10 Standard and Robot-Assisted Laparoendoscopic Single-Site Urologic Surgery

Riccardo Bertolo, Rair José Valero Carrion, and Jihad H. Kaouk

Standard Laparoendoscopic Single-Site Surgery

Laparoendoscopic single-site surgery (LESS) represents an evolution in laparoscopic surgery to potentially further reduce morbidity and improve cosmesis [1, 2]. The term LESS has been recently coined to incorporate a group of related techniques that perform laparoscopic surgery through a single access site in the abdomen typically concealed in the umbilical scar [3]. LESS came in vogue due to a perceived impression that reducing the number of ports would naturally result in reduced morbidity and improve cosmesis of conventional multiport laparoscopy. Since its initial report by Raman and colleagues, LESS surgery has increasingly been used to perform various urological procedures, including those on the kidney, ureter, bladder, and prostate. At the time of this writing, a total of 1023 manuscripts written have been reported on LESS, of which 328 have been from urology. The aim of the current chapter is to describe specialized instrumentation and technical nuances with respect to LESS renal surgery.

Access Instrumentation

LESS can be performed by inserting conventional laparoscopic ports through a single umbilical incision or with the use of one of the commercially available multichannel trocars. The advantage of the single-site approach of using typically three low-profile laparoscopic trocars minimizes the need for specialized instrumentation as relates to access (Fig. 10.1). In contrast, the single-port approach utilizes a variety of purpose-specific ports that have multiple channels for the use of the optic and instruments [4]. Some of the clinically used industry-driven access devices for LESS are TriPort TM and QuadPort TM (Olympus Medical, Tokyo, Japan), Uni-X Single Port TM (Pnavel Systems, Cleveland, OH, USA), and GelPort™ (Applied Medical, Rancho Santa Margarita, CA). These trocars are all typically inserted through a single umbilical incision, although extra umbilical sites have also been utilized. The TriPort™ and QuadPort™ (Olympus Medical, Tokyo, Japan) are the most commonly used and known FDA-approved, first-generation access system. The TriPort and TriPort Plus have a smaller ring compared to the larger QuadPort. Each device consists of a retractor component and a valve component, where the instruments are inserted. The design advantages of this port are as follows: tight seal, complete flexibility, no internal profile, and compatibility with curved, straight, and articulating instruments.

R. Bertolo · R. J. Valero Carrion · J. H. Kaouk (✉)
Center for Robotic and Image Guided Surgery, Glickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, OH, USA
e-mail: kaoukj@ccf.org

S. L. Best, S. Y. Nakada (eds.), *Minimally Invasive Urology*,
https://doi.org/10.1007/978-3-030-23993-0_10

Fig. 10.1 Low-profile laparoscopic trocars (*blue circles*) can be used with a single-port device or a single-skin incision through multiple aponeurosis accesses

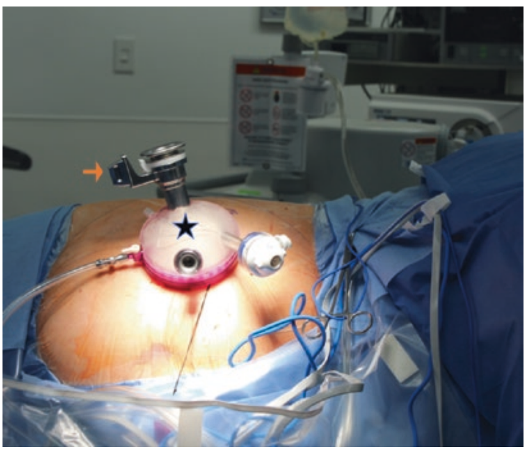

Fig. 10.2 GelPORT/GelPOINT™ (*black star*), low-profile trocar (*orange arrow*), comes with the device. It can be used for laparoscopic or robotic technique

Additionally, specimens can be easily retrieved through the TriPort and QuadPort by detaching the valve without the need to remove the ring.

The GelPort™ (Applied Medical, USA) was already in use in hand-assisted laparoscopic surgery and is now modified for use in LESS (Fig. 10.2). It has a GelSeal cap that provides a pseudo abdomen for a larger platform for triangulation, incorporates insufflation and smoke evacuation capabilities, provides a flexible fulcrum for improved instrument articulation, and maintains pneumoperitoneum. There is an Alexis wound protector/retractor that accommodates 1.5–7 cm incisions. GelPort™ also facilitates extracorporeal anastomosis and specimen retrieval while protecting the incision site.

The low-profile sleeves accommodate 5–12 mm instrumentation and offers greater freedom of movement due to low-profile design. The advantage of the GelPort is that the exact location of the ports can be selected by the surgeon, as is the length of the fascial incision. Thus, for procedures that require extraction, one can make a larger incision and position the working ports to achieve triangulation in the small space. Other access devices (SILS Port™ (Covidien), X-Cone™ (Karl Storz), Air Seal™ (SurgiQuest), SLASS™ (Ethicon), and Octoport™ (Daikin Surgical, Korea)) and a detailed description of them are beyond the scope of this chapter.

