

Chapter 2

Robotic Instrumentation, Personnel and Operating Room Setup

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Introduction

Over the past decade the field of robotic-assisted surgery has evolved from endoscope positioning to “master-slave systems,” where the surgeons hand movements are translated to robotic instrument arms positioned inside the patient several feet away [1, 2]. The da Vinci® is currently the most commonly utilized “master-slave system” system. Since the first robotic-assisted prostatectomy in 2000 and subsequent Federal Drug Administration approval, the use of the da Vinci® in urologic surgery has increased to include the upper and lower urinary tracts and is rapidly expanding in the field of pediatric urology. Over the years four different da Vinci® models have been introduced – standard, streamlined (S), S-high definition (HD), and recently the S integrated (i) systems. This chapter will review the personnel, operating room setup and equipment for urologic surgical procedures utilizing the da Vinci®. This chapter is not designed to replace the hands-on training session provided by Intuitive Surgical, but act as a reference for any member of the surgical team.

Surgical Team

The surgical team consists of the surgeon, circulating nurse, surgical technician and surgical assistant(s). Each member must be knowledgeable in robotic-assisted surgery and communication between each of these individuals is vital for successful outcomes [3, 4]. Intuitive Surgical offers a training course for the surgical team and each member should complete the course prior to starting on the surgical team. It is also important for the surgical team to remain consistent and it is generally recommend to have a dedicated team to work through the learning curve and if possible, all robotic cases [3].

The surgeon will lead the team and should not only master driving the robot, but also become familiar with the setup, basic operation and troubleshooting the system. The circulating nurse and surgical technician are critical for operating the robot and should become experts on system startup, draping, docking, instruments, troubleshooting, exchanging instruments, and turn-over. The surgical assistant should have a similar knowledge, but will also need to understand the basics of laparoscopic surgery and be comfortable assisting with trocar placement, clipping, suction, irrigation, retraction and cutting [1, 3].

Operating Room Setup

The operating room should be able to accommodate all of the robotic components so there is a clear view of the patient from the surgeon

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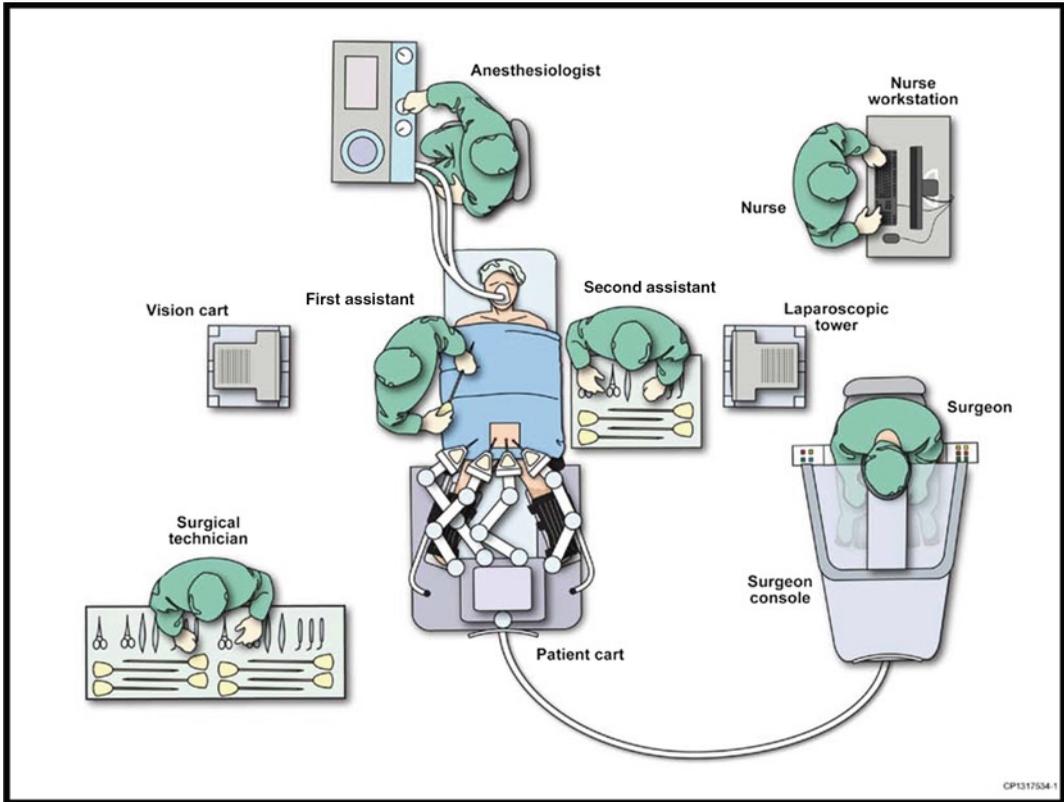


Fig. 2.1 Schematic of operating room setup and surgical team for the da Vinci®

console, tension-free cable connections between the equipment, and clear pathways for operating room personnel to move freely around the room (Fig. 2.1). In addition the room should be able to facilitate docking of the robot from several different angles depending on the type of surgery being performed.

