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Chapter

Robotic Laparoscopic Single-Site Surgery

Rene I. Luna

Abstract

Minimally invasive surgery has changed the landscape of women's surgical healthcare. Conventional and robotic laparoscopy are the preferred approach for many major minimally invasive gynecological procedures. However, the philosophy of minimally invasive surgery has been pushed to reduce the size and minimize the number of ports placed. Many conventional minimally invasive surgical procedures use 3–5 ports through multiple small incisions. Laparoscopic single site surgery tries to perform on that philosophy but has its limitations. Enters robotic surgery already a major force in minimally invasive surgery and now sets to remove the limitations of single site surgery. However it requires proper understanding of the instruments and the techniques for successful robotic single site surgery. It starts with patient selection. Knowing the instruments needed and the proper set up of those instruments. Then knowing how to use the instruments in operating and suturing and closing. And finish with special considerations.

Keywords: robotic single-site, patient selection, set up, port entry, instruments, first assist and closure, special considerations

1. Introduction

Minimally invasive surgery has changed the landscape of women's surgical healthcare. Women are now able to undergo major surgeries as outpatient procedures leading to faster recoveries and more importantly, faster return to normalcy. Conventional and robotic laparoscopy are now the preferred approach for many major minimally invasive gynecological procedures. The predictable result has been a change in the overall philosophy of minimally invasive surgery in gynecology today. This philosophy constantly pushes to reduce the size of each trocar port and to minimize the number of ports placed. Currently, many conventional minimally invasive surgical procedures use 3–5 ports through multiple small incisions. Each port carries a small, but not statistically zero risk for a port site complication [1]. These port site complications may include bleeding, infection, organ injury, soft tissue trauma (leading to increased post op pain,) the risk of herniation and decreased final cosmesis [2].

Now with new instrumentation, as well as better visualization and greater surgeon dedication, procedures can be performed using a single incision port entry. This leads to often entirely concealing the incision at the umbilicus. The result is rewarding the patient and surgeon with a virtually scarless procedure [3].

This is not to say, however, that no challenges remain. Some of these new challenges Include mastering inline camera viewing, off center operating, the difficulty

Instruments Needed for Robotic Single Port Hysterectomy
30-degree robotic scope in downward position
Intuitive Gelport™
Intuitive right and left curved trocars
Fenestrated Bipolar grasper
Monopolar hook
Single site wristed needle driver
AirSeal™ insufflator
8 mm AirSeal™ port
Bariatric suction tip
Barbed 2.0 trimethylene carbonate suture on a P14 reverse cutting needle V-Loc™
Uterine manipulator (surgeon's preference on type used)

Table 1.
Instruments needed for robotic single port hysterectomy.

of instrument crowding and a lack of instrument triangulation resulting in technically challenging laparoscopic single-site surgery. To try and improve on these challenges, the only commercially available system currently available, The Intuitive Robotic Surgical System™ comes equipped with a single-site robotic instrument set on their Si and Xi models. The Robotic single-site instruments provide and enable a broader range of instrument movement with flexible instruments which allows them to fit into curved trocars. The result is greatly improved triangulation and almost a complete elimination of instrument crowding. These changes significantly improve surgical movements allowing the surgeon to have greater motion and technical ease of operating. The surgeon has complete control of the camera and instruments and remains sitting at a comfortable surgeon console. This provides an extremely ergonomically friendly procedure, almost regardless of surgical time [4, 5]. This procedure, however, is not without its own challenges.

In the following sections, we will discuss patient evaluation, instruments needed, and some important differences between robotic multiport and robot single-site surgery. Further along we will go through the sequence of steps necessary for port placement and docking while performing a robotic single-site hysterectomy. We will then finish by discussing special considerations (**Table 1**).

2. Patient evaluation

The process of deciding the appropriate surgical route remains as recommended by the American College of Obstetricians and Gynecologists [6]. This generally means that a diligent surgeon should take into account the individual circumstances of the patient, along with the patient's medical and surgical histories, as include consideration of the particular surgeon's own skills as well as the modalities available prior to deciding on the final surgical route. However, when beginning robotic single-site surgery, patient selection is an even more important process. Patients with a body mass index (BMI) of less than 32 to 34 are going to be the best candidates due to the height of the single-site port trocar and the complex nature of laparoscopic surgery in more obese patients. An initial uterine size of 12 cm or smaller in length will also be ideal for port placement and maximize the comfortable range of instrument movements. A larger uterus will significantly limit both of these aspects, requiring more advanced maneuvers to proceed. Also, a patient's surgical history, especially when indicating the likelihood of adhesive disease and/or adjacent adnexal disease may significantly raise the level of surgical difficulty and case complexity. In less experienced surgeons these cases should be initially avoided without proctorship and consideration may be given to less complex modalities such as conventional laparoscopy or laparotomy. Once comfortable and experienced, a surgeon's patient selection can then be opened to more complex and larger pathology.

