

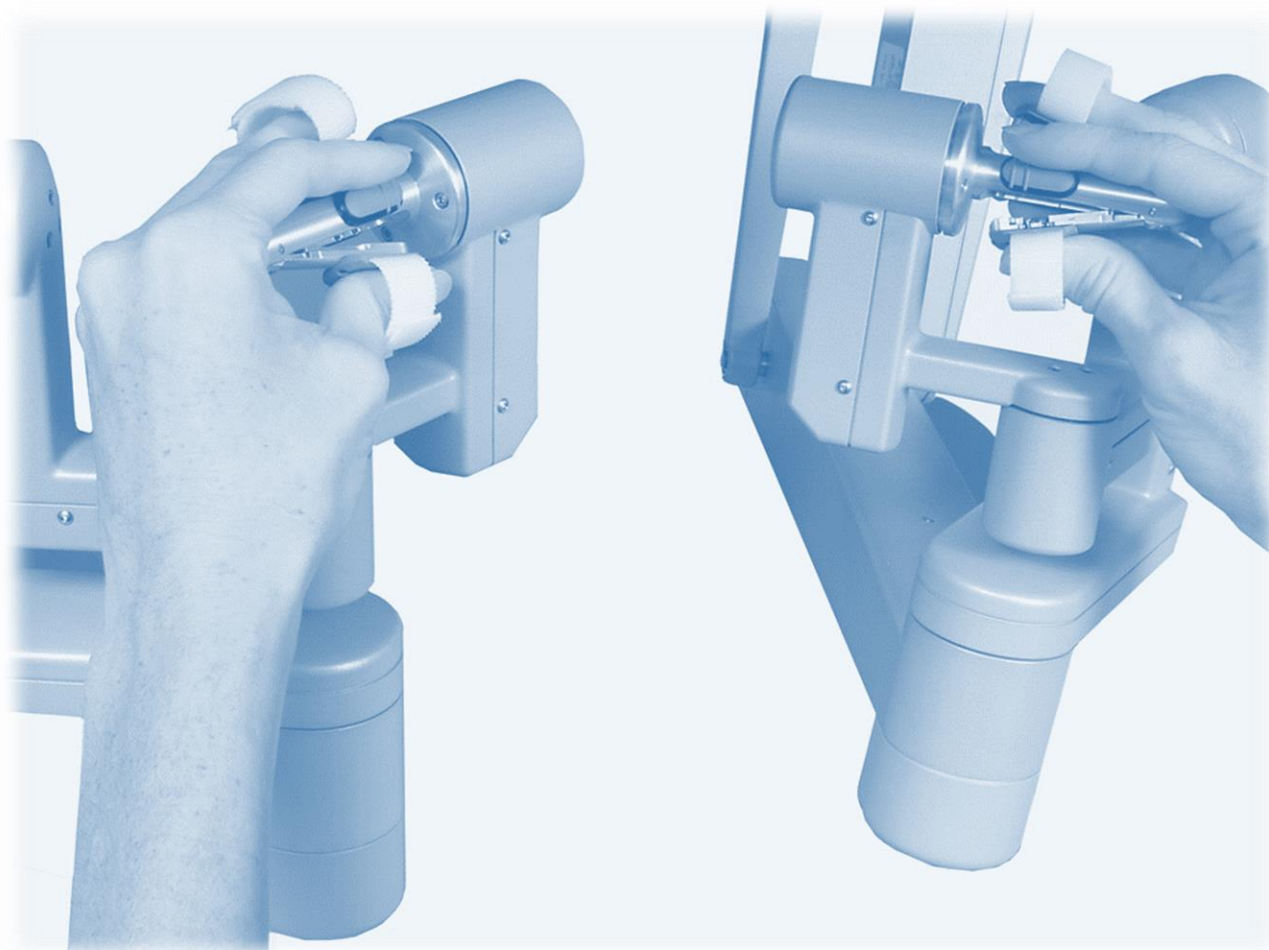


ALSGBI MANUAL FOR ROBOTIC SKILLS COURSES

Mandatory pre-course reading for training on Da-Vinci systems

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The information contained is an extract from Intuitive In Service Guides, Intuitive educational videos and the Intuitive website (used with permission).

The aim of this document is to provide the learners with the required knowledge that is needed to understand the structure and the function of the robot to aid hands-on training.

The expectation is this manual must be read by each course delegate prior to attending the course as the content of this manual should set you up with background knowledge about the robot and procedure that you will need to understand and work effectively during machine trouble shooting.

August 2021

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1. Introduction

Robotics is being hailed as the future of surgery. For those who can see it, the future is now.