If the operating room is a standard operating room (Fig. 2.2a) that is converted to a robotics room on operative days, there may need to be additional laparoscopic towers to hold the insufflator, insufflation tank, electrosurgical units, video system and extra monitors. In this situation, some of the equipment may also be placed on the vision cart. Ideally the operating room will be in a dedicated room designed for laparoscopic surgery with an integration system to allow DVD recording and telemedicine (Fig. 2.2b). In addition, flat panel monitors are mounted from the ceiling, CO₂ gas is piped

directly into the room for insufflation, and ceiling mounted equipment booms can house insufflators, electrosurgical units, laparoscopic camera equipment and lights sources.

Patient Positioning

For surgery of the pelvis and anterior transabdominal surgery, patients are moved directly onto an operating room table with a gel pad (Fig. 2.2) [4, 5]. The gel pad increases friction and prevents patients from sliding during the procedure. The patient is positioned in a modified lithotomy position using yellow fin stirrups (Fig. 2.3a) with thromboembolic stockings and sequential compression devices. Both arms are padded and positioned along side of the patient on arm boards. A safety strap or tape can be

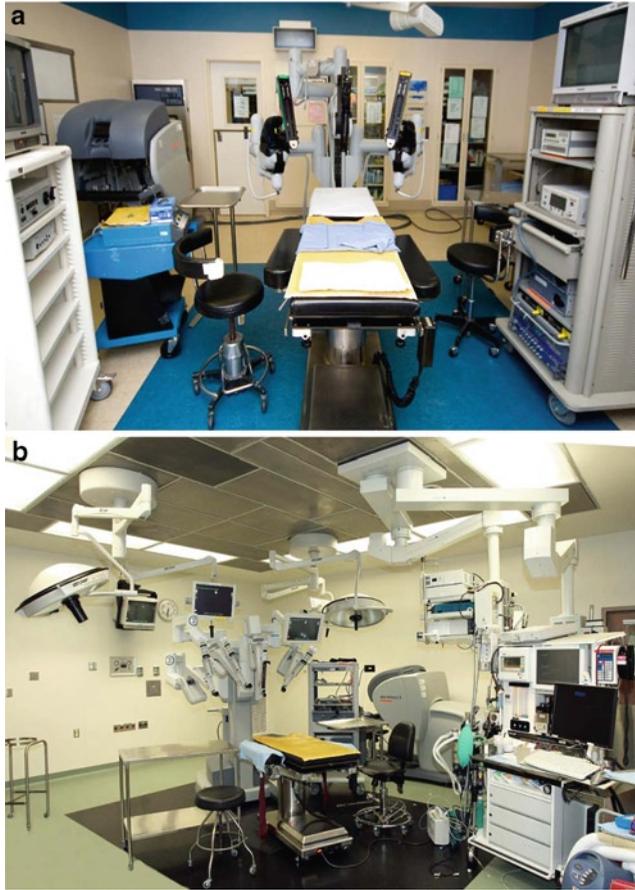


Fig. 2.2 Photograph of operating room for the da Vinci® standard (a) and S (b) systems. Standard system operating room (a) with an additional laparoscopic tower and seating for a second surgical assistant. S system operating room (b) where several telemonitors are

mounted from the ceiling and a laparoscopic tower is mounted on a ceiling boom with the electro-surgical unit, insufflator and light source. The room is also equipped with an integration system for DVD recording and telemedicine

used to secure the patient to the table and it is recommended that it not be placed across the shoulder to prevent the risk of postoperative neuropathy. An upper body Bair Hugger® (Arizant Inc., Eden Prairie, MN) is then placed above the xiphoid and insulated with a blanket. Once the patient is positioned, we secure a face shield plate (Fig. 2.4) to protect the patient's face and endotracheal tube from inadvertent damage or dislodgement during movement of the robotic endoscope. The patient is then prepped from the xiphoid to perineum to midaxillary lines and draped.

For surgery of the kidney or ureters the patient is moved onto the surgical table with a beanbag immobilizer and positioned in a 45° modified flank position for transperitoneal access or a full flank position for transperitoneal or retroperitoneal access [6] (Fig. 2.3b). The patient is positioned with the space between the costal margin and anterior superior iliac spine over the kidney rest; however the kidney rest is not typically used for these cases. Thromboembolic stockings and sequential compression devices are placed and a urethral catheter inserted. In both positions, the patient is rolled onto their side into a 45° or full

Fig. 2.3 Photographs of patients positioned in modified lithotomy for pelvic and anterior transabdominal surgery (a) and flank position for upper urinary tract surgery (b)

