewhere [15].
All procedures were performed via supine anterior retroperitoneal access as originally described by Pellegrino et al. [16]. Generally, patients were positioned in a supine position with a rubber roll under the ipsilateral flank to achieve a slight 10-degree tilt. A 4 cm incision was made approximately 3 cm medial and 3 cm cranial to the anterior superior iliac spine (Figure 1A).
Subsequently, once the subcutaneous fat tissue is retracted, the anterior fascia is visualized and incised. Then, the muscular layers are bluntly dissected to access the retroperitoneal space. During this step, the use of a space-making balloon is not necessary. Instead, a retroperitoneal space lateral to the peritoneal wall is manually created with gentle digital dissection without entering the peritoneum. The small (4–7 cm) access port (Intuitive Surgical, Sunnyvale, CA, USA) is placed. Additionally, a 8 mm AirSeal assistant trocar is inserted in a "sidecar" fashion (through the same skin incision and separate fascia access) [17] (Figure 1B).
Insufflation is started and maintained at 10 mmHg. SP robotic instruments are deployed with a robotic camera at 6 o'clock, Cadiere forceps at 12 o'clock, monopolar scissors at 3 o'clock, and fenestrated bipolar forceps at 9 o'clock. In the absence of the Remotely Operated Suction Irrigation System (ROSI), a modified 14 Fr nasogastric tube connected to a classic aspiration system was used as an alternative flexible suction.
Once retroperitoneal defatting is performed, the psoas muscle is identified and traced upwards. Main anatomical landmarks can be identified at the time, such as the ureter or the vena cava on right side cases and aorta on left side cases. The ureter is then traced to the renal pelvis and hilum. Due to the lack of low-pressure robotic bulldog clamps designed explicitly for SP surgery in Europe, renal vessels are clamped using laparoscopic bulldog clamps, which are introduced through a sidecar trocar by the assistant (Figure 2A, B). Subsequent surgical phases are completed following standard procedures [18].

Bioethical standards

Due to the retrospective nature of the study, approval from the bioethics committee was not required. All patients provided written informed consent for the use of their clinical data.

RESULTS

A total of 10 consecutive patients underwent SP RAPN. The population baseline and tumour clinical characteristics are summarized in Table 1. The medium tumour size was 2.3 cm (IQR 1.2–4). Median RENAL score was 8 (IQR 7–9), and the median PADUA score was 7 (IQR 7–8). The median MAP score was 2 (IQR 0.81–2.8).