Robotic surgery is gaining momentum and with increasing surgeons' experience the indications are ever expanding. The robot is a surgical tool that can enable surgeons to perform minimally invasive procedures which are otherwise extremely difficult with standard laparoscopic inventory.

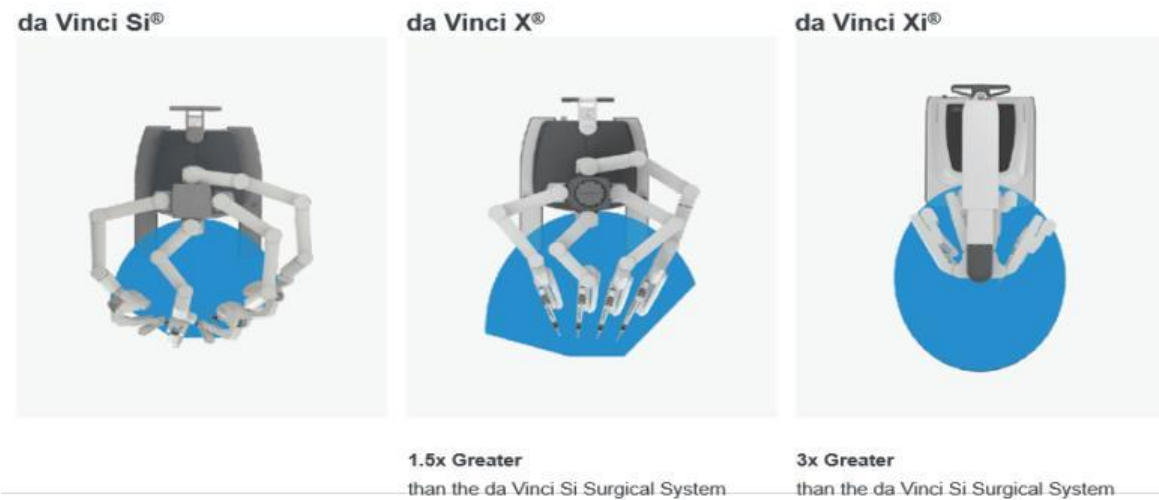
Robotic surgery has been widely adopted across specialties and approximately 1.5 million robotic procedures were performed worldwide in the last decade. Robotic platforms offer 3D-HD magnified and stable view, Endowrist® instruments that offer seven degrees of freedom mimicking movements of the human hand and the luxury of sit in console for surgeon comfort. This platform offers significant advantages over the standard laparoscopic approach and can allow more complex resections to be done in a minimally invasive manner.

Although the robotic surgical platform is viewed as an evolution of laparoscopic surgery, it represents a technological change, as additional skills required for novice robotic surgeons are console control and manoeuvres without haptic feedback, rather than those required for two-dimensional surgery with a set of instruments with restricted range of movement (as with laparoscopic surgery). Structured training is therefore required to ensure acquisition of the basic robotic skills as well as more complex manoeuvres to enable the development of these skills in a safe and stepwise manner over a relatively short learning curve. In this manual, we aspire to share the basic knowledge necessary to assist and operate robotic platforms, with specific references to the most commonly used 4th generation da Vinci robotic platforms, followed by a guide to basic exercises that would lead to competence in basic robotic surgical skills.

1. System appraisal

There are over 12 different manufacturers at various stages of launching their robotic systems, but the da-Vinci Surgical System (Intuitive Surgical, California, USA) is the most commonly used robotic platform around the world.

Intuitive currently offers 4th generation X and Xi systems, the 3rd generation Si is still supported but will be phased out gradually. The new systems boast 8 mm ports, thinner arms, longer instruments, advanced energy and port hopping options.



Gen4 Technology Enhancements

	da Vinci Si®	da Vinci X®	da Vinci Xi®
CAPABILITY ENHANCEMENTS			
Streamlined Port Placement	x	✓	✓
Full Multi-quadrant Access	x	x	✓
Integrated Table Motion	x	x	✓
Boom Rotation	x	x	✓
EASE OF USE ENHANCEMENTS			
Automated Setup Tasks	x	x	✓
Advanced Intraoperative Adjustments	x	x	✓
Simplified Cart Positioning	x	x	✓
Optimized Patient Side Access	x	x	✓

Most robotic platforms have three components:

- Surgeon console
- Patient cart
- Vision cart.