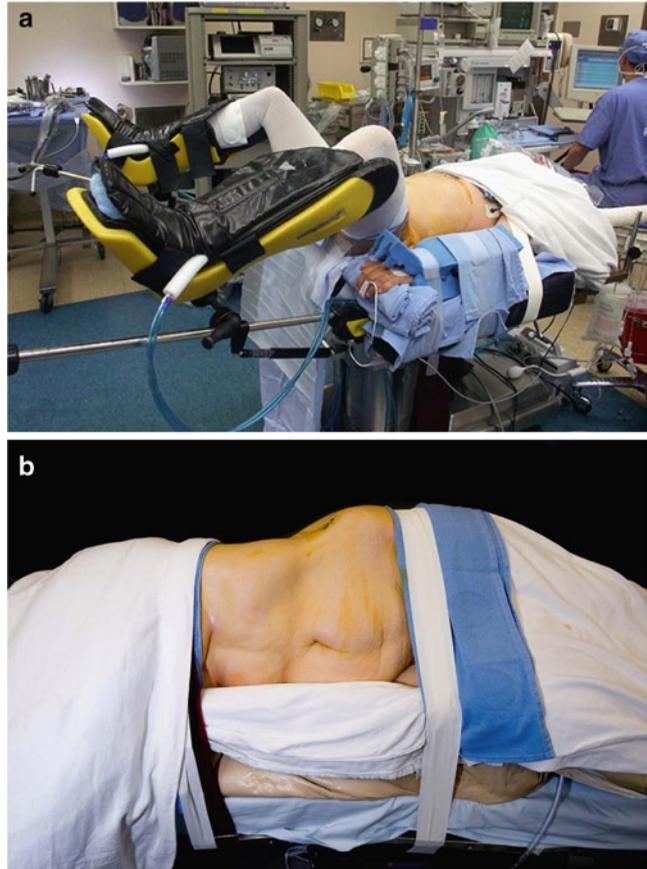


Fig. 2.4 Photograph of patient with a protective face shield plate secured to the operating room table

flank position with the surgical side up. The surgical side leg is bent slightly and padded with pillows or towels. An axillary roll is placed to prevent postoperative neuropathy and the arm is padded and secured. The upper arm is padded and secured to an arm board and the table can then be flexed. When flexing the table, the anesthesiologist should be alerted to support the head and place several pillows or towels to avoid hyperextension of the cervical spine. Safety straps or tape can be used over the hip, lower extremity and thorax to secure the patient to the bed. An upper body Bair Hugger® is placed and insulated with a blanket. The patient is prepped from the nipples to anterior superior iliac spine and midline to erector spinae.

Abdominal Access

Robotic-assisted surgery begins with abdominal access and trocar placement. Pneumoperitoneum may be established using a Veress needle or with open trocar placement by the Hasson technique [4]. We typically gain abdominal access by making a small incision and carrying the dissection down to the level of the fascia. The fascia is then elevated with tracheal hooks and the Veress needle is inserted [7]. Placement is verified with the hanging drop test and the abdomen is insufflated to 15 mmHg. A 12 mm trocar is then placed with a Visiport™ device (Ethicon Endo-Surgery, Inc., Cincinnati, OH). This will serve as the trocar for the da Vinci® endoscope, and the robotic camera arm is compatible with most 12 mm laparoscopic trocars. The camera trocar should be placed 15–18 cm from the target anatomy to allow optimal visualization of the surgical field. For obese patients, the camera trocar may need to be placed closer to target anatomy to adjust for abdominal girth. This is especially important when using the da Vinci® standard system [5].

After visual access is obtained, secondary trocars can be placed under laparoscopic vision. The robotic instrument arms are compatible with specific da Vinci® 5 or 8 mm metal trocars that can be placed using blunt or sharp obturators (Fig. 2.5). The robotic trocars need to be

inserted with the thick black band at the level of the abdominal fascia. This acts as the pivot point for the trocar and robotic instrument arm. It is recommended that the robotic trocars be placed at least 8–10 cm away from the camera to avoid instrument arm collision and facilitate intracorporeal suturing. In addition, the angle created by the robotic and camera trocars should be greater than 90° to increase instrument arm maneuverability [1, 3]. Other laparoscopic instruments may need to be available for lysis of adhesions prior to robot docking and for the first assistant to use during the procedure (Table 2.1).

The da Vinci® Surgical System

The da Vinci® is available in four different models – standard, streamlined (S), S-high definition (HD), and S integrated (i)-HD. Each system has three components: surgeon console, patient cart, and vision cart [2, 8]. There are several sterile accessories and EndoWrist® (Intuitive Surgical, Inc., Sunnyvale, CA) instrument required for each system (Table 2.1). The standard system was released in 1999 and was originally offered with one camera arm and two instrument arms. Later a third instrument arm became available



Fig. 2.5 Photograph of 8 mm trocar for the da Vinci® standard (a) and S systems (b). The trocars for the S system also have a trocar that can be connected to the insufflator. Also shown are the sharp and blunt obturators used for trocar placement

Table 2.1 Instruments for robotic-assisted surgery**Laparoscopic instruments**

Veress needle
Visiport™ (Ethicon Endo-Surgery, Cincinnati, OH)
12 mm Optiview™ (Ethicon Endo-Surgery, Cincinnati, OH)
12 mm Xcel™ (Ethicon Endo-Surgery, Cincinnati, OH)
6 mm TERNAMIAN EndoTIP™ (Karl Storz Endoscopy America, Inc., Culver City, CA)
Fascial closure device
10 mm ENDO CATCH® entrapment sac (Covidien, Mansfield, MA)
Curved endo Metzenbaum scissors
Maryland dissector
Hook cautery
Needle driver
Endoscopic clip applier
Suction irrigator
0° and 30° laparoscope lens
Camera and fiber optic cords
5 mm and 10 mm Hem-o-lok® clips (Teleflex Medical, Research Triangle Park, NC)
Hot water bath for endoscopes