Important Differences from Multiport Robotics.

There are many important differences between robotic multiport and robotic single-site surgical platforms. There are no advanced instruments such as the Intuitive Vessel Sealer™ for use in the single-site set. The set does contain a full range of graspers, however they have no energy application available to them. As a result, with the standard set your energy comes from two instruments, a fenestrated bipolar grasper (for burning and sealing) and a monopolar hook (mainly for cutting.) Another major difference from Multiport is the loss of wristed instruments in the single-site set. In fact, only the needle driver instrument is wristed. All other single-site instruments are straight. Another major difference is that the instruments are flexible. While this maximizes triangulation, it also serves to take away from maximum instrument force and torque. This is most noticeable during suturing or "traction-counter-traction" movements. Because of these changes the single-site instruments actually cost less than the multiport instruments, which is an advantage. This cost change actually brings robotic single-site surgery closer in cost to conventional laparoscopic surgery than to multiport robotic assisted surgery [7]. Hopefully in the future these costs will continue to decline.

3. Set up

Correctly completing the set-up process is extremely important to a successful surgery, as it allows instruments to be in their proper place to allow for maximum movement. When using the Intuitive Gelport™, there will be an arrow which needs to point towards the target anatomy when placed in the abdomen. This aligns the port entries of the Gelport.

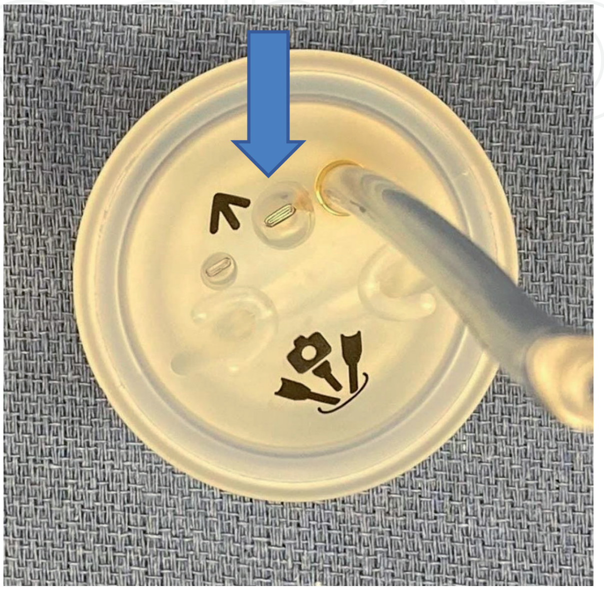

Figure 1.
Intuitive Gelport(™).

After placement in the abdomen, the ports are placed in the following sequence:

The camera port is placed first in the top port site as indicated by the blue arrow (**Figure 1**).

(The camera port is placed first in the top port site as indicated by the blue arrow).