Optics with LESS

Optics has also been optimized to accommodate the needs of LESS. Conventional laparoscopes result in external clashing because of their large camera head and light cable exiting at 90° (Fig. 10.3). Newer scopes combine light and camera systems to keep the camera head and

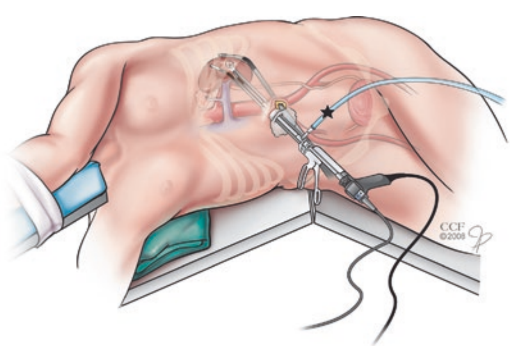

Fig. 10.3 Conventional laparoscope during a kidney single-site surgery. Camera head (*blue circle*), light cable (*black star*). Associated with crowded space and frequent instrument clashing. (© Cleveland Clinic Foundation, used with permission)

light cord out of the operative field. In addition, extra-long scopes allow the camera operator to work outside of the operative space, providing the surgeon with more room to operate.

Most recently, endoscopes with a deflectable tip have been developed to provide the adequate angle of view while keeping the assistants' hand outside the already cramped working space during LESS surgery. In addition to technologic developments, many technical tips may help minimize clashing between the camera assistant and the surgeon (e.g., combination of instruments: (1) large and short, (2) curved and straight, (3) straight and articulated; extra-large and flexible endoscopes, and also putting camera assistant in a sit-down position or in a different ground level).

LESS Instruments

Clashing of hands and instruments is inherent to LESS, and much of the instrument development is aimed at minimizing clashing and restoring triangulation. LESS procedures can be performed using a combination of conventional straight, bent rigid, and actively articulating instruments. In straight instruments, the parallel and close distance of the right-hand and left-hand instrument shafts of standard laparoscopic instruments through a single access site results in the crowding of the laparoscope and the instruments. The surgeon can hold instruments in a different axis and use variable length instruments, which help to keep away the working hand from the retracting hand to partially offset this limitation. With regard to rigid-bent instruments, those with a single bend or multiple bends are available. The advantage is that these are generally reusable, resulting in a minimum increase in disposable cost. The bends are strategically located to improve triangulation and/or increase space external to the port to reduce clashing. Limitations of these instruments are that the bends are fixed and not always optimal.

Additionally, these instruments require specialized trocars to be inserted. For articulating instruments, several of them that have a wristed internal motion are available for LESS surgery. The articulation is typically controlled by intuitively manipulating the handle around a pivot point. The advantages of articulating instruments are that the angle of articulation can be changed, and these instruments can be inserted through standard straight, rigid trocars. Limitations include relative lack of robustness, cost, and a learning curve to control articulation. Experts have varied in their choice of instruments, and often surgeons use a combination of straight, bent, and articulating instruments during LESS procedures.

New Technologies in LESS

Magnetic anchoring and guidance system (MAGS) is a novel technique that may alleviate many of the current challenges of LESS. The system centers around intracorporeal instruments that are delivered through the single access site and anchored through the abdominal wall with extracorporeal magnetic devices. The theoretical benefits of this system are the following: ability to be externally controlled, continuously adjustable positioning without the need for external incisions or dedicated ports, reduction of internal and external collisions, restoration of triangulation, and improvements in visualization. Recently, the initial clinical experience with the MAGS camera for LESS nephrectomy and appendectomy was described [5].

During these procedures, the entire dissection was carried out with rigid, straight instruments with only MAGS camera visualization. The authors found that the use of MAGS camera resulted in fewer instrument collisions and improved surgical working space and provided an image comparable to conventional laparoscopy. Although currently limited by a fixed 0° lens, fixed focus, external wires, magnets requiring a thin abdominal wall, and limited light delivery, innovations on the horizon aim to address each of these issues [5, 6].

Another area of development is the use of in vivo robotic instruments with the potential to provide a stable platform while providing precise tip maneuverability [7]. Similar to MAGS, these robots are delivered through the single incision and come in two types: either independently mobile or fixed to a base that extends through the port. Several examples have been described such as pan and tilt cameras, 3D-imaging systems, mobile adjustable-focus robotic cameras (MARC), and mobile biopsy graspers [6, 7].

These instruments seek to minimize internal and external clashing while providing improved dexterity and intuitive tissue manipulation, which could be used alone or in conjunction with standard LESS instrumentation, as well as with each other. Although their applications are currently limited, further developments aim to increase battery life, increase the complexity of allowable maneuvers, and include transition to wireless technology for control [7].

Common LESS Clinical Procedures

In general, standard LESS surgery has been performed for extirpative and reconstructive renal surgery, including transperitoneal and retroperitoneal nephrectomy (radical and partial), nephroureterectomy, donor nephrectomy, and pediatric LESS interventions. The majority of pelvic LESS has been performed using robotic assistance and will be described elsewhere in the text. When it comes to patient selection, in general, patients of average build and height should be preferred so that the kidney is within the reach of the umbilicus. For obese patients, the incision can be moved outside the umbilicus. For the extraction of larger specimens, a larger incision should be used from the outset to improve mobility and to have some triangulation. Finally, the threshold for adding ports should be minimal.

Conclusions

LESS is appropriate for patients interested in better cosmesis. Ablative and reconstructive renal procedures are appropriate, and the threshold for converting to standard laparoscopy should be low. Better instrumentation, especially dedicated robotic platforms, may enable the wider use of LESS.

Robotic LESS Approaches

Introduction

It has been established that robotic-assisted laparoscopic surgery has several advantages when compared to standard laparoscopic surgery. Optics, ergonomics, dexterity, and precision are all enhanced with use of the robotic platform for a number of urologic procedures. For these reasons, it was postulated that the application of robotics to LESS could overcome some of the constraints seen with the conventional laparoscopic approach. Issues such as instrument clashing, inability to achieve effective triangulation for dissection, and difficulties with intracorporeal suturing have limited the widespread adoption of conventional LESS in urology.