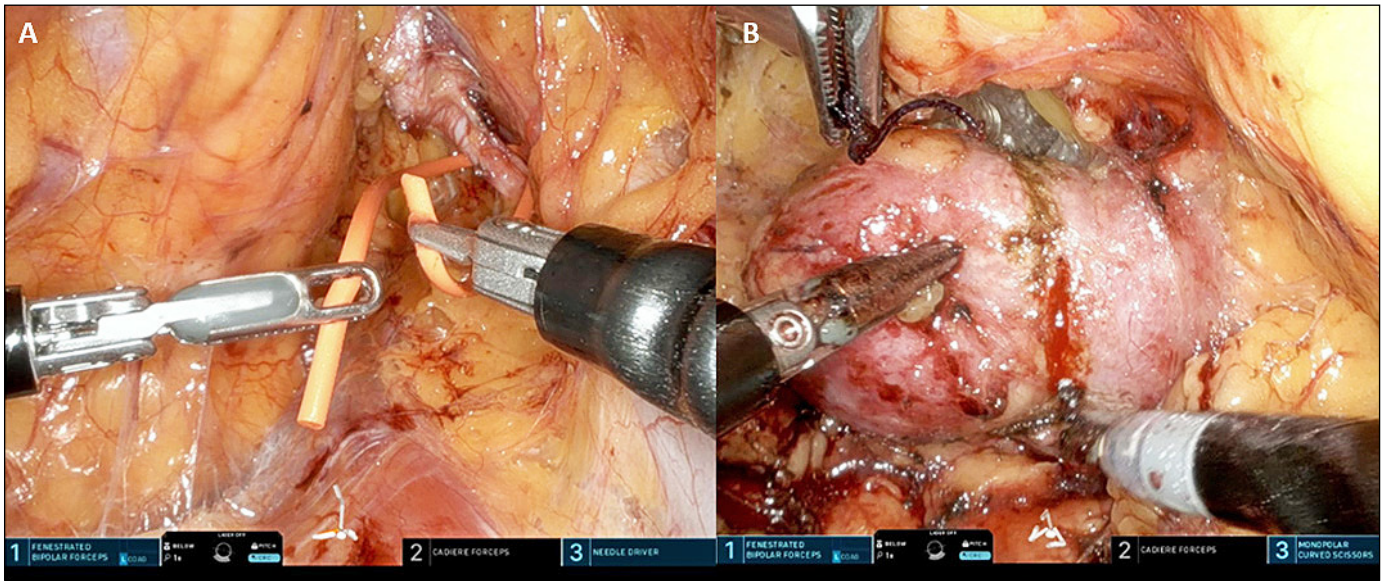

Figure 2. A, B) *Intraoperative view during single-port robot-assisted partial nephrectomy.*

Perioperative data are detailed in Table 2. All procedures were successfully completed without any conversion to multiport robotic or open surgery. In 1 case, an additional port was placed to assist in the management of bleeding. One procedure was converted to a radical nephrectomy for oncological reasons, without the need to modify the surgical approach. In this case, intraoperative findings revealed features highly suspicious for invasive disease, including loss of normal tissue planes and adherence to surrounding structures, which precluded safe partial resection. The decision to convert was made to ensure oncological safety while avoiding additional access-related morbidity.

The median warm ischaemia time was 21.5 minutes (IQR 15.25–26.5).

The median EBL was 60 ml (IQR 50–80), and the median operative time was 120 minutes (IQR 100–180). All patients were discharged on the first postoperative day. The average pain score at discharged was 3.2 (IQR 2.4–5). No high grade (Clavien-Dindo grade III or above) complications were reported. Positive surgical margin was found in 1 patient. The trifecta outcome was achieved in 7 out of 10 patients (70.0%). No patients required narcotic use one week after discharge.

DISCUSSION

In this study, we describe our initial experience with application of the da Vinci SP surgical platform in RAPN. Our findings show that we were able to safely incorporate this novel technology in our robotic surgical practice with immediately favorable surgical outcomes.

Despite the positive outcomes achieved in this series, it is important to acknowledge that patient selection was limited to low-to-intermediate risk cases. The median RENAL score was 8 (IQR 7–9), and the median PADUA score was 7 (IQR 7–8), indicating moderate tumour complexity. Furthermore, the median MAP score was 2 (IQR 0.81–2.8), reflecting a low-to-moderate risk of intraoperative adhesions. The majority of tumours (8/10) were located in the posterior renal region, while the remaining lesions (2/10) were situated anteriorly. All tumours (10/10) were confined to the inferior or mesorenal pole, which are anatomical locations generally regarded as optimal for single-port robotic surgical access.

Our series was deliberately designed to include patients with low BMI and renal masses in favorable locations to minimize procedural challenges and reduce the risk of complications. This careful case selection was crucial during the initial implementation phase of the da Vinci SP platform, as it allowed for the optimization of outcomes while navigating the learning curve associated with this novel technology. Similar approaches have been emphasized in the literature as essential for procedural success when introducing innovative surgical techniques, ensuring both safety and feasibility during early adoption. The lack of low-pressure robotic bulldog clamps specifically designed for SP surgery in Europe posed a unique challenge during SP RAPN. To address this