Robotic instruments

da Vinci® (Intuitive Surgical, Inc., Sunnyvale, CA)
8 mm or 5 mm robotic trocars (2–3 depending on the number of instrument arms)
EndoWrist® instruments (Intuitive Surgical, Inc., Sunnyvale, CA)
Sterile drapes for camera and instrument arms, camera and telemonitor
Sterile camera mount and camera trocar mount (depending on the type of system)
Sterile trocar mount (depending on the type of system)
Sterile instrument adapter (comes attached to the drape for the S)
Sterile camera adapter

as an option on new systems or an upgrade to existing systems. In 2006 the da Vinci® S system was introduced. This system has a similar platform to the standard system, but added numerous improvements including a motorized patient cart, color coded fiber-optic connections, easier instrument exchanges, quick click trocar attachments, increased range of motion and reach of instrument arms and interactive video touch screen display. In 2007 the S system became available with an HD camera and video system. Recently, the Si-HD system was released with enhanced HD vision at 1080i, upgraded surgeon

console and dual console capability. The dual console feature connects two surgeon consoles to the same patient cart. This allows two surgeons to coordinate a surgical procedure by exchanging control over instruments arms and the endoscope. The dual console feature and HD vision can be added to existing S systems as an upgrade by the manufacturer.

Surgeon Console

The surgeon console (Figs. 2.6 and 2.7) is the driver's seat for controlling the da Vinci®. From here the surgeon views a three dimensional image of the surgical field through the stereoviewer, adjusts the system with the pod controls, and controls the instruments arms using the master controllers and foot pedals [2, 8]. The standard and S systems have similar surgeon consoles with minor differences (Fig. 2.6), while the Si surgeon console was remodeled to increase ergonomics and working space, and integrates the right and left pod control into a central touch pad that can be seen without the surgeon removing their head from the stereoviewer (Fig. 2.7).

The stereoviewer displays the real-time high-resolution three dimensional image of the surgical field and system status icons and messages. The three dimensional image is created by capturing two independent views from two 5 mm endoscopes fitted into the stereo endoscope (Fig. 2.8) and displaying them into right and left optical channels [2]. The system status icons and messages are displayed in specific locations within the stereoviewer and alert the surgeon to any changes or errors with the system. Directly adjacent to the stereoviewer are infrared sensors that activate the surgeon console and instruments when the surgeon's head is placed between them. This feature prevents unintentional movement of robotic instruments inside of the patient's body as the robotic instruments are immediately deactivated when the surgeon looks away from the stereoviewer and

Fig. 2.6 Photograph of da Vinci[®] S surgeon console (a), right (b) and left-side (c) pod controls



Fig. 2.7 Photograph of da Vinci[®] Si-HD surgeon console (Reproduced with permission from Intuitive Surgical, Inc © 2009)

removes his head from between the infrared sensors. Below the stereoviewer are knobs to adjust the intraocular distance, intercom volume, brightness and contrast. Some of these controls may not be equipped on every model.

The da Vinci[®] standard and S-models (Fig. 2.6) have right- and left-sided pod controls on the end of the arm rest. The right-side pod controls communicate major system errors and turn the system on and off, while the left-side pod controls are used to set the system configuration and troubleshoot system faults. On the outside edge of the left-sided pod controls are adjustment buttons for raising and lowering the height of the surgeon console. The Si-HD combines the right and left pod controls into a central touchpad on the arm rest (Fig. 2.7). In addition, the console can be adjusted in four different directions to facilitate better ergonomics and the specific settings can be stored for each surgeon.

For all of the da Vinci[®] systems, the master controllers (Fig. 2.9) are the manual manipulators the surgeon uses to control the instrument arms and endoscope. The controllers are grasped with the index finger and thumb and movements

Fig. 2.8 Photograph of da Vinci® stereo endoscope (a) showing the two individual 5 mm endoscopes (b) and camera (c) with right and left optical channels



Fig. 2.9 Photograph of master controllers from the da Vinci® S system



are translated by a computer that scales, filters and relays them to the instruments. There is no measurable delay between surgeon and robotic instrument movement and there is a filtering mechanism that eliminates physiologic tremor [8]. Total working area for the masters in the da Vinci® standard and S systems is 1 cubic foot, while the Si-HD has 1.5 times the working space. Surgeons should adjust their working space between the master controllers to a comfortable working distance using the master clutch (see below) to avoid collision between the master controllers as well as against the walls of the working space. This helps to prevent reaching or stretching with eventual arm and wrist fatigue. The Si-HD also has added a

finger clutch on each of the master controllers that can also be used to adjust the working space of each individual master controller independently. To activate the instrument arms during surgery, the surgeon must “match grips” by grasping the masters to match the position and grip of the EndoWrist® instrument tips as seen within the body. This feature prevents accidental activation of the instrument arms and inadvertent tissue damage. When toggling between two instruments and taking control of an instrument that is retracting tissue, keep the master closed to prevent dropping the tissue.