Kaouk et al. [8] reported the first experience with robotic LESS (R-LESS) in 2008 (radical prostatectomy, nephrectomy, and pyeloplasty). They noted that intracorporeal suturing and dissection were easier, as compared with standard LESS. Since then there have been numerous reports and refinements in technique from the same group, for a number of different urologic procedures [9–11]. Furthermore, there have been a number of series that have compared R-LESS to either standard laparoscopy, conventional LESS, or standard robotic surgery [9, 12, 13]. While these studies have been small and retrospective in nature, they have shown that R-LESS is not inferior with regard to perioperative outcomes and may offer better cosmesis. Additionally, the surgeons found the EndoWrist technology and three-dimensional high-definition camera beneficial. However, despite the advantages of the robotic platform, R-LESS is not free of challenges, which are similar to conventional LESS. Instrument clashing remains an issue due to the bulky external profile of the current robotic system. Other issues include lack of space for the assistant at the bedside, inability to incorporate the fourth robotic arm for retraction, and difficulties with triangulation.

Although solutions for some of these issues are currently under development [14, 15], R-LESS is still very much in its infancy. Standard robotic surgery and R-LESS share numerous similarities. The setup of the operating room is identical, as well as all the instruments, drapes, sutures, etc. Docking of the robot is also identical, although the arms may be angled differently to minimize instrument clashing. With regard to the procedures, almost all of the steps of standard robotic surgery are carried out in R-LESS. That being said, there are improvisations that are made because of the limited space with R-LESS. For example, because there is no space for the fourth arm, which is often used to retract tissue, various other techniques have been employed (i.e., stay and marionette sutures). Also, other strategies are employed to minimize instrument clashing, such as moving the two arms and camera together in unison. For this reason, this chapter will focus on the equipment and aspects of each procedure that are specific to R-LESS and differ from standard robotic surgery.

Access/Port Placement

An important distinction must be made with regard to access in R-LESS, and that is single port vs. single site. Single-port access utilizes a single skin and fascial incision, through which a multichannel access platform is placed (Fig. 10.4). The endoscope and instruments are all placed through the access platform. Single-site access also utilizes a single-skin incision; however, multiple fascial incisions are made, through which the access platform and low-profile ports are placed (Fig. 10.5). The point of access can be umbilical

Fig. 10.4 Robotic single-port approach. Trocars are introduced through a device using a simple skin and fascial incision (GelPOINT™)

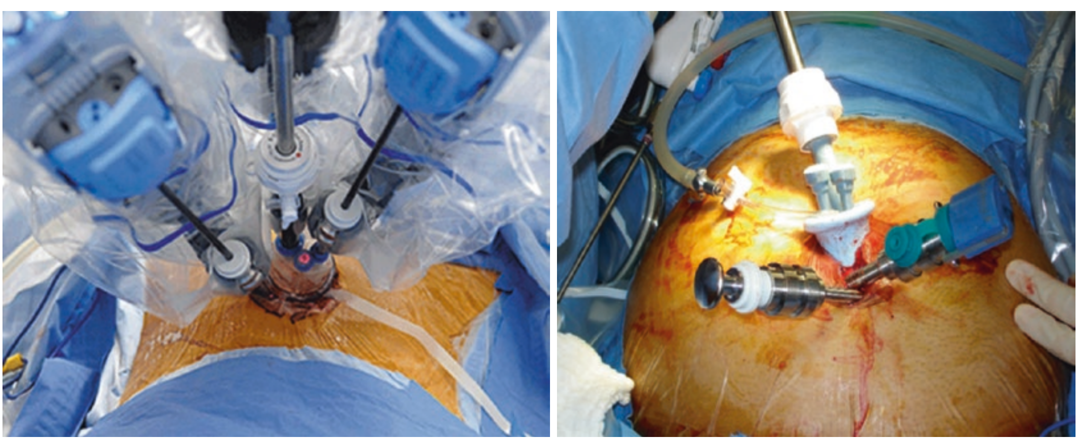

Fig. 10.5 Robotic single-site approach allows to use one skin incision with a different combination of trocars—robotics and conventional—and locations through multiple fascial depending on the type of surgery and surgeon's preferences

or extraumbilical. The umbilical access point has been most commonly utilized [16] as the scar can more easily be hidden and cosmesis maximized.

Single-Port Access

A number of different access devices for single port exist, including a TriPort [8] and a GelPort [9]. Single-port access for upper- and lower-tract R-LESS procedures is similar. A 2–5-cm trans-umbilical incision is made, either directly through the umbilicus or using a semicircular incision concealed within the umbilicus. Dissection then proceeds, using a combination of blunt dissection and electrocautery, to the anterior rectus fascia. A 3–4-cm vertical incision is then made in the linea alba, access to the peritoneal cavity is gained, and the chosen multichannel access device is placed. Stay sutures can be placed in the fascia to aid with port placement and wound closure, if desired. If the GelPort is to be used, the wound protector is placed first. Next, the GelSeal cap is placed, after the port sites have been marked on its surface. Depending on the procedure/pathology, access can be transperitoneal or extraperitoneal, as both approaches have been described. Additionally, a transvesical approach has been utilized, specifically for robotic enucleation of the prostate [17].