Robotic platforms operate as a master-slave system where the surgeon sits at the console some distance from the operating table and controls the robotic arms. Robotic instruments are attached to the arms and these are controlled by the surgeon's hand movements via the console. The "master" instruments at the console sense the surgeon's hand movements and translate them electronically into scaled-down micro-movements. Hand tremors are filtered and the surgeon observes the operating field through console binoculars and the image comes from a maneuverable stereoscopic camera (endoscope). A second optional console allows tandem surgery and training.



Surgeon Console

Patient Cart

Vision Cart

Surgeon Console:

The surgeon console enables the surgeon to remotely control the Endowrist® instruments and endoscope via the hand controllers.

Two **master controls** take input from the surgeon's finger and thumb and translate the operator's movements in real time to the robotic arms and EndoWrist instruments.

Some basic force feedback is felt by the surgeon but there is no true tactile feedback.



A **touchpad** is located in the center of the **arm bar** at the Surgeon console and it provides control of video audio scaling and ergonomic settings and gives the surgeon full control of the camera while operating.



Stereo viewer offers 3D HD view which is normally set at a scale of 1:10



The **rocker switches** at the left of the arm bar allows the surgeon to adjust the height and angle of the console stereo viewer. The arm bar height can be adjusted using these switches and the foot pedals platform can extend or retract for comfort and ease of access.



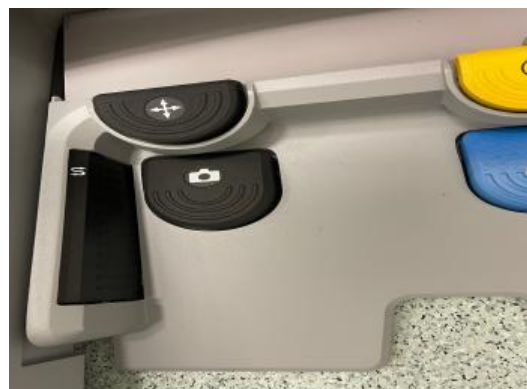
The **blue** foot paddles are used for coagulation and **yellow** for cutting, depending on the side energy enables instruments are held. These paddles are also used for advanced bipolar energy and stapling.

The foot paddle with **camera symbol** is used to manoeuvre the endoscope.

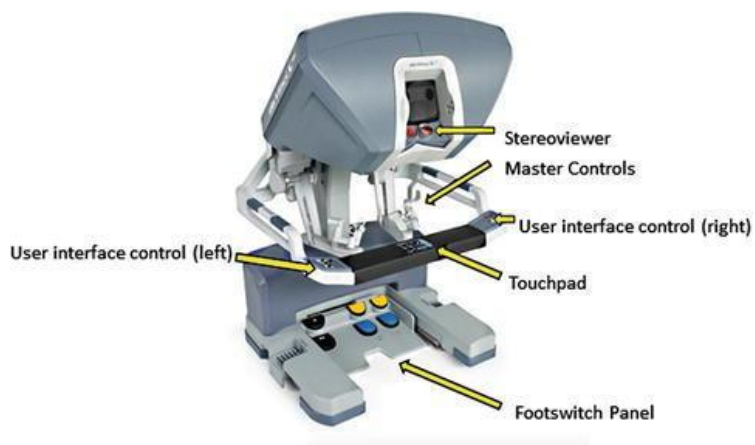
The paddle with **compass symbol** (master clutch) is used to disengage instruments for re-positioning hand controls.



The side “**S paddle**” is used to switch control of the two instruments on the opposite side of the camera i.e. ports 3 and 4.



Repositioning hand controls: To reposition both hand controls, press and hold the master clutch and bring them within the working space. To reposition one hand control, the surgeon can use the finger clutch located on each hand control.



Patient Cart:

Patient cart docks to the patient and overhangs the operating table with its four robotic arms (see section 5 for full details of docking). The robotic arms incorporate remote center technology with a defined fixed virtual point around which the surgical arms move so that the stress on the abdominal or thoracic wall is minimized. Each robotic arm has identical controls as below:

Individual robotic arms position can be adjusted without moving the port or the cannula by pressing the **instrument clutch button** at the top.

Patient clearance buttons can be used to raise or lower the robotic arm joints to avoid injury. Patient clearance can be achieved without removing the instruments.

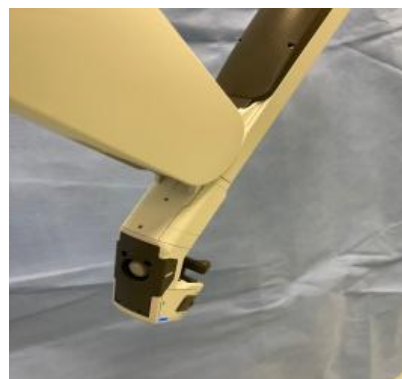


When an instrument is inserted, the **arm clutch button LED** starts blinking blue, **quick click** will turn the light solid blue and the arm will be ready for use by console surgeon. Pulsing Blue light means that the arm is performing an activity which requires the user to wait. Blinking green light indicates that the Guided Tool Change is available (explained later).