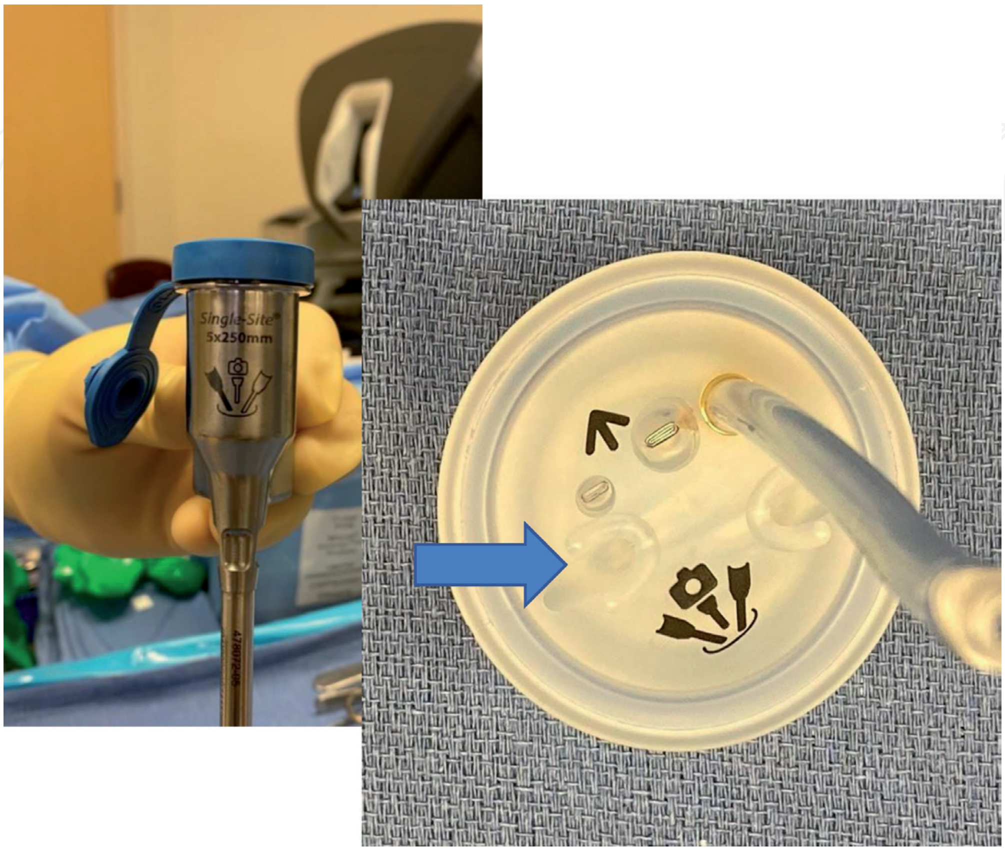

Figure 2.
The left trocar and Gelport are shown prior to insertion.

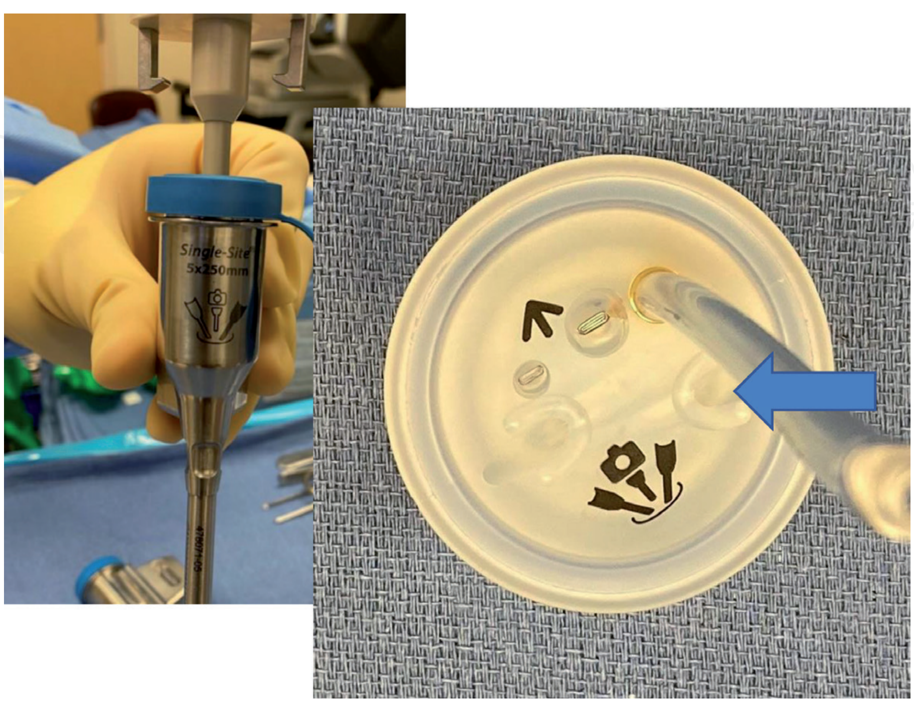

Figure 3.
The right trocar and Gelport are shown prior to insertion.

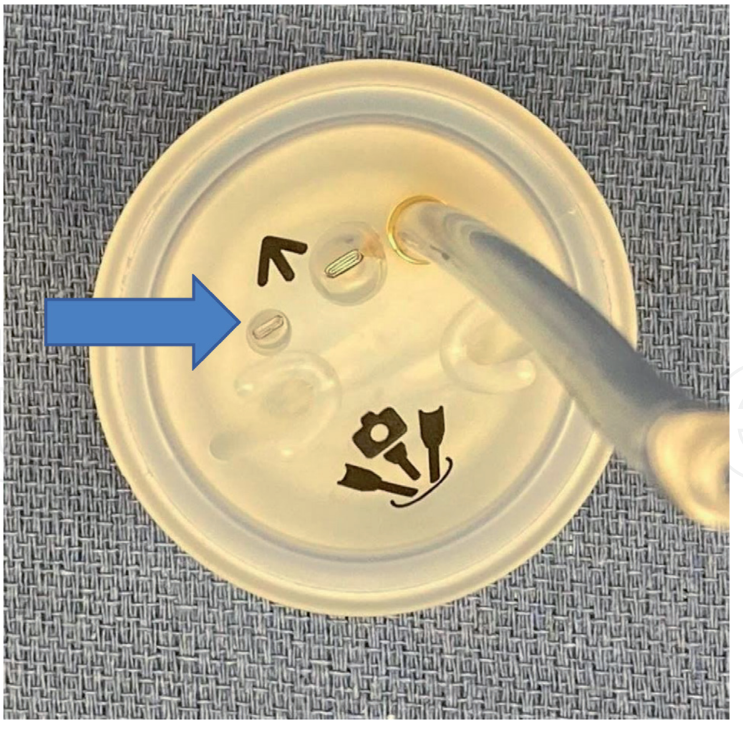

Figure 4.
Gelport is shown with the assistant port indicated by the blue arrow.