Single-Site Access

In a similar fashion to single-port access, an incision is created intraumbilically (3–4.5 cm), and the umbilicus is released from the rectus fascia. A 2-cm incision is then made through the linea alba. The robotic ports are then placed through the same umbilical incision, but through separate fascial stab incisions. Typically, they are tunneled under the skin to the appropriate location. For example, during an R-LESS radical prostatectomy, the first 8-mm robotic port is placed at the most caudal part of the incision and tunneled as far laterally as possible. The subsequent robotic port is then placed on the opposite side of the incision, in a similar fashion. Finally, a multichannel port is inserted through the fascial incision into the peritoneal cavity (or extraperitoneal space).

Multichannel Port Selection

A number of different multichannel ports have been used for R-LESS [18, 19]; however, there have been no direct head-to-head comparisons. In Kaouk's initial R-LESS series, the R-port (Advanced Surgical Concepts, Dublin, Ireland) was used. This port consists of one 12-mm channel, two 5-mm channels, and an insufflation cannula. The port is placed using the Hasson technique through a 2-cm umbilical incision. The authors made no specific comments with regard to the performance of the port, and there were no reported issues with pneumoperitoneum leakage or instrument crowding. White et al. [20] reported their experience with 50 patients, which included 24 renal procedures and 26 pelvic procedures. They used three different commercially available ports, including the SILS Port, the R-port, and the GelPort/GelPOINT. The authors mentioned the three multichannel ports used; they preferred the SILS Port because of its durability, the free exchange of cannulas of varying size, and the ease of passage of staplers, clip appliers, sutures, and entrapment bags through the port. However, they noted that gas leakage was experienced with three multichannel ports, which was usually caused by a fascial incision that was too large. To combat this, they placed a fascial suture or petroleum impregnated gauze along the tract of the port. Stein et al. [9] used the GelPort laparoscopic access system to perform 4 R-LESS upper tract procedures (pyeloplasty $n = 2$, partial nephrectomy $n = 1$, radical nephrectomy $n = 1$). They concluded that the GelPort was beneficial for R-LESS because it allowed for greater spacing and flexibility of port placement and easier access to the surgical field for the bedside assistant. Although the fascial incision used was larger so as to place the port (2–2.5 cm), they found that this facilitated specimen extraction, especially during the radical nephrectomy.

Finally, there have been a number of centers that have had experience using a homemade port, both for conventional LESS and R-LESS. Lee et al. [18] reported the largest series of R-LESS procedures using a homemade port, which consisted of an Alexis wound retractor (Applied Medical, Rancho Santa Margarita, California) and a standard size 7 surgical glove stretched over top. They utilized a 5–6-cm fascial incision to place the wound retractor. Four trocars were placed through the fingers of the glove, including two 8-mm robotic trocars and two 12-mm optical trocars. They performed 68 upper tract procedures, including 51 partial nephrectomies, 12 nephroureterectomies, 2 adrenalectomies, 2 radical nephrectomies, and 1 simple nephrectomy. The authors felt that the homemade port offered greater flexibility of port placement than any of the commercially available multichannel devices, as well as is extremely cost-effective. Limitations included the susceptibility of the glove to tearing with the insertion of the robotic instruments, the larger fascial incision required to place the wound retractor, and ballooning of the glove under higher pneumoperitoneum pressures (>20 mmHg). However, the authors concluded that their homemade port was a safe, effective, low-cost alternative to commercially available multichannel ports.

Docking the Robot

There are only a few subtle differences between docking the robot for standard robotic surgery and R-LESS. The DaVinci Si model has been preferred over the S model because of its enhanced visualization, ability to customize the console settings ergonomically, and smaller external profile, which helps to minimize clashing of the robotic arms [20, 21]. Otherwise, the robot is brought into the surgical field in a standard fashion, which is from behind the patient and over the shoulder for upper-tract procedures and in between the patient's legs for lower-tract procedures.

Additionally, because of the limited working space, the majority of R-LESS procedures employ a two-arm approach. There have been a number of strategies employed in order to minimize clashing of the robotic arms, which is a limitation that is encountered with the current robotic platforms. Joseph et al. [14, 22] developed a "chopstick" technique, whereby the robotic instruments are crossed at the abdominal wall to reduce instrument clashing and improve triangulation. This concept had already been used in conventional LESS; however, the crossing of instruments and resultant "reverse handedness" made the cases very challenging. However, with the DaVinci system, the inputs to the left- and right-hand effectors can be switched electronically, which eliminates the reverse handedness and restores intuitive control of the instruments as they appear on the screen.

Instrumentation

The vast majority of the R-LESS procedures to date have been performed with standard instruments as task-specific tools have remained mostly under development and testing. Two of the larger clinical series report the use of standard 8- and 5-mm instruments for a wide range of R-LESS procedures [18, 20]. White et al. [11] described using an 8-mm instrument in the right hand and a 5-mm pediatric instrument in the left hand for their R-LESS prostatectomy series of 20 patients. The authors felt that this configuration maximized the benefit of each instrument. The 5-mm instruments do not articulate but instead deflect, which greatly increased their range of motion.

Conversely, the authors found that the EndoWrist action of the standard 8-mm instruments greatly facilitated complex tasks, such as suturing. Furthermore, they reported that the 8-mm robotic Hem-o-lok clip applier was beneficial during nerve sparing as clip placement was in the surgeon's hands and clashing with the bedside assistant's instruments was minimized.