Port clutch button at the bottom can be used to release tension at port site. Pressing the port clutch button allows arm movement to adjust flex joints and manage space between arms.

Press and holding the port clutch button allows up or down movement on the arm.



Cannula mount holds the robotic ports. Using one hand, pull the cannula mount lever with the thumb. Then align and insert **port fin** into the cannula mount. Make sure the ports are not under tension.



Instrument housing at the top end of the robotic arm is where the instruments rest while in action.

The LEDS lights at instrument housing show status of the instrument:

- Solid Blue: System is operating properly
- Blinking Blue: Arm is clutched
- Pulsing Blue: The arm is performing an activity which requires the user to wait
- Blinking Green: Guided Tool Change

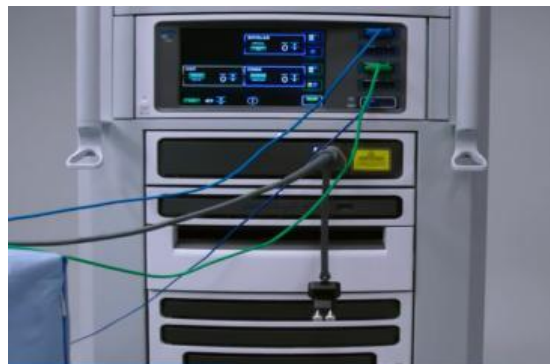


Vision Cart:

The vision cart includes a **touchscreen monitor** with adjustable height for the assistant. The vision cart has the optics, light source, energy and the camera attachment. It is connected to both consoles and the patient cart by cables.

The vision cart houses the system electronics, video processors and an integrated generator. Communication to all three components is via fiberoptic cables.

In addition to the processing equipment the vision cart also houses the ERBE generator which is a fully integrated electro-surgical unit designed to work with the da Vinci energy instruments as well as with laparoscopic energy instruments.



2. Instrument appraisal

Intuitive Endowrist® instruments can be used multiple times with 10 to 18 lives. They mimic surgeon's hands movements through the master controllers and offer 7 degrees of freedom.



Instrument insertion:

1. Before inserting an instrument, straighten the instrument wrist and close the tips (attach energy cables to the instruments before installing)
2. Place instrument tip in the cannula then advance and until fully seated on the housing
3. Solid blue LED and an audible tone indicates instrument has been docked properly
4. Visualise the cannula tip and advance the instrument towards the target anatomy under vision
5. Quick click the instrument arm clutch button to lock into place. Do not move any instrument that is not under direct visualization.

Instrument removal:

1. Visually and verbally confirm that the instrument is **straight and free** ie., not holding tissue
2. Use read-back technique to confirm which instrument to remove. Identify the instrument by both name and arm number.
3. Squeeze release buttons on instrument housing and pull the instrument straight up and out without using excessive force

Monopolar Instruments (8mm)

Instruments shown are monopolar hook, curved scissors and spatula



Bipolar Instruments (8mm)

From left to right are Maryland forceps, fenestrated forceps and curved bipolar dissector



Clip appliers (8mm)

Medium Hem-o-lok applier, Large Hem-o-lok applier, small clip applier



Needle drivers (8mm)

Large needle driver, Large SutureCut needle driver, Mega needle driver



Non-energised graspers (8mm)

Cadiere forceps, ProGrasp forceps, Tip-Up fenestrated grasper



Non-EndoWrist Harmonic ACE curved shears (8mm)

Ultrasound energy cannot be bent, therefore the Harmonic ace comes in a non-endowrist format and is an accessory developed in conjunction with Ethicon.



Suction irrigation (8mm)

EndoWrist suction instrument can be used for blunt dissection and clear the surgical field.



Advanced EndoWrist energy instrument (Vessel Sealer extend and SynchroSeal)

Vessel Sealer Extend is a wristed advanced energy instrument and has bipolar cautery function with a blade to divide the tissue after coagulation. The coagulation is carried out with the blue pedal and the yellow paddle is pressed twice to engage and cut the tissues. It can take vessels up to 7 mm in size.



SynchroSeal is the latest device with faster coagulation and cutting function and has slim curved blade mimicking Harmonic and can take vessels up to 5 mm.