This is followed by the shaded left curved trocar (Xi system) in the left outside port site indicated by the blue arrow, or the #2 curved trocar (Si System) (**Figure 2**).

The shaded right curved trocar is then placed in the right lateral port site indicated by the blue arrow or the #1 curved trocar (**Figure 3**).

Last, the assistant port is placed in the port site on the left side of the camera port as indicated by the blue arrow (**Figure 4**).

4. Robot positioning

Another important step is the positioning of the Da Vinci surgical system itself. The Xi system, which has better range of motion, can be angled on either right or left side facing towards the patient's hip and the overhead boom is rotated into place. If using the Si system, the robot must be positioned directly between the patient's legs leaving enough space for the bottom assistant. The right and left arms of the Si system are bent at the first joint and locked into place to allow for instrument triangulation.

5. Operating

Begin by placing your preferred uterine manipulator. At our institution we commonly use the Delineator™ from CooperSurgical™. Following this, your attention turns to the abdomen to identify the best position for the 2.5 cm incision that will be placed. This incision can be directly within the umbilicus or directly above or below the umbilicus. Typically, the lines of the umbilicus are used, and a vertical incision is most commonly made directly through the umbilicus. This allows for concealment of the incision line creating a superior cosmetic effect. Another common incision is a "U" incision cut either inferior or superiorly made. Great care should be taken while performing this step and again at the time of skin closure to ensure careful reconstruction. This will ensure the best cosmetic results. At times the umbilical stalk can be detached during entry. If this occurs, it should be reattached to the fascia for best cosmetic effect, preserving the depth of the umbilicus. Typically, a 2.5 cm–3 cm incision is required to install the Intuitive Gelport(™). If the incision is made too small, a visible dark, purplish ring can be seen on the skin around the umbilicus resulting from pressure necrosis. Although we have found that this usually heals over time without complication, this can simply be prevented by creating an appropriately sized incision in the first place.

Next, the fascia is identified and incised to the same length. The intuitive Gelport is then clamped at the base with long tissue forceps. Be careful not to grasp the small bronze sphere on the bottom of the port as this is part of the insufflation mechanism on the Gelport, and could be damaged by the forceps (**Figures 5** and **6**).

An army/navy retractor is then used to lift the inferior opening of the incision and the clamped gelport is inserted with downward pressure through the incision until the port is buried to the upper base. Traction and counter traction are used to perform this. Once inserted, the army/navy is again used, this time in a circular motion to sink the port into place beyond its initial ring.

Once the port is in place, gas is attached to the Gelport and insufflation begins. The single-site camera trocar is then inserted into the appropriate space in the Gelport. The trocar should be moistened with saline. Do not use gel as it will cause the trocar to slip from position during the procedure.

The patient can now be placed into Trendelenburg and the camera inserted to survey the surgical field. A 30-degree angled scope is recommended. The robot can then be moved into position and the camera docked into the trocar.

Insertion of the trocars begins with the left curved trocar first, and then the right curved trocar. While holding the port with the left hand, the right hand guides the curved trocar which starts parallel with the patient abdomen and is moved until the marked arrow passes through the Gelport. The trocar is then moved vertically and advanced to the solid line on the trocar (**Figure 7**).