Intuitive Surgical Inc. has also addressed the problem of instrument collision and developed a set of R-LESS-specific instruments (Fig. 10.6). The set consists of a multichannel access platform with channels for four ports and an insuf-

Fig. 10.6 R-LESS Intuitive set. (**a**) curved cannulas. (**b**) Cannulas, instruments, endoscope, and multichannel port assembly

flation valve. The ports themselves consist of two with curved cannulas for the robotic instruments and two with straight cannulas for the endoscope and assistant instruments. The robotic instruments are also curved and are designed to cross at the abdominal wall, effectively separating the arms in space extracorporeally. Furthermore, the design of the system also minimizes internal instrument collision with the camera as they are not arranged in parallel. We described the first urologic applications in the laboratory at our center [15, 23]. Both the porcine model and human cadavers were used to perform a number of upper tract procedures (i.e., pyeloplasty, partial nephrectomy, etc.). Setup and docking times were comparable with the standard robotic system, and there were no significant complications. All procedures were completed successfully without the need for completion. Major limitations included collision with the assistant instruments, which at times limited suction and retraction, and lack of articulation of the robotic instruments, which made suturing difficult when required. The majority of clinical experience with the single-site instruments has been with cholecystectomy [24, 25]; however, Cestari et al. [26] reported their experience in a highly selected group of nine patients with a UPJO. Exclusion criteria included BMI >30 kg/m^2, a large renal pelvis, previous abdominal/renal surgery, and concomitant stone disease. All procedures were performed successfully without the need for conversion or additional ports. Mean OR time was 166 min. A number of different lens configurations have been used with the 12-mm robotic camera during R-LESS procedures. For their R-LESS prostatectomy series, White et al. [11] attempted to use the 0° lens for all procedures but found that the 30° upward lens was beneficial in instances where instrument clashing occurred by positioning the scope out of the path of the instruments. For upper tract procedures, all lens configurations have been used, with no clear advantage favoring one particular choice. It seems that when choosing a lens, one must tailor it to the particular situation and consider port placement, the degree of instrument clashing, and the pathology at hand.

The New Era of Single-Port Robotic Surgery

While the application of robotics to LESS has been somewhat beneficial, there have been several drawbacks, such as instrument clashing and reduced space for the bedside assistant. This is largely due to the fact that the standard multi-arms robotic systems have not been specifically designed for their adoption during single-site surgery. The Da Vinci Single-Site was an attempted answer, specific for R-LESS, but the platform lacked the EndoWrist technology, which had obvious limitations.

Multiple series using multiarm robotic systems have been reported showing the feasibility of different urological procedures and approaches; despite that, the abovementioned difficulties remained and prevented the widespread diffusion of the technique. Table 10.1 [8–13, 17, 18, 21, 26–31] summarizes information about these clinical series.

The evolution of robotic platforms, the recent FDA approval, and the introduction of new purpose built single port robotic systems to the market offer an option to fill the gap presented with the older generations and robotics systems.

The SP® Surgical Platform

The SP platform designed for single-port and single-site approach possess features that facilitates the use of this technique for multiple procedures. A single robotic arm is connected to a unique 25 mm multichannel port that holds a 10 × 12 mm articulating camera, three 6 mm robotic instruments with 7° of movement; the double joint configuration of the robotic allows to preserve the triangulation principle once deployed into the workspace (Fig. 10.7). Other characteristics are a 360° anatomical access, a guidance system that shows the surgeon the location of each instru-

Table 10.1 Clinical series of R-LESS using multi-arms robotic systems

Series	Type of procedure(s)	Approach
Kaouk et al. [8]	Radical prostatectomy ($n = 1$) Dismembered pyeloplasty ($n = 1$) Radical nephrectomy ($n = 1$)	Transumbillical/ transperitoneal
Stein et al. [9]	Pyeloplasty ($n = 2$) Radical nephrectomy ($n = 1$) Partial nephrectomy ($n = 1$)	Transumbillical/ transperitoneal
White et al. [11]	Radical prostatectomy ($n = 20$)	Transumbillical/ transperitoneal
White et al. [10]	Radical nephrectomy ($n = 10$)	Transumbillical/ transperitoneal
Arkoncel et al. [12]	Partial nephrectomy ($n = 35$)	Transumbillical/ transperitoneal
Lee et al. [18]	Partial nephrectomy ($n = 51$) Nephroureterectomy ($n = 12$) Nephrectomy ($n = 3$) Adrenalectomy ($n = 2$)	Periumbilical
Olweny et al. [13]	Pyeloplasty, RLESS ($n = 10$) vs conventional LESS ($n = 10$)	Transumbillical/ transperitoneal
Fareed et al. [17]	Simple prostatectomy ($n = 9$)	Transvesical/extraperitoneal
Cestari et al. [26]	Pyeloplasty ($n = 9$)	Transumbillical/ transperitoneal
Siedeman et al. [21]	Pyeloplasty ($n = 12$)	Transumbillical/ transperitoneal
Khanna et al. [27]	Radical nephrectomies ($n = 11$) Partial nephrectomies ($n = 5$) Nephroureterectomies ($n = 3$) Pyeloplasties ($n = 7$) Simple nephrectomy ($n = 1$) Renal cyst decortication ($n = 1$)	Transumbillical/ transperitoneal
Tobis et al. [28]	Pyeloplasty ($n = 8$)	Transumbillical/ transperitoneal
Park et al. [29]	Adrenalectomy ($n = 5$)	Retroperitoneal
Kaouk et al. [30]	Partial nephrectomy ($n = 4$) Simple nephrectomy ($n = 2$) Radical nephrectomy ($n = 2$) Radical prostatectomy ($n = 11$)	Transumbillical/ transperitoneal
Kaouk et al. [31]	Perineal prostatectomy ($n = 4$)	Perineal