The foot switch panel (Fig. 2.10) is used in conjunction with the master controllers to drive the surgery. The clutch pedal allows the

Fig. 2.10 Photograph of foot switch panels from the da Vinci® S system with pedals for clutch, camera, focus control, accessory/bipolar, and monopolar electrocautery



surgeon to shift to the third arm or adjust the working distance between the master controllers. By quickly tapping the clutch pedal once, the designated master controller toggles between control of the current arm to the third robotic arm. Tapping the clutch pedal once again will toggle back to the default settings and control of the original robotic arm. This feature allows the surgeon to toggle control of two different robotic arms using the same master controller. Completely depressing the clutch pedal disengages the master controls from the instrument arms and the surgeon can readjust their arms to a more comfortable position in the working space. Adjusting the working space is similar to moving a computer mouse when the limits of the mouse pad are reached. We generally recommend adjusting the working space when your elbows start to lift off of the armrest, your hands are in an awkward position, or if the master controllers are colliding with the side walls or with one another. Completely depressing the camera pedal disengages the master controls from the instrument arms and instead engages the endoscope. The endoscope may then be moved or rotated to the appropriate area of interest within the body. Tapping the camera pedal on the S system activates the auxiliary visual channels in the lower third of the stereoviewer which can be connected to intraoperative monitors or ultrasound allowing for picture-in-picture view (called TilePro™, Intuitive Surgical Inc., Sunnyvale, CA). There is a focus control pedal on the standard and S systems for the endoscope labeled “+/-” in the

center of the footswitch panel. The standard system has an auxiliary pedal, while the S system has a bipolar pedal that can be connected to bipolar energy. The coagulation pedal is connected to a compatible electrosurgical unit. With the dual energy capabilities, one instrument arm can be connected to bipolar energy while the other one is connected to monopolar energy. The Si-HD system has a completely remodeled foot panel with two tiers of pedals and pedals on the side of the panel (Fig. 2.7). There are still clutch and camera pedals on the left side of the panel, while on the right side there is a cut and coagulation pedal. The pedals on the side of the panel are used to switch control between the two surgeons in dual console mode. In addition the footswitch panel on the right can be used to change the coagulation pedal to bipolar mode. This feature prevents inadvertent electrosurgical activation of the wrong instrument arm. On all of the systems, the back of the surgeon console houses the AC powerconnection, color-coded cable connections, bipolar and monopolar electrocautery inputs, and additional audio and visual connections.

Patient Cart

The patient cart for the standard (Fig. 2.11) and S (Fig. 2.12) systems house the camera and instrument arms [2, 8]. Each arm has several clutch buttons that assist with the gross movements of the arm and to insert or withdraw



Fig. 2.11 Photograph of the da Vinci® standard patient cart with optional third instrument arm

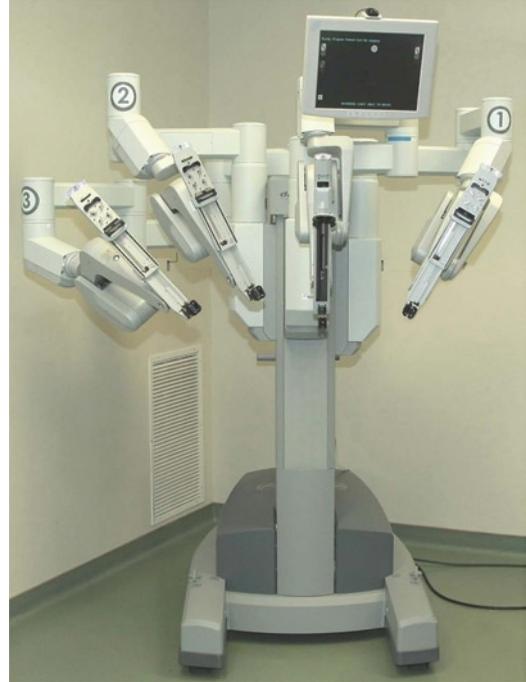


Fig. 2.13 Photograph of the da Vinci® S patient cart



Fig. 2.12 Photograph of the da Vinci® standard instrument arm showing the port clutch joystick button (*arrow*), port clutch button (*arrowhead*) and instrument clutch button (*asterisks*) used to position the arm for draping, docking and storage



Fig. 2.14 Photograph of the da Vinci® S and HD instrument arm showing the port clutch buttons (*arrows*) and instrument clutch button with LED indicator (*asterisks*). Also seen is the trocar mount (*arrowhead*)

instruments (Figs. 2.13 and 2.14). To activate the clutch, the buttons is depressed and the arm is moved, otherwise there will be resistance encountered and the arm will return to the original position. Each arm has two port clutch buttons used for gross movements of the instrument arm and there is a specific camera or instrument clutch button located at the top of each arm to

adjust the final trajectory of the arm during docking and to insert or withdraw endoscope/instruments. Each arm requires several sterile accessories that are placed during the draping procedure (Fig. 2.15).