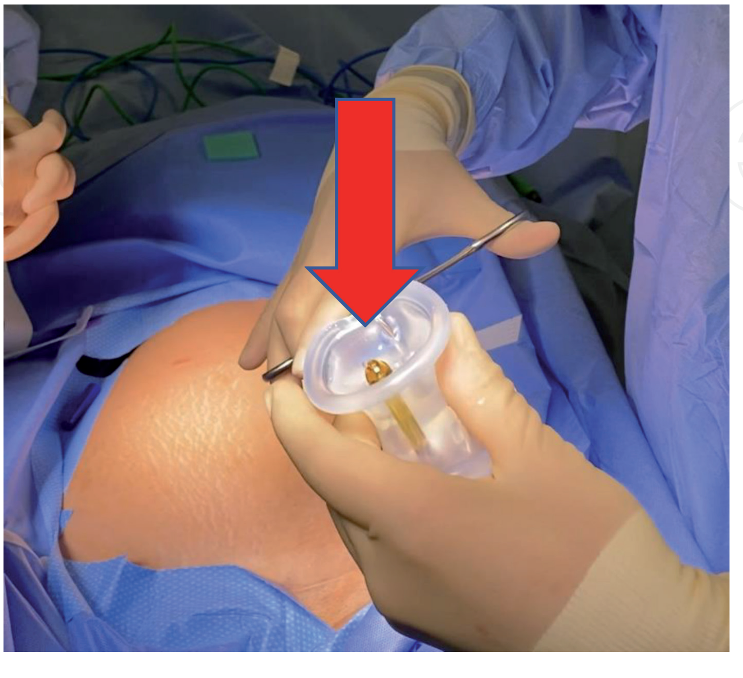

Figure 5.
A red arrow shows the small bronze sphere on the bottom of the Gelport. This is part of the insufflation mechanism on the Gelport, and could be damaged if inadvertently grasped by the forceps.

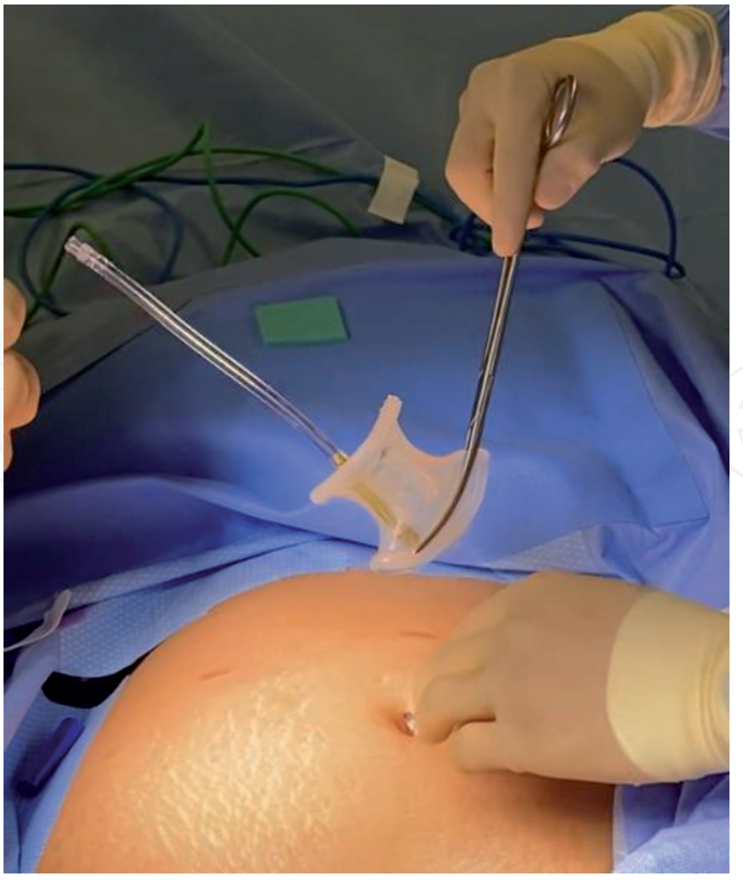

Figure 6.
Proper grasping of the base of the Gelport with forceps is shown.

At the same time the trocar tip can be seen on the screen entering the patient's right side.

Note that as the trocar passes into the abdomen it crosses over to the opposite side.

The same procedure is then repeated with the right trocar. Again, it enters from the right side and passes to the left side of the patient (**Figure 8**).

The 30-degree scope can be rotated to opposite sides to visualize the trocars safely entering the abdomen (**Figure 9**).

The camera port is then brought to a 90-degree angle, with the skin of the abdomen, and the assistant port is inserted until the pre-marked area is reached. A 5 mm or 10 mm assist port can be used. At our institution, I prefer an 8 mm AirSeal™ port. The camera is then brought back to center with the trocar tips in view. All trocars are then docked and positioned. The trocars should be clearly visible on the right and left sides of the camera view. Remember all trocars are moistened with saline prior to positioning in the Gelport. Again we do not recommend using gel to avoid slippage during the procedure.

Once the robot is docked, the left sided instrument clutch is pressed. This will reassign the right and left arms making the right internal arm now controlled by your right joystick, and the left internal arm now controlled by your left joystick. This switch allows the surgeon sitting at the console to have traditional right and left control. The instruments most commonly used for hysterectomy will be the Monopolar Hook and the Fenestrated Bipolar grasper. With the trocars crossed the monopolar hook is commonly placed in the left trocar and becomes your right arm. The fenestrated bipolar grasper is placed in the right trocar and becomes the left arm. Many authors have described constant camera and instrument movement as well as frequent clutch control as factors most associated with success [8, 9]. Constant centering of instruments allows for maximum traction and counter traction movement.