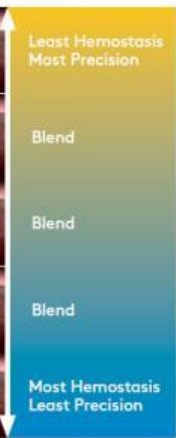











SureForm EndoWrist Stapler

Sureform® is endowrist stapler that uses the smart fire technology to provide compression and then firing for secure division. The stapler is single use and can fire up to 12 times.




Energy setting: The strength, depth and character of monopolar and bipolar energy can be adjusted from surgeon console touchpad. The available options are Auto Cut, Forced monopolar coagulation, swift monopolar coagulation or classic monopolar coagulation mode. Effect setting changes the relative amount of coagulation or cutting effect for the selected mode, and can increase the coagulation zone.

	Tissue Effect		Pedal	Effect Range
AUTO CUT		 <p>Least Hemostasis Most Precision</p> <p>Blend</p> <p>Blend</p> <p>Blend</p> <p>Most Hemostasis Least Precision</p>		1-8
DRY CUT				1-8
CLASSIC COAG				1-2
SWIFT COAG				1-8
FORCED COAG				1-4



VIO dV Bipolar Mode

BIPOLAR COAG	<p>Soft Coag: Lower voltages, carbonization of the tissue is prevented, adhesion of the electrode to the tissue is very much reduced</p> <p>AUTO STOP: Ends activation of BIPOLAR SOFT COAG automatically before the tissue adheres to the instrument.</p>		1-8
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3. Port placement:

Ports Selection: The choice of ports depends on the robotic system used. All ports are 8 mm in 4th generation X/Xi systems®. 12 mm robotic port is required for stapling. The assistant port can be a size 5 or 10 mm, depending on surgeon's preference. 10mm assistant ports are useful for inserting needles and swabs.

Da Vinci cannulas

Robotic ports are reusable with blunt or sharp trocars.

Remote center solid circumferential marking is the pivot point around which the arm moves.

Position remote center in the muscle layer to help minimize the amount of force the system may exert on the body wall during surgery.

Cannula seals are disposable and have inlet for insufflation or smoke evacuation and can also be used with 5 mm laparoscopic instruments.

Cannula obturators come as 8 mm blunt reusable in 10 cm and 15 cm lengths and 8 mm bladeless optical disposable in 10 cm and 15 cm lengths.

The remote center concept: The robotic arms have three markings at the distal end of cannula. The thick middle mark should be at the level of rectus sheath and represents the vector point of the port around which the robotic arm can rotate the port at 360° without causing damage or pressure to the abdominal wall. This minimizes tissue damage and reduces the postoperative pain. The proximal thin line is usually at skin level and the distal one is the guide inside the abdomen during the insertion of the port.

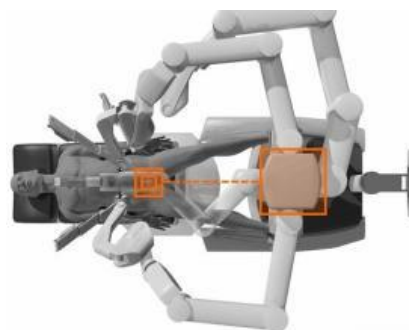


General principals of ports placement:

A linear port placement is recommended to minimize arm-to-arm interferences in the 4th generation da-Vinci systems.

- 1- Create pneumoperitoneum (using cut down port or Veress needle) and anticipate effect of patient position before ports placements.
2. Identify the surgical workspace and **Target Anatomy** (the farthest point required to reach within the workspace, this is not necessarily location of the pathology).

3. Mark the endoscope port 20-25 cm from the target anatomy.
4. For instrument arm ports, mark 6 – 10 cm from initial endoscope port in a line. Ports can be a minimum of 4 cm apart in certain cases. Maintain 2 cm or more between ports and any bony prominences.
5. Mark the assistant port on either side of the patient, 6 – 10 cm from the nearest da Vinci port, and in line with all other da Vinci ports and consider location of internal anatomy to be retracted.
6. Consider **port hopping** potential when placing ports. Placing 4 ports allows switching between 2 right hands/left hands, changing vantage point and placing 5 ports allows switching between two right hands and two left hands, while maintaining vantage point. The additional port can be used as an assistant port.
7. Mark the assistant port lateral to or triangulated between the da Vinci ports. Ensure the assistant port is at least 7 cm away from all other ports and has a clear path to the target anatomy. Use long length instruments for greater reach and access. Do not place the assistant port between da Vinci ports and the target anatomy.
8. Align the camera arm with the helm of the patient cart to prevent clashing of the arms.