The standard system was originally offered with a camera arm and two instrument arms. Later an optional third instrument arm became

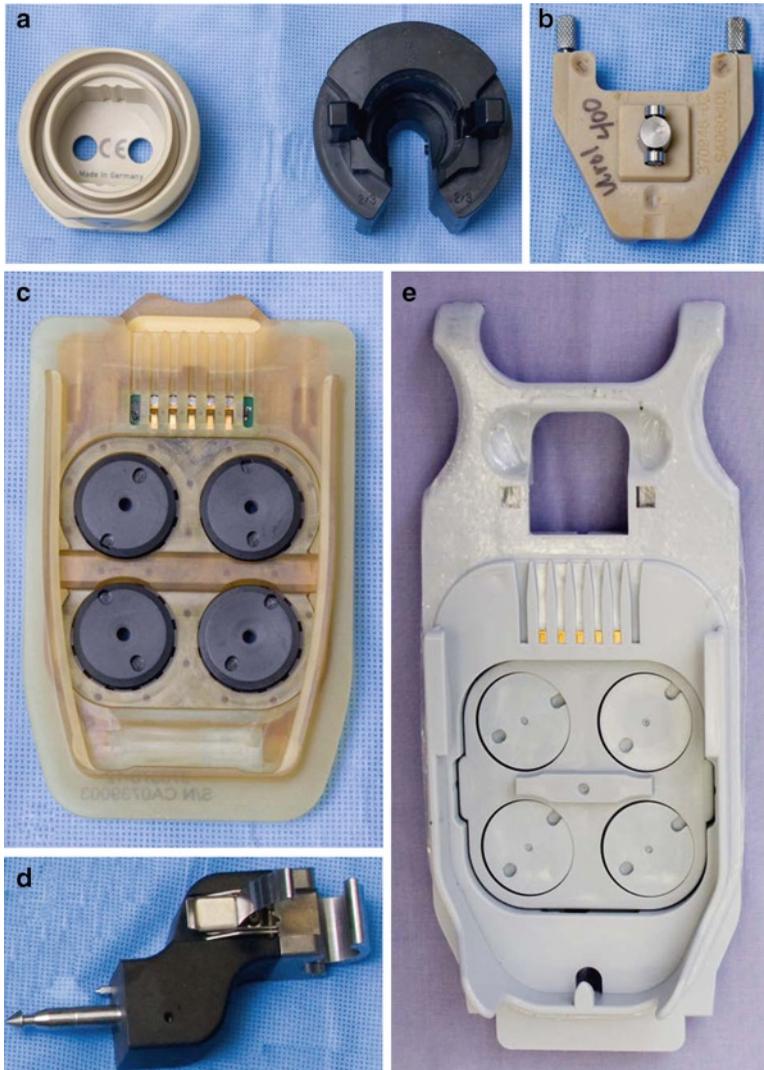


Fig. 2.15 Photographs of sterile accessories placed during the draping procedure. (a) Camera sterile adapter (left) and camera arm sterile adapter (right). Da Vinci® standard trocar mount (b), instrument arm sterile adapter

(c) and camera trocar mount (d). The instrument arm sterile adapter may be reused 50 times (e). Da Vinci® S instrument arm sterile adapter can only be used one time before being discarded

available for new standard systems or could be added as an upgrade to existing systems. The third instrument arm is mounted on the same axis as the camera arm (Fig. 2.11). Therefore care must be taken when positioning the third arm so that it does not collide with the other arms or operating room table. Each arm on the standard system is color coded with the camera arm (blue) and the instrument arms (yellow, green, and red). When moving the instrument arms using the port clutch, you should use your free

hand to brace the instrument arm for better control. With the standard system, you can only use one clutch at a time to move the instrument arm. With the S and Si systems you can use the port clutch and camera/instrument clutch simultaneously to maneuver the arm into position.

Similar to the standard system, the S and Si systems have a camera arm and two instrument arms (Fig. 2.12) and are available with an optional third instrument arm. Each instrument arm is numbered. These models also added an

Fig. 2.16 Photograph of the back of the da Vinci® S patient cart showing the power switch and motor drive controls



LED light below the camera/instrument clutch and a touchscreen monitor. The LED light communicates the status of the arm to the surgical team using a preset color scheme. The touchscreen monitor is synchronized with the surgeons view and displays all of the system status icons and messages. It can be used for endoscope alignment, telestration, or to toggle between video inputs. The telestration feature can be used to draw real time images on the screen that is relayed to the stereoviewer. This feature is especially useful for training residents or fellows. The touchscreen monitor can also be mounted on the vision cart. The patient side cart of the S and Si systems also feature a motor drive (Fig. 2.16), which assists in docking the patient cart to the operating table and trocars. All cable connections are located at the back of the cart.

Vision Cart

The vision cart (Fig. 2.17) contains the light source, video processing equipment, camera focus control, and camera storage bin [2, 8]. There are also several empty storage areas that can be used for insufflators, electrosurgical units or a DVD recording device. A telemonitor may be placed on the top of the tower. The light source is a xenon fiber optic system with a lamp life of approximately 500 h.

On the standard and S systems the light source is connected to the endoscope by a sterile bifurcated cable to illuminate the right and left channels, while the Si has a single cable. On some of the standard systems two light sources and two cables were required. The lamp on the S and S-HD systems can be changed by a member from the surgical team, while the standard systems require a service visit.