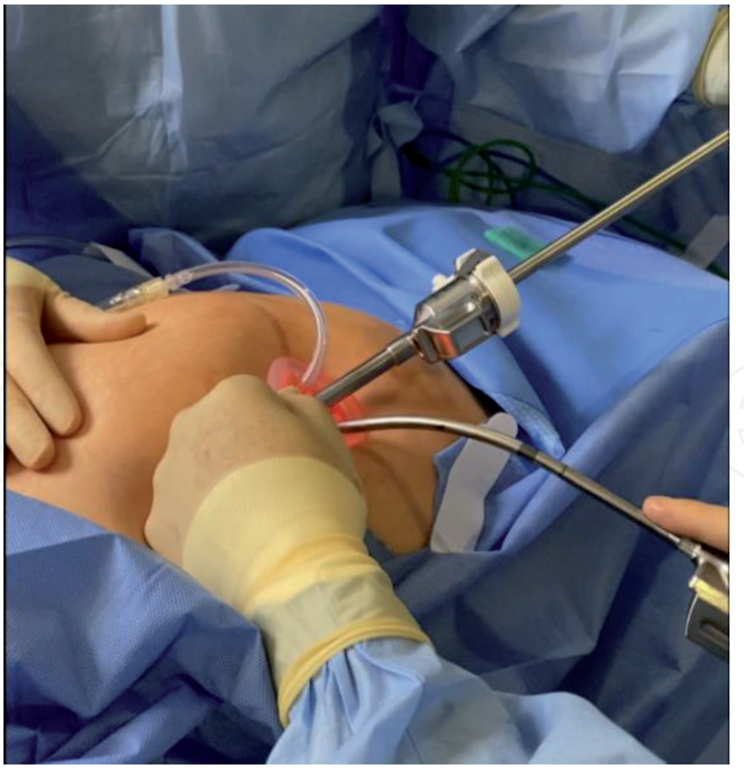

Figure 7.
The left curved trocar is inserted first, as shown in this picture.

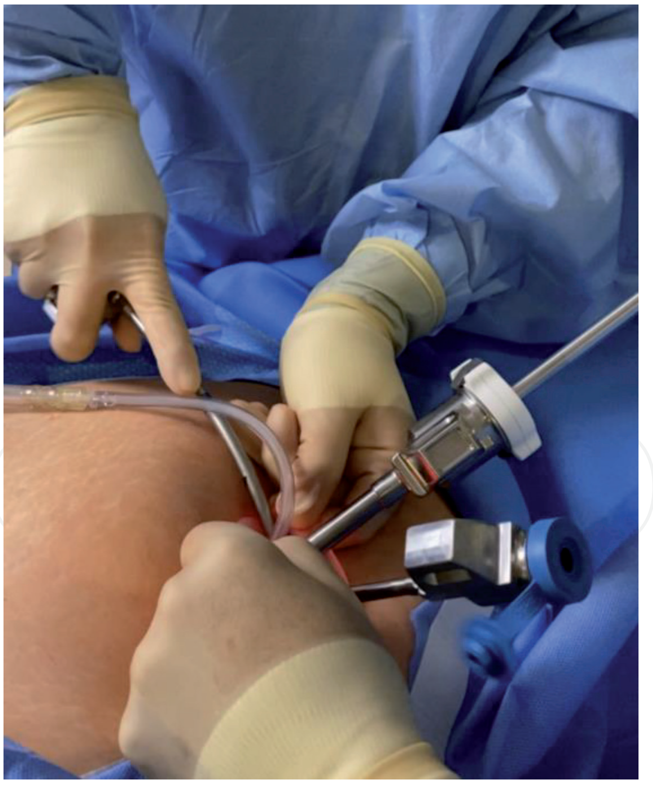

Figure 8.
A 30-degree scope is ideal for visualizing the insertion of the lateral trocars.

Another factor that plays a large role in successful robotic single-site surgery is the uterine manipulating device (and the assistant controlling it). Their strategic movements of the uterus help bring the tissue to the instruments and are crucial to procedure success [10].

Figure 9.
Installation is complete with the camera and both trocars in position.