In summary, the target anatomy (TA) should be 25 cm away from camera port (C) and there should be at least 6 cm distance between instruments ports (R1 to R4) and assistant ports (A1 and A2).

The 12 mm assistant port can then be extended to extract specimens.

Endoscope:

Newer 4th generation da Vinci systems use 8 mm scope that is available in both zero- and 30-degree lenses ([see video through link or scan QR code](#))



While installing the scope, wrap the cable between the endoscope shaft and the arm before inserting the endoscope tip into the cannula. This minimizes the cable length that is free to swing during the procedure.

Surgeon can change the up or down orientation of the 30-degree endoscope from the console touchpad without removing the endoscope from the arm.

The scope can jump to any port during surgery without undocking the robot.

The surgeon can also customize colour balance, brightness, contrast, zoom and working distance from the touchpad.

The TilePro[®] multi-image display feature allows display of up to two auxiliary video inputs (PACS, ultrasound, room video) along with the operative image in the Surgeon Console viewer. When TilePro[®] is active, the system detects auxiliary video inputs and arranges the TilePro[®] display automatically.

Firefly fluorescence imaging can be activated from the settings tab on the Vision Cart touchscreen or Surgeon Console touchpad

Caution: The distal tip of the endoscope may reach high temperatures during use. Avoid contact with skin, tissue, and clothing.

4. Docking

This docking procedure is outlined based on the 4th generation da-Vinci systems.

Drive and position the patient cart

Patient cart is moved by grabbing the cart handlebars and holding them down while driving. Once the cart is in position, release the cart drive handlebars and this will deactivate the motor drive and activate the cart breaks



Adjust boom via Touchpad

Non-sterile staff can adjust the boom by pressing and holding the enable joysticks button on the patient cart touchpad.

The boom position control allows the non-sterile staff to manually extend, rotate or pivot the boom. The boom height can be adjusted and limited to avoid clashing with the overhead theatre operating lights.



Deploy for docking

Once the patient cart has been draped, the patient has been positioned and ports have been placed, the system is ready to deploy for docking.

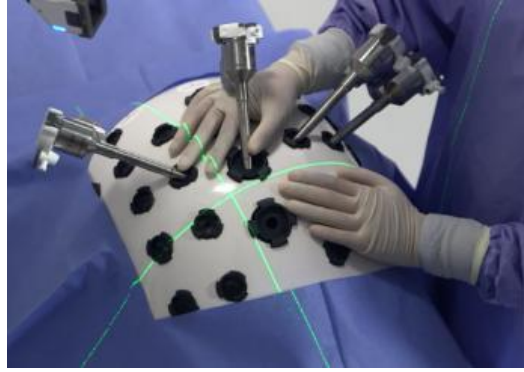
The non-sterile staff member should select the anatomy and cart location on the touchpad. To deploy the robot for docking, the non-sterile staff member presses and holds the deploy for docking button which raises the pivots and extent and rotates the boom for deployment.



Drive and Position

Once the boom has been deployed a non-sterile staff member can begin to drive the patient cart into position over the patient. A sterile staff member directs the non-sterile staff member using room landmarks rather than left or right directional language to avoid confusion.

The non-sterile staff member drives the patient cart from the helm until the laser lines are positioned within 5 cm of the initial endoscope port which can then be docked to the patient.



Docking and Targeting

Install the endoscope onto the arm and point the scope of the target anatomy. Then press and hold the targeting button which automatically positions the boom to maximise range of motion and creates adequate clearance between the arms.



Dock and space arms

Once targeting is complete, rest of the robotic arms can be docked using the port clutch buttons.

Adjust the robotic arms so that all are working in parallel towards the target anatomy leaving a fist width spacing between them.

To increase instrument reach, bring the patient clearance joints down leaving a fist width space between the arms and the patient.



How to dock an instrument

Always use two hands when installing an instrument; one hand holding the jaws closed and the other supporting the housing of the instrument. Insert the instrument tip into the cannula and slide the instrument housing into the sterile adapter, review the screen to ensure the instrument is recognized and ready to use.

Move the instrument forward and follow this under direct camera vision. Park the instrument at the desired location and press the clutch button so that the flashing light at the port clutch becomes static.

Instrument Clutch Button

The instrument clutch button is located on the back of each arm at the top of the grey handle. It is activated by pressing and releasing known as “quick click” or by pressing and holding the instrument clutch button.

Instrument carriage LEDs and instrument clutch LEDs will blink blue when activated. When activated, the instrument clutch button allows the arm to move around a fixed point in space called the “remote center”.