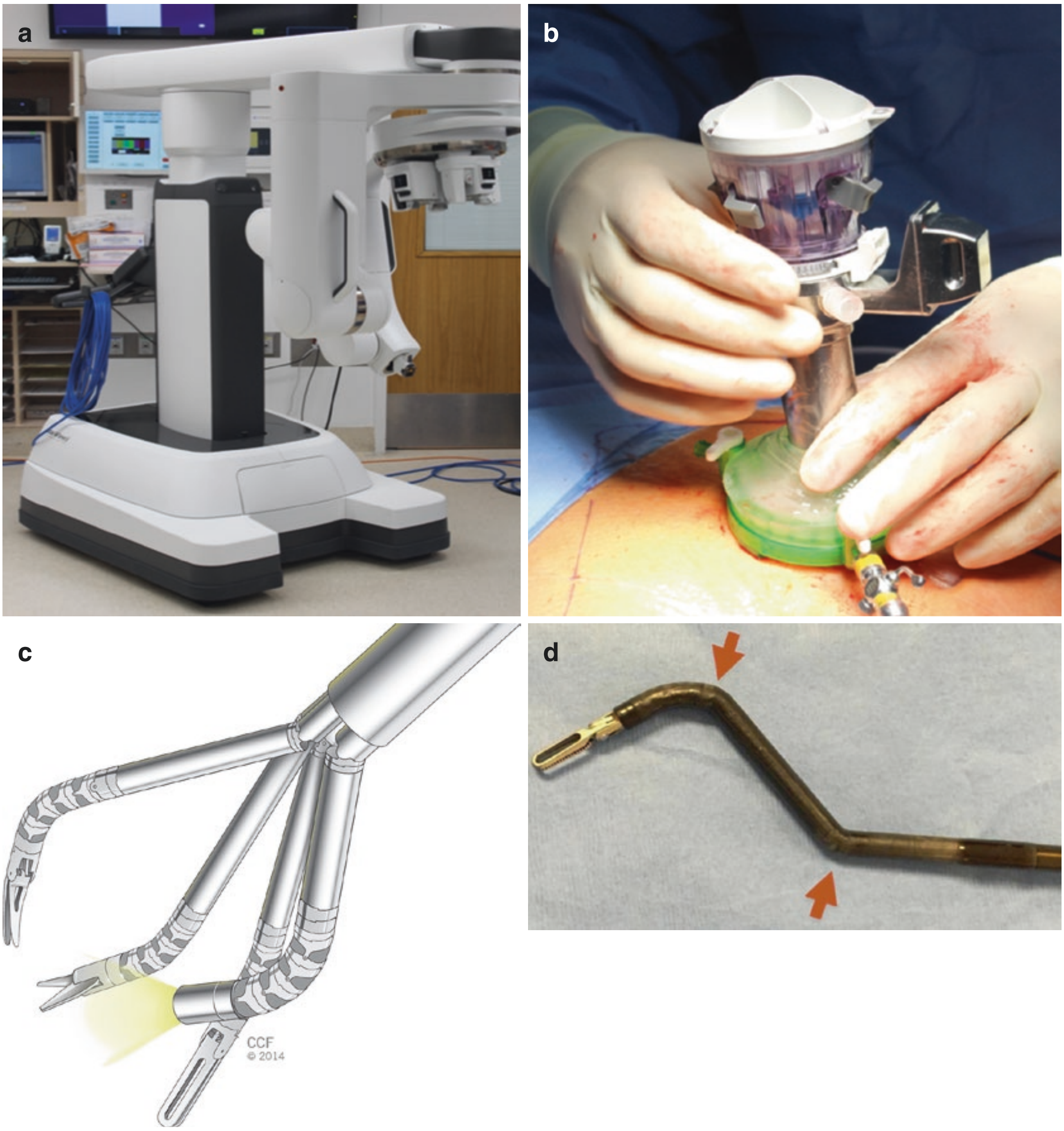

Fig. 10.7 (**a**) Patient cart with single robotic arm. (**b**) da Vinci SP® 25 mm Multichannel port. (**c**) Double-jointed instruments—10 × 12 mm camera, three 6 mm instruments—passing through the multichannel port (© Cleveland Clinic Foundation, used with permission). (**d**) Double-joint (*red arrows*) design of robotic instruments

ment, and an extra clutch allowing for the moving of the instruments and the camera as a unit or individually as needed.

Recent publications showed the feasibility and described techniques with the use of SP platforms. Maurice et al. [32] reported the use of SP1098 surgical system (a predecessor of the new SP) for retroperitoneal approach to partial nephrectomy, and other approaches to pelvic fossa surgeries, such as transvesical, transperitoneal, and transperineal, have also been described in the preclinical setting [33].

The initial clinical experiences using the new SP da Vinci surgical system describing techniques such as ureteral reimplantation, partial nephrectomy, prostatectomy and cystectomy have been successfully reported [34–37] (Fig. 10.8).