The initial steps in a robotic single-site hysterectomy largely depend on if the ovaries are to be removed or remain, as this will determine the plane of dissection. The round ligament is coagulated with the fenestrated Bipolar and transected with the Monopolar hook. The anterior and posterior peritoneal planes are separated with traction and counter traction and Monopolar Hook to skeletonize the uterine vasculature down to the uterine artery. A bladder flap is then created by dividing the vesico-uterine fascia, and the bladder is bluntly pushed out of the operating field. Traction and counter traction are again used for dissecting and opening the bladder flap. Once the flap is created, the ring or cup of the uterine manipulator must be identified. The colpotomy is begun in the anterior portion and is made with the hook cautery. This acts to further isolate the uterine arteries. Surgeon's preference may dictate coagulating the uterine arteries before the colotomy is made or as they are identified while creating the colpotomy. The arteries are coagulated and sealed using the fenestrated bipolar grasper and transected with the monopolar hook. The colpotomy can then be completed using the hook. Once the uterus is detached and removed, our next step will be the closure of the vaginal cuff.

Robotic single-site suturing has great advantages over laparoscopic suturing because of the availability of wristed instruments. The wristed needle driver is, in fact, the only wristed instrument in the set. When closing the vaginal cuff, the fenestrated arm can remain on the left arm to allow for grasping of the vaginal cuff. The monopolar hook is replaced with the wristed needle driver. The wristed single-site needle driver's movements are slightly more encumbered in comparison to the multiport version, however it is still wristed and allows for increased articulation for driving a needle. Another difference is the loss of strength or torque in using the single-site needle driver due to its curved flexible nature. My preferred suture and needle is a barbed 2.0 trimethylene carbonate suture on a P14 reverse cutting needle V-Loc™. Many authors have recommended this system for cuff closure when performing a robotic single-site hysterectomy [11]. This allows for an easier drive of the needle through the cuff for suturing. Another way to help with instrument torque or force if having trouble driving the needle, is to advance the trocars slightly inward to decrease the flexibility of the instruments. In my experience, mastery of traction and counter traction are the keys to successful closure. The needle is small enough to pass through the 8 mm air seal port for entry and removal. I recommend 1–2 redundant throws of the V-Loc™ stitch device in order to secure the suture line after completing the vaginal closure.

6. Closing the fascia

Once the surgery has been safely completed, remove all trocars so that only the camera and assistant trocars remain and evacuate the gas. Next, grasp the gel port and place a lap sponge over the Gelport to prevent splashing and gently remove the port. To close the fascial opening, I recommend grasping the fascial edge with a kocher clamp and securing each edge with a figure-of-eight stitch using a 0 vicryl on a UR6 needle, and then holding the tissue with hemostat clamps. Next, with an army/navy, I recommend grasping the lateral edges and displacing them outward and then upward using the hemostats. This will bring the fascia away from the underlying bowel. Finally, finish closing the fascia with several more figure-of-eight sutures. Generally, approximately 4–5 figure-of-eight sutures are needed to complete the closure. Lastely, I recommend reapproximating the subcutaneous tissues with 3–0 vicryl and performing skin closure with 4–0 monocryl followed by Dermabond™ adhesive.

7. Special considerations

There are surgical considerations when performing robotic single-site laparoscopic surgery.

Visually the surgeon will be operating from the midline or a slightly off center position. In these situations, a 30-degree scope can be very helpful. Camera movements and instrument movements are all occurring in a very confined space within the center of the screen. Surgical instruments cannot cross or move to as far as their multiport versions can. They cannot reach opposite ends of the screen. As the instruments follow camera movement, camera clutching and instrument movements are frequently needed in order to move around the surgical field and operate safely and effectively. Instrument tips are typically working side by side.

In addition, the surgical assistant controlling the assistant port may have a challenging task. They will have limited freedom of movement and need to keep their instrument in the view of the camera at all times. The assistant must carefully control the movement of their instrument, such as a suction irrigator or a grasper. One technique to give the accessory port some additional freedom is to occasionally pull back on the camera and attempt to visualize the operative area from under the assistant's instrument. This technique resembles diving downward in practice. Generally, this will create some freedom of operation to avoid collision with your assistant's instrument. Care and vigilance must be taken, however, because too much movement may still move the assistant which can lead to unintended tissue trauma. As a result, constant coordination between the movements of the surgeon and the surgical assistant is critical for safe, effective surgery.

If during a robotic single-site case, the surgeon encounters complex pathology and the case becomes too difficult to complete through single-site technique, the surgeon then has several options. The operator is able to utilize the 4th arm of the DaVinci robot and add an extra lateral single multiport trocar. This allows for utilization of an extra multiport surgical arm and the use of a full wristed surgical instrument such as a Vessel Sealer or Monopolar Scissors. This conversion makes it a robotic single-site plus one surgery. If the surgeon continues to have difficulty safely completing the surgery, then the robotic single-site surgery can be fully converted to traditional robotic multiport by removing the curved trocars and adding both right and left lateral abdominal multiport trocars. The gelport with the camera trocar can remain along with the assistant port or the assistant port can be moved to a more traditional site. This allows the surgery to remain a minimally invasive approach before needing to convert to laparotomy.