The endoscope is available as a 0° and 30° lens. We typically use the 30° downward lens for most robotic procedures in the pelvis, while a variety of endoscopes (i.e., 0°, 30° upward, 30° downward) are used for interventions of the upper urinary tract depending on the particular procedure and approach. With the standard and S system, the endoscope is connected to either a high-magnification (15× magnification with 45° view) or wide-angle (10× magnification with 60° view) camera head with right and left optical channels. The HD systems only come with one camera (see below). The right and left optical channels are connected to two 3 chip camera control units (CCU) (Fig. 2.8). The input from these CCUs is integrated in the surgeon console to produce the three dimensional image. The camera head is also connected to an automatic focus control that is linked to the surgeon console. The S-HD system adds a high definition camera and CCUs to increase resolution and aspect ratio. The first generation HD system had a resolution of

Fig. 2.17 Photographs of vision cart for the da Vinci® standard (a) and S systems (b)



720p (1280 × 720) which is significantly increased from standard NTSC 720 × 480. The aspect ratio also increases to 16:9, which improves the viewing area by 20%. The system also has a digital zoom that allows the surgeon to magnify the tissue without moving the endoscope. This is done by pressing the left and right arrow keys on the left-side pod controls or depressing the camera pedal and moving the masters together or apart. The Si-HD system is equipped with increased resolution to 1080i (1920 × 1080). The patient cart for the Si-HD was remodeled to integrate the light source and camera control unit into single connections. In addition, the camera adjustments and white balance are performed using the central touch pad or telemonitor.

EndoWrist® Instruments

The EndoWrist® instruments (Fig. 2.18) carry out motions originating from the master controllers. The instruments have seven degrees of freedom with 180° of articulation and 540° of rotation

simulating a surgeon’s hand and wrist movements (Fig. 2.19). Each instrument has a fixed number of uses before becoming deactivated. The system automatically tracks the number of uses remaining on each instrument and communicates this in the stereoviewer. An instrument arm will not function if an outdated instrument is loaded [8].

EndoWrist® instruments are composed of an instrument housing with release levers, instrument shaft, wrist and a variety of instrument tips (Fig. 2.18). The da Vinci® standard instruments are 52 cm with grey housing compared to the S systems being 57 cm with blue housing. The instruments are not interchangeable between the systems. Currently, there are more than 40 EndoWrist® instruments available in 8 mm or 5 mm shaft diameters and several have been designed specifically for urologic surgery. The 8 mm instruments operate on an “angled joint” compared to the 5 mm on a “snake joint” (Fig. 2.20). The angled joint allows the tip to rotate using a shorter radius compared to the snake joint. We have consistently used the 8 mm ProGrasp™ forceps (Intuitive Surgical, Inc., Sunnyvale, CA), monopolar curved shears, large

Fig. 2.18 Photograph of an EndoWrist® instrument for the standard (a) and S (b) systems

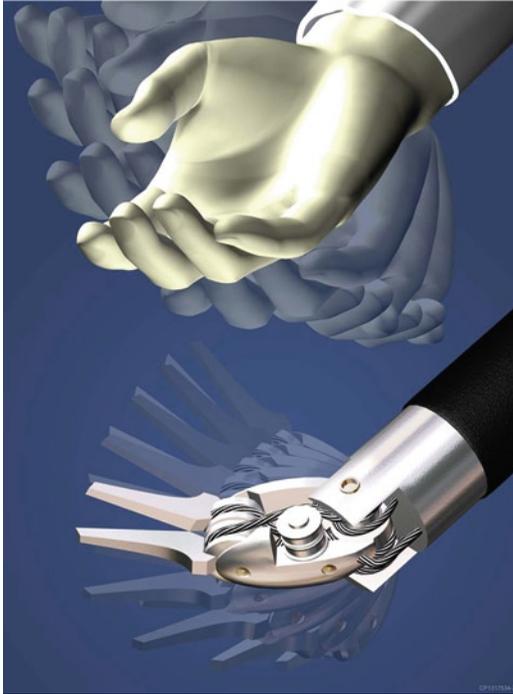


Fig. 2.19 Illustration comparing surgeon hand movements to EndoWrist® instrument



Fig. 2.20 Photograph of EndoWrist® needle drivers. On the left is a 5 mm needle driver with the “snake joint” compared to the 8 mm needle driver with an “angled joint”

needle driver, and Maryland bipolar forceps for our robotics practice.

Preparing the da Vinci® for Surgery

Preparing the operating room for robotic assisted procedures begins well before the patient enters the room. Once the equipment is positioned, the surgical team can prepare the system [8].

1. Connect system cables, optical channels, focus control, power cables and turn the system on. The system will then perform a self-test. During this time, do not attempt to manipulate the system or a fault may be triggered.
2. Position the instrument and camera arms so they have adequate room to move.
3. Initiate homing sequence.
4. Drape the patient cart arms. This takes a coordinated team effort between surgical technician and circulating nurse and uses system specific sterile drapes and accessories. Make sure the drapes are not too tight as this may decrease the range of motion of the robotic arms.
 - a. The instrument arms are draped to completely cover the arm and the sterile instrument adapter is locked into the instrument arm carriage. For the standard system the sterile trocar mount is also locked into position, while the S system has the trocar mount permanently attached and the drape is placed over the mount.
 - b. The camera arm is draped in a similar fashion. For the standard system, a sterile endoscope trocar mount and camera arm sterile adapter are also placed at this time.