Table 1. *Baseline and pathological characteristics*

Variable	Overall (n = 10)
Age, median (IQR)	72 (64.0–72.0)
BMI, median (IQR)	28 (24,9–34)
Male gender [n (%)]	10 (100.0)
Charlson Comorbidity Index [n] (IQR)	5 (4–6)
ASA score [n (%)]	
2	4 (40.0)
3	6 (60.0)
Hx of previous abdominal surgery [n (%)]	2 (20.0)
PADUA score, median (IQR)	7 (7–8)
RENAL score, median (IQR)	8 (7–9)
MAP score, median (IQR)	2 (0.81–2.8)
Tumor location [n (%)]	
Inferior	4 (40.0)
Middle	6 (60.0)
Tumor side [n (%)]	
Right	8 (80.0)
Left	2 (20.0)
Baseline Hb [g/dl], median (IQR)	14.9 (13.5–16.1)
Baseline creatinine [mg/dl], median (IQR)	0.95 (0.86–1.06)
Baseline eGFR [ml/min], median (IQR)	84.9 (47.6–112.1)
cT stage [n (%)]	
T1a	10 (100.0)

Table 2. *Outcomes*

Variable	Overall (n = 10)
Operative time [min], median (IQR)	120 (100–180)
Warm ischemia time [min], median (IQR)	21.5 (15.25–26.5)
Estimated blood loss [ml], median (IQR)	60 (50–80)
Intraoperative complications [n (%)]	0 (0)
Discharge Hb [g/dl], median (IQR)	14.1 (13.2–16)
Discharge creatinine [mg/dl], median (IQR)	1.23 (0.98, 1.36)
Discharge eGFR [ml/min], median (IQR)	84.2 (67.6–94.2)
Discharge on POD1 [n (%)]	10 (100.0)
Pain score 24 h discharge, median (IQR)	3.2 (2.4, 5.0)
pT stage [n (%)]	
T1a	10 (100.0)
Positive surgical margins [n (%)]	1 (10.0)

issue, renal vessels were clamped using laparoscopic bulldog clamps, which were introduced via an 8 mm AirSeal assistant trocar in a sidecar position. This setup allowed the assistant to place the clamps manually, compensating for the fact that most vascular bulldogs available on the market are incompatible with the SP robotic arm. Additionally, only small-to-medium-sized laparoscopic bulldogs could pass through the robotic trocar, which occasionally resulted in suboptimal arterial clamping and necessitated the placement of plus one trocar in 2 cases.

Perioperative results showed no conversion to open surgery, minimal blood loss, and a median warm ischaemia time of 21.5 minutes. Notably, 70.0% of patients achieved a trifecta outcome, with only one case of positive surgical margins, and no patients required postoperative narcotic use or adjuvant treatment.

The number of published series on SP RAPN remains limited, with current evidence primarily derived from early institutional experiences and small cohorts (Table 3). Initially, Kaouk et al. [19] reported their experience in RAPN using the SP system, demonstrating the possibility of completing procedures without the need for additional surgical ports. Subsequent studies conducted by Shukla et al. [20] and Palacios et al. [21] confirmed the efficacy and safety of RAPN with the SP system, achieving results comparable to traditional multi-port partial nephrectomy.

Table 3. *SP RAPN: overview of main reported series (at least 10 pts)*

Author	Year	N	Approach	Tumor size [cm]	Main outcomes
Shukla et al. [20]	2021	12	TP	3.1*	171.6 min* WIT: <25 min Complication rate: 0% LoS: 1.2 days* PSM: 1%
Palacios et al. [21]	2022	20	RP	3^	OT: 166.5 min^ WIT: 25 min^ Postoperative complications: 2 (10.0%) PSM: 0%
Bang et al. [22]	2023	30	TP and RP	2.1*	OT: 108 min* WIT: 11.5 min* Complication rate: 3.0% LoS: 4.13 days* PSM: 0%
Francavilla et al. [2]	2022	14	TP	2.6^	OT: 202 min^ WIT: 18 min^ Complication rate: 14.0% LoS: 1 day^ PSM: 7.0%
Ditonno et al. [8]	2024	12	TP	2.7^	OT: 156.5 min^ WIT: 29.5 min^ Complication rate: 0% LoS: 25 hours^ PSM: 0%
Licari et al. [9]	2024	30	TP and RP	3.1^	OT: 155.5 min^ WIT: 25 min^ Complication rate: 26.7% LoS: 25 hours^ PSM: 5.0%