This keeps the point of entry into the surgical site static and helps minimise port site trauma once positioned. The arm can be locked into place by letting go of the button or by using a quick click feature a second time.



Port Clutch Button

The port clutch button is located behind the cannula mount and is activated by pressing and holding. It is used for adjusting the vertical and horizontal position of the arms including flex joints. It can also be used to adjust the remote center. The cannula mount LED will blink blue when the port clutch button is activated.



Instrument insertion

Before insertion instrument tip should be closed and wrist straight. When inserting an instrument for the first time always insert under direct vision. If an instrument is out of view, you will see an off-screen tool indicator on the vision cart monitor.

For energy instruments, always make sure cables are connected before installing the instrument onto the patient cart arm.





Instrument Removal

Once the wrist is straight and the tip is not holding any tissue, the sterile staff can squeeze the release buttons on either side of the instrument housing and carefully pull the instrument out and up away from the patient cart arm.



Guided Tool Change

When an instrument is removed and another instrument installed, the LED on the arm starts blinking green. Slowly insert the instrument into the surgical field and the system will stop the instrument 3 mm short of the previous instrument tip location, the LEDs will then turn solid blue.

Pressing any clutch button on the arm can disable guided tool change.



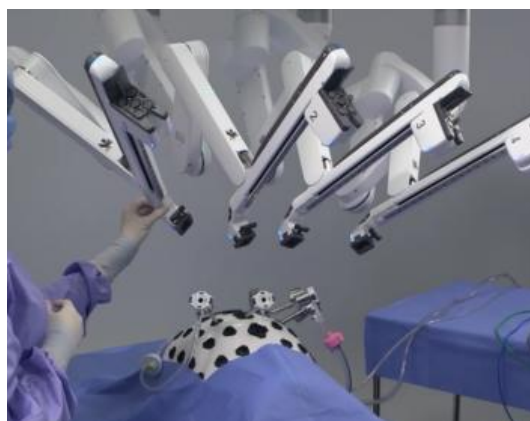
Port Hopping

Consider port hopping potential when placing ports. Placing 4 ports allows switching between 2 right hands/left hands, placing robotic 5 ports allows switching between two right hands and two left hands.

The additional port can be used as an assistant port.

Undock Arms

When the procedure is over and the surgeon has released any tissue from instruments' grip, the sterile staff member removes all the instruments and endoscope under vision by squeezing the release buttons and pulling straight out and up away from the arm. The cannulas can then be disconnected from the arms and raise the boom boot as required to ensure patient clearance.



5. Troubleshoots

Image is too bright: Use the brightness slider on the Vision Cart touchscreen or Surgeon console touchpad to decrease brightness to the desired level.

Image is too dark: Clean the endoscope, increase brightness level from the Surgeon Console touchpad or increase dynamic contrast setting from the Surgeon Console touchpad. The endoscope may need changing or repair if problem persists.

Flickering Image (Diathermy shortening): Check for cautery interference (move the energy cables away from the vision cables). If this doesn't settle the problem, try another endoscope or restart the system.

Blurry or out-of-focus Image: Adjust the digital zoom setting from the touchpad and select 1x. Position the endoscope between 2 - 14 cm from target tissue. Clean the endoscope or try another endoscope. If the problem persists, contact Intuitive Surgical technical support for a replacement.

How to minimise fogging:

- Connect the endoscope to the controller 30 min prior to the procedure
- Use heated insufflation and set insufflator to maximum flow rate (speed of inflow, not pressure)
- Use a scope warming device immediately prior to insertion -
- Insert endoscope tip beyond the tip of the cannula upon initial entry
- Maintain distance from tissue, especially during use of cautery. Use 2X or 4X digital zoom to create the same view as if the endoscope is closer to tissue.
- Use heated insufflation and check that the insufflation/smoke evacuation tubing is not connected to endoscope cannula

Emergency undocking:

In case of a surgical or anesthetic emergency, urgent undocking may be required. All teams should practice this drill and the aim is to remove the instruments quickly and safely and pull the ports out while still attached to the arms and then move the arms away from the patient so that the patient cart can be wheeled back. It should not take more than 30-60 seconds to achieve this and a laparotomy can be carried out quickly.