The technique for single-port transperitoneal robotic radical prostatectomy has been reported as the first clinical experience ever with the use

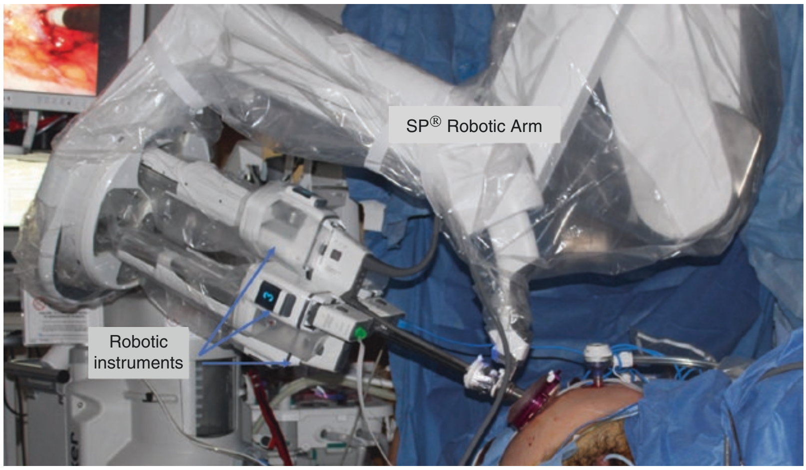

Fig. 10.8 da Vinci SP platform docked during a transperitoneal approach (left robot-assisted partial nephrectomy)

of the SP surgical platform [34]. Kaouk et al. [35] published a step-by-step technique for the management of benign distal ureteral strictures in three consecutive patients with strictures of different etiology. They reported adequate operative time and no complications in all cases, including one bilateral reimplantation. They also described a technique for partial nephrectomy with this device, including three patients; ischemia time averaged 25 min, median operative time was 180 min, and negative surgical margins were achieved in all patients. One patient presented bleeding after surgery and required angioembolization [36]. Limitations reported in initial series are related to restricted access and range of movement for laparoscopic assistance and a new learning curve even for experienced robotic surgeons [37, 38].

Conclusions

R-LESS is a feasible and secure option for multiple approaches and surgical techniques in urology. The intrinsic features of the new SP platform represent a portal for expanding the indications of robotic single port and overcoming the limitations of the former non-dedicated-to-LESS robotic platforms. Further and larger investigations will determine the real utilization of this tool in the urological field. Comparative studies with standard multiarms robotics are needed.

References

1. Raman JD, Bensalah K, Bagrodia A, Stern JM, Cadeddu JA. Laboratory and clinical development of single keyhole umbilical nephrectomy. Urology. 2007;70(6):1039–42.
2. Desai MM, Rao PP, Aron M, Pascal-Haber G, Desai MR, Mishra S, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. BJU Int. 2008;101(1):83–8.
3. Gill IS, Advincula AP, Aron M, Caddedu J, Canes D, Curcillo PG 2nd, et al. Consensus statement of the consortium for laparoendoscopic single site surgery. Surg Endosc. 2010;24(4):762–8.
4. Guillotreau J, Crouzet S, Haber GP. Access techniques, platforms and instruments for LESS. Arch Esp Urol. 2012;65(3):285–93.
5. Cadeddu J, Fernandez R, Desai M, Bergs R, Tracy C, Tang SJ, et al. Novel magnetically guided intra-abdominal camera to facilitate laparoendoscopic single-site surgery: initial human experience. Surg Endosc. 2009;23(8):1894–9.
6. Raman JD, Scott DJ, Cadeddu JA. Role of magnetic anchors during laparoendoscopic single site surgery and NOTES. J Endourol. 2009;23(5):781–6.
7. Canes D, Lehman AC, Farritor SM, et al. The future of NOTES instrumentation: flexible robotics and in vivo minirobots. J Endourol. 2009;23(5):787–92.
8. Kaouk JH, Goel RK, Haber GP, Crouzet S, Stein RJ. Robotic single-port transumbilical surgery in humans: initial report. BJU Int. 2008;103(3):366–9.
9. Stein RJ, White WM, Goel RK, Irwin BH, Haber GP, Kaouk JH. Robotic laparoendoscopic single-site surgery using GelPort as the access platform. Eur Urol. 2010;57(1):132–6.
10. White MA, Autorino R, Spana G, Laydner H, Hillyer SP, Khanna R, et al. Robotic laparoendoscopic single-site radical nephrectomy: surgical technique and comparative outcomes. Eur Urol. 2011;59(5):815–22.