*Mean; ^median; LoS – length of stay; OR – operating room; OT – operative time; PSM – positive surgical margin; RAPN – robot-assisted partial nephrectomy; RP – retroperitoneal; SP – single port; TP – transperitoneal; WIT – warm ischaemia time

These findings highlight the potential of the da Vinci SP platform to revolutionize partial nephrectomy procedures. Another retrospective analysis of 30 patients undergoing SP RAPN either by transperitoneal or retroperitoneal approach led to similar results [22]. Additionally, Na et al. [23] assessed the feasibility of performing RAPN via a single incision using the SP system in a cohort of 14 patients, comparing it to the previously employed Xi single-site platform. The results confirmed the feasibility of SP-RAPN, overcoming many limitations of previous single-site techniques. Notably, the use of articulating instruments helped overcome the loss of triangulation between laparoscopic instruments, thereby reducing instrument collisions and enhancing traction force.

Recently, Nguyen et al. [24] conducted a meta-analysis comparing SP-RAPN and MP-RAPN. Their results showed that SP-RAPN had longer ischaemia times and higher blood transfusion rates compared to MP-RAPN, but it was associated with significantly less estimated blood loss and higher postoperative glomerular filtration rates at 6 months. In contrast to the aforementioned studies, in our recent experience, all procedures were performed extraperitoneally utilizing the Lower Anterior Access (LAA) technique which involves creating a retroperitoneal space through a small incision near the McBurney point while the patient is positioned supine.

This approach minimizes tissue dissection and avoids entry into the peritoneum, offering several benefits such as reduced operative times, fewer complications, and early patient mobilization with same-day discharge in most cases. Additionally, it shortened operating room time by eliminating the need for lateral decubitus positioning.

However, since we are still in the learning curve, operative times were slightly longer compared to the average RAPN performed with a multiport platform at our institution. As for intraoperative blood loss, it was minimal. Furthermore, based on our experience, despite the numerous advantages associated with single-port access, the application of Hem-o-Lok clips during renorrhaphy presents significant challenges without the use of an accessory port, such as the "sidecar" or "plus-one" configuration.

The evaluation of RAPN efficacy based on Trifecta criteria demonstrated a high success rate, highlighting the validity of this surgical technique. Particularly surprising was the minimal postoperative pain, which enabled us to refrain from using analgesic medications such as narcotics or opioids. This facilitated early mobilization on the day of surgery and enabled discharge on the first postoperative day. Further examination of this data, especially concerning postoperative opioid prescriptions, deserves attention, given the prevalent opioid consumption in some countries.

Finally, we acknowledge the presence of a learning curve associated with the use of the da Vinci SP platform, especially in managing the new modalities (Relocate, Adjust) and the articulated camera. Nevertheless, despite these technical challenges, the safety and effectiveness of SP-RAPN in the hands of experienced surgeons have been confirmed. Moreover, given the relatively high median patient age in our cohort (72 years), our findings further support the feasibility and safety of single-port RAPN even in elderly patients [25].

CONCLUSIONS

Our initial experience suggests that SP RAPN via supine anterior retroperitoneal approach can be safely implemented at a center with an established robotic program and it is a reproducible technique. The standardization of a retroperitoneal approach allowed us to streamline the procedure without significant issues. Despite the challenges of the initial learning curve, good surgical outcomes could be immediately achieved. There is an obvious clinical benefit for the patient in terms of reduced hospitalization and lower surgical morbidity. We plan to further implement this procedure by expanding our indications as our experience matures.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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ETHICS APPROVAL STATEMENT

The ethical approval was not required.

DATA AVAILABILITY

https://zenodo.org/records/14621656

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