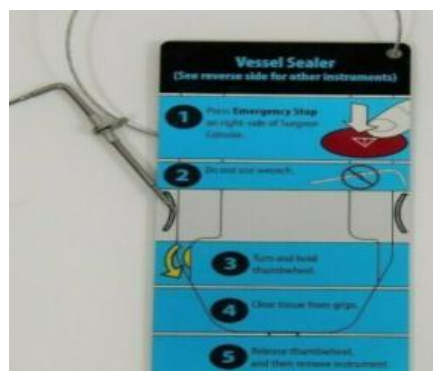
It is sensible that while performing major resections, an emergency conversion tray is open and ready to be used, including hand held diathermy, suction, large abdominal packs and self-retaining retractors.

Conversion to Open and Lap/Immediate Patient Access Discussion

If a situation arises where conversion to open surgery or immediate access to the patient is required, remove instruments from the patient under direct visualization, use Surgeon Console control to release the instrument grips. If robotic control cannot be used to release the instrument grips, manually release grips using the Instrument Release Kit (stored in vision cart). Then remove the endoscope from the patient and disconnect the cannulas from the arms.

Manual Instrument Grip Release

In the event of a system fault where normal instrument removal is not possible (Instrument jamming or becoming unresponsive) or when Surgeon Console control of the instrument is not practical or available, use the Instrument Release Kit.



If the instrument tips are holding tissue, the instrument release wrench allows the patient-side operator to manually open the grips to release tissue – the instruction card is attached to the wrench. Note that the instrument should not be re-used on an arm after the instrument release wrench has been applied.

1. Ensure that the system is in a fault state. If not, press the "Emergency Stop" button on the Surgeon Console to trigger a system recoverable fault.
2. Insert the wrench into the grip release socket on the instrument housing
3. Stabilize housing with one hand while pushing the wrench into the socket to ensure it engages
4. Turn wrench in the direction of the arrow on the housing, approximately 1/4 turn
5. Under endoscopic visualization, verify the grips are not grasping tissue
6. Once the tissue is released from the grips, remove the wrench from the instrument
7. Squeeze the release buttons on the sides of the instrument housing and remove instrument
8. Tap "Recover Fault" or "Resume Use" on the touchscreen or touchpad, restart the system as necessary

The Instrument Release Kit is usually individually sterile wrapped, labelled and is placed in the Vision Cart drawer for easy access.

System Fault Management:

When a fault occurs, the system determines whether the fault is recoverable or non-recoverable. The system behaves in the following manner when a fault occurs:

- Locks all the Patient Cart arms. In this state the Patient Cart clutch buttons function normally but the instrument is slightly harder to move and is not able to be left in clutch mode.
- Sounds a series of error beeps
- Displays a text message on the monitors to describe the error
- If the fault is arm-specific, the system displays an error icon and the specific arm LED will be amber or red
- If the fault is not arm-specific, all arm LEDs will be amber or red

Recoverable fault: A recoverable fault is one that the system can recover from and does not require a system restart. Amber LEDs on the arm/ system are associated with a recoverable fault and the fault can be overridden by pressing the “Recover Fault” button.

Read messages on the Vision Cart touchscreen, fault tab and observe amber LEDs/audible feedback, follow the instructions on the screen. Once the issue is resolved, tap the “Resume Use” button and the system should continue to work normally

Non-recoverable fault: A non-recoverable system fault is associated with red arm/system LEDs and requires a system restart. This can be resolved by following the below troubleshooting steps:

1. Read messages on Surgeon Console touchpad and Vision Cart touchscreen
2. Where possible, leave the instruments and endoscopes installed and inserted in the patient
3. Press the Power button on any system component to power off the system
4. Once powered off, wait for all system power buttons to be lit amber, indicating standby mode
5. Press the Power button on any system component to restart the system

(During system restart, video is temporarily unavailable at the Surgeon Console view and touchscreen monitor)

Clashing: (External, Internal)

Prevent clashing by appropriately distanced port placement.



External interferences between the patient cart arms can be resolved by adjusting flex joints to manage spacing between the front ends of the arms. Patient clearance joints can be adjusted to manage spacing between the back ends of the arms.

Team Communication

Two-way verbal communication between theater staff and the surgeon is extremely important and a “read-back” technique is a valid technique in this setting.

Example:

Surgeon: “Please remove the Monopolar Curved Scissors from arm 1 and replace with a Large Needle Driver”

Patient-side assistant: “Monopolar Curved Scissors coming out of arm 1. Large Needle Driver coming in.”

Surgeon: “Thank you.”

Prevention of pressure injuries (compartment syndrome, nerve damage etc)

Ensure that any ports are placed 2 to 5 cm away from boney parts and the flex joints of the robot are not pressing on the patient. Once the robot is docked, it is a good practice to move hand below and around all flex joints and cannula to ensure pressure injuries do not happen.