The S system also requires a camera arm sterile adapter. Depending on when the S system was purchased, some use a sterile endoscope trocar mount, while others have the mount permanently attached. There are different robotic camera arm trocar mounts for each trocar manufacturer.

- c. The touchscreen monitor is draped for the S systems.
5. Drape the endoscope by connecting the camera sterile adapter to the endoscope and then taping the drape to the sterile adapter. The camera head is connected and the drape is inverted over the camera head and optical cables.
6. Connect the light source to the endoscope with the sterile light cable. Perform a black and white balance.
7. Align the endoscope and set endoscope settings (three dimensional vs. two dimensional, 0° vs. 30° up or down).
8. Set the “sweet spot” of the camera arm by aligning the trocar mount with the center of the patient cart column and extending the camera arm so there is approximately 20” between the back of the camera arm and patient cart. The S systems have a guide on the camera arm to assist with setting the sweet spot. This allows maximal range of motion of the camera and instrument arms and prevents collisions.

Patient Cart Docking

After abdominal access is obtained, the patient cart is maneuvered into position to align the patient cart tower, camera arm and target anatomy. One member of the surgical team drives the patient cart while another one guides the driver. To avoid any confusion during docking, it is recommended that the navigator use anatomic or room references versus directional cues. The surgical table should be placed in the desired position (Trendelenburg, etc.) prior to docking the patient cart.

The standard system is pushed into position and the brakes at the base of the cart are hand-tightened. The S and Si systems have a motor drive

to assist with docking, however use of the motor drive is not mandatory for the docking process (Fig. 2.16). To operate the motor drive, unlock the brakes and turn the shift switches on the base of the cart to the drive position. Engage the motor drive by holding the throttle-enable switch on the left and turning the throttle forward or backwards with the right hand. To move the cart without the motor drive assist turn the shift switches to neutral. There is no mechanical brake like the standard system and once an instrument arm is connected to a trocar, the motor drive brakes automatically to keep the cart from moving.

The camera arm is the first one connected to the patient by locking the camera trocar mount to the camera trocar. It is important to use the camera setup joint buttons to move the camera arm into position and the camera clutch to adjust the final trajectory of the arm. Exclusively using the camera clutch to move the camera arm, may limit the range of motion of the camera during surgery. The instrument arms are then attached to the robotic trocars and screwed into place using a twist-lock device when using a standard system. When using the S or Si system, snap mounted devices are used to engage the robotic trocars. Again use the port clutch for gross movements of the instrument arms and the instrument clutch for the final trajectory. When using the standard system with the third instrument arm for surgery of the pelvis, the arm comes from below the table and wraps around the patient's leg. Care must be taken when docking to avoid collision, contact or pinching the patient's arm, body, or leg.

Once all of the robotic arms are connected, the surgical team should check each of the arms for proper working distance and make sure the arms are not compressing the patient. The endoscope is inserted by placing the lens into the trocar and locking it into the camera trocar mount. The endoscope can then be advanced into the surgical field using the camera clutch button. EndoWrist® instruments are inserted by straightening the instrument wrist and placing the instrument tip into the trocar and sliding the instrument housing into the adapter. The instrument is then advanced into the surgical field using

the instrument clutch button. Each instrument should be placed into the patient under laparoscopic vision. To remove an instrument, the surgeon should straighten the instrument wrist and the assistant squeezes the release levers and pulls the instrument out. Maintaining close communication between the surgeon and assistant especially during instrument exchanges is important so as to avoid inadvertent adjustment, movement, and complete removal of an instrument that is in active use. As a safety measure, the S system features a guided tool change where a new instrument can be inserted and placed to a depth 1 mm short of the previous instrument position.

For surgery of the pelvis, the surgical team can take their positions for the procedure (Figs. 2.1 and 2.2). The surgeon sits at the console, circulating nurse at their workstation, surgical technician on the patient's left and the surgical assistant on patient's right side. When using a system with two instrument arms, a second surgical assistant or the surgical technician can assist with the procedure from the patients left side. In this instance, the second assistant uses a separately prepared Mayo stand with the instruments they need to complete the case. Using a third instrument arm can often eliminate the need for a second surgical assistant during the procedure. The cost and benefits of the third instrument arm must be weighed against the cost of a second assistant.

System Shutdown

Once robotic assisted surgery is completed, all of the instruments are removed first, followed by the endoscope. The arms are disconnected from the trocars and the patient cart is undocked from the patient. For the S and Si systems the motor drive system cannot be activated until all the instruments are removed and the camera and instrument arms are disconnected. The specimen is delivered within a specimen retrieval bag by extending one of the incisions. This incision and any 12 mm trocars made with a cutting trocar require fascial closure to prevent incisional

hernias. The 8 and 5 mm trocars generally do not require fascial closure [3, 4]. Once the surgery is completed, the sterile accessories and drapes are removed and the system is cleaned. It is not necessary to power the system off between surgical procedures.

Conclusions

Robotic-assisted urologic surgery has increased significantly over the past decade. Successful implementation of a robotics program hinges on proper operating room setup and a complete understanding of instrumentation required. In addition, a knowledgeable, well-trained and collegial surgical team is crucial for operating room dynamics and likely contributes to positive patient outcomes.

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