Once the surgeon operates consistently and becomes more comfortable and confident another port option is the GelPoint™ or GelPoint Mini™ from Applied Medical. The GelPoint and Gelpoint mini allows for a smaller 2.0–2.5 cm incision and an increased range of motion with your single-site instruments. We do not recommend starting single site training with these ports because of the increased range of the instruments can lead to sudden slippage. This can lead to uncontrolled movements and possible surgical complications. Instrument control must be mastered prior to attempting these modifications. Also, the gel interface of the Gelpoint™ is known to be more prone to leaking gas due to tearing than it's Gelport™ counterpart. To negate this loss of gas, an AirSeal™ port can be used to hold the pneumoperitoneum (**Table 2**).

Advantages	Disadvantages
High Definition 3D immersed vision console	The loss of instrument strength and torque
Complete instrument and camera control	Loss of wristed instruments
Superior instrument movement	Limited range of motion
No instrument clashing	Surgical assist movements are limited
Superior cosmetic incision	
Suturing is made easier	
Port incision allows for large tissue extraction	
Competitive surgical cost	

Table 2.
Advantages and disadvantages of single port robotic surgery.

8. In conclusion

Minimally invasive surgery continues to evolve providing dedicated surgeons with the instruments and confidence to bring less invasive procedures to patients. I have enjoyed learning and mastering these skills over the years. I have experienced great patient satisfaction as well and personal satisfaction in my surgical journey. I look forward along with many of my colleagues to the future and the continued advancements of minimally invasive surgery and robotics.

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Author details

Rene I. Luna
Women's Robotic Surgery, Renaissance Women's Hospital, Institute for Robotic Surgery, University of Texas Rio Grande Valley, McAllen, Texas, USA

*Address all correspondence to: drlunaobgyn@gmail.com

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References

[1] Tracy CR, Raman JD, Cadeddu JA, Rane A. Laparoendoscopic single-site surgery in urology: where have we been and where are we heading? Nat Clin Pract Urol. 2008;5:561-8.

[2] Fanfani F, Fagotti A, Rossitto C, Gagliardi ML, Ercoli A, Gallotta V, Alletti SG, Monterossi G, Turco LC, Scambia G. Laparoscopic, minilaparoscopic and single-port hysterectomy: perioperative outcomes. Surgical endoscopy. 2012 Dec 1;26(12):3592-6.

[3] Jung YW, Kim YT, Lee DW, Im Hwang Y, Nam EJ, Kim JH, Kim SW. The feasibility of scarless single-port transumbilical total laparoscopic hysterectomy: initial clinical experience. Surgical endoscopy. 2010 Jul 1;24(7):1686-92.

[4] Lux MM, Marshall M, Erturk E, Joseph JV. Ergonomic evaluation and guidelines for use of the daVinci Robot system. Journal of endourology. 2010 Mar 1;24(3):371-5.

[5] Angioni S, Pontis A, Pisanu A, et al. Single-port access subtotal laparoscopic hysterectomy: a prospective case-control study. J Minim Invasive. 2015;22:809-12.

[6] American College of Obstetricians and Gynecologists. Choosing the route of hysterectomy for benign disease. ACOG Committee Opinion No. 444. Obstetrics and Gynecology. 2009;114(5):1156-8.

[7] Arghami A, Dy BM, Bingener J, Osborn J, Richards ML. Single-port robotic-assisted adrenalectomy: feasibility, safety, and cost-effectiveness. JSLS: Journal of the Society of Laparoendoscopic Surgeons. 2015 Jan;19(1).

[8] Palep JH. Robotic assisted minimally invasive surgery. Journal of minimal access surgery. 2009 Jan;5(1):1.

[9] Stegemann AP, Ahmed K, Syed JR, Rehman S, Ghani K, Autorino R, Sharif M, Rao A, Shi Y, Wilding GE, Hassett JM. Fundamental skills of robotic surgery: a multi-institutional randomized controlled trial for validation of a simulation-based curriculum. Urology. 2013 Apr 1;81(4):767-74.

[10] Senapati S, Advincula AP. Surgical techniques: robot-assisted laparoscopic myomectomy with the da Vinci® surgical system. Journal of Robotic Surgery. 2007 Mar 1;1(1):69.

[11] Cong L, Li C, Wei B, Zhan L, Wang W, Xu Y. V-Loc™ 180 suture in total laparoscopic hysterectomy: a retrospective study comparing Polysorb to barbed suture used for vaginal cuff closure. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2016 Dec 1;207:18-22.