11. White MA, Haber GP, Autorino R, Khanna R, Forest S, Yang B, et al. Robotic laparoendoscopic single-site radical prostatectomy: technique and early outcomes. Eur Urol. 2010;58(4):544–50.
12. Arkoncel FR, Lee JW, Rha KH, Han WK, Jeoung HB, Oh CK. Two-port robot-assisted vs standard robot assisted laparoscopic partial nephrectomy: a matched pair comparison. Urology. 2011;78(3):581–5.
13. Olweny EO, Park SK, Tan YK, Gurbuz C, Cadeddu JA, Best SL. Perioperative comparison of robotic assisted laparoendoscopic single-site (LESS) pyeloplasty versus conventional LESS pyeloplasty. Eur Urol. 2012;61(2):410–4.
14. Joseph RA, Goh AC, Cuevas SP, Donovan MA, Kauffman MG, Salas NA, et al. Chopstick surgery: a novel technique improves surgeon performance and eliminates arm collision in robotic single-incision laparoscopic surgery. Surg Endosc. 2010;24(6):1331–5.
15. Haber GP, White MA, Autorino R, Escobar PF, Kroh MD, Chalikonda S, et al. Novel robotic da Vinci instruments for laparoendoscopic single-site surgery. Urology. 2010;76(6):1279–82.
16. Kaouk JH, Autorino R, Kim FJ, Han DH, Lee SW, Yinghao S, et al. Laparoendoscopic single-site surgery in urology: worldwide multi-institutional analysis of 1076 cases. Eur Urol. 2011;60(5):998–1005.
17. Fareed K, Zaytoun OM, Autorino R, White WM, Crouzet S, Yakoubi R, et al. Robotic single port suprapubic transvesical enucleation of the prostate (R-STEP): initial experience. BJU Int. 2012;110(5):732–7.
18. Won Lee J, Arkoncel FR, Rha KH, Choi KH, Yu HS, Chae Y, Han WK. Urologic robot-assisted laparoendoscopic single-site surgery using a homemade single-port device: a single-center experience of 68 cases. J Endourol. 2011;25(9):1481–5.
19. Autorino R, Kaouk JH, Stolzenburg JU, Gill IS, Mottrie A, Tewari A, Cadeddu JA. Current status and future directions of robotic single-site surgery: a systematic review. Eur Urol. 2013;63(2):266–80.
20. White MA, Autorino R, Spana G, Hillyer S, Stein RJ, Kaouk JH. Robotic laparoendoscopic single site urological surgery: analysis of 50 consecutive cases. J Urol. 2012;187(5):1696–701.
21. Seideman CA, Tan YK, Faddegon S, Park SK, Best SL, Cadeddu JA, Olweny EO. Robot assisted laparoendoscopic single-site pyeloplasty: technique using the da Vinci Si robotic platform. J Endourol. 2012;26(8):971–4.
22. Joseph RA, Salas NA, Johnson C, Goh A, Cuevas SP, Donovan MA, et al. Video. Chopstick surgery: a novel technique enables use of the da Vinci robot to perform single-incision laparoscopic surgery. Surg Endosc. 2010;24(12):3224.
23. Kaouk JH, Autorino R, Laydner H, Hillyer S, Yakoubi R, Isac W, et al. Robotic single-site kidney surgery: evaluation of second-generation instruments in a cadaver model. Urology. 2012;79(5):975–9.
24. Morel P, Hagen ME, Bucher P, Buchs NC, Pugin F. Robotic single port cholecystectomy using a new platform: initial clinical experience. J Gastrointest Surg. 2011;15(12):2182–6.
25. Konstantinidis KM, Hirides P, Hirides S, Chrysocheris P, Georgiou M. Cholecystectomy using a novel Single-Site® robotic platform: early experience from 45 consecutive cases. Surg Endosc. 2012;26(9):2687–94.
26. Cestari A, Buffi NM, Lista G, Lughezzani G, Larcher A, Lazzeri M, et al. Feasibility and preliminary clinical outcomes of robotic laparoendoscopic single-site (R-LESS) pyeloplasty using a new single-port platform. Eur Urol. 2012;62(1):175–9.
27. Khanna R, Stein RJ, White MA, Isac W, Laydner H, Autorino R, et al. Single institution experience with robot-assisted laparoendoscopic single-site renal procedures. J Endourol. 2012;26(3):230–4.
28. Tobis S, Houman J, Thomer M, Rashid H, Wu G. Robot-assisted transumbilical laparoendoscopic single-site pyeloplasty: technique and perioperative outcomes from a single institution. J Laparoendosc Adv Surg TechA. 2013;23(8):702–6.
29. Park JH, Kim SY, Lee CR, Park S, Jeong JS, Kang SW, et al. Robot-assisted posterior retroperitoneoscopic adrenalectomy using single-port access: technical feasibility and preliminary results. Ann Surg Oncol. 2013;20(8):2741–5.
30. Kaouk JH, Haber GP, Autorino R, Crouzet S, Ouzzane A, Flamand V, Villers A. A novel robotic system for single-port urologic surgery: first clinical investigation. Eur Urol. 2014;66(6):1033–43.
31. Kaouk JH, Akca O, Zargar H, Caputo P, Ramirez D, Andrade H. Descriptive technique and initial results for robotic radical perineal prostatectomy. Urology. 2016;94:129–38.
32. Maurice M, Ramirez D, Kaouk J. Robotic laparoendoscopic single-site retroperitioneal renal surgery: initial investigation of a purpose-built single-port surgical system. Eur Urol. 2017;71(4):643–7.
33. Garisto J, Bertolo R, Kaouk J. Technique for docking and port placement using a purpose-built robotic system (SP1098) in human cadaver. Urology. 2018;119:91–6.
34. Kaouk J, Bertolo R, Eltemamy M, Garisto J. Single-port robot-assisted radical prostatectomy: first clinical experience using the SP surgical system. Urology. 2019;124:309.
35. Kaouk J, Garisto J, Eltemamy M, Bertolo R. Robot-assisted surgery for benign distal ureteral strictures: step-by-step technique using the SP® surgical system. BJU Int. 2019;123(4):733–9.
36. Kaouk J, Garisto J, Eltemamy M, Bertolo R. Pure single-site robot- assisted partial nephrectomy using the SP surgical system: initial clinical experience. Urology. 2019;124:282–5.
37. Kaouk J, Garisto J, Bertolo R. Robotic urologic surgical interventions performed with the single port dedicated platform: first clinical investigation. Eur Urol. 2019;75(4):684–91.
38. Kaouk J, Bertolo R. Single-site robotic platform in clinical practice: first cases in the USA. Minerva Urol Nefrol. 2019;71:294–8. https://doi.org/10.23736/S0393-2249.19.03384-8.