

OR Configuration, Port Placement and Docking

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Before any procedure, the robot has to be prepared for surgery. It includes the connection of all necessary parts, such as sterile drapes and connectors needed for surgery and the calibration process. These steps are conducted by a core team of scrub nurses specifically trained in handling the robot while the patient is in preparation for surgery. Currently, the only available system for laparoscopic surgery is the da vinci surgical system, developed by Intuitive Surgical (Sunnyvale, CA, USA).

Any robotic procedure is performed by a team of surgeons and nurses. It includes the console surgeon, patient side assistant surgeon and the scrub nurse. Although console surgeon is the leader of the team, a trained assistant surgeon is of paramount importance as he / she is the person responsible for robot docking, instrument change, manipulation of laparoscopic instruments, application of hemostatic instruments / clips, lavage and aspiration, specimen extraction, drainage and closure of abdominal wall. A trained scrub nurse is also important in draping the robotic arms, attaching the optics, instrument changes and undocking of the robot.

OR CONFIGURATION

This topic includes the optimum positioning of the following components in the operating room so as to allow for maximum functionality:

- Surgeon Console Positioning
- Patient Cart Positioning
- Vision Cart Positioning

Surgeon Console Position

The Surgeon Console is placed outside of the sterile field. It should be oriented in such a position so that the surgeon has a clear view of the operative field, vision cart and able to communicate directly with the assistant surgeon and the scrub nurse.



Fig. 1: Surgeon console handle

For moving or positioning the surgeon console, only the handle (Figure 1) on the back of the console is used. It should never be pushed or pulled by the console body or armrest to maneuver the console into place. Wheel locks located on the rear wheels of the surgeon console should be locked after positioning of console for the surgery.

Patient Cart Positioning

The Patient Cart is placed in the sterile field.

It should be draped in a separate area in the room prior to moving it into place for surgery. This should be an area of the room where it will not easily come into contact with non-sterile objects or impede traffic. Once the patient cart is draped, and the patient is positioned, prepared, draped and ports are placed. Then use the patient cart motor drive to help move the cart into the sterile field.

The Patient Cart brakes are designed to automatically engage when the motor drive is not in use.

Motor Drive Operation

The motor drive interface consists of the following components (Fig. 2):

- Throttle
- Throttle enable switch
- Shift switches

To operate the motor drive:

1. Ensure that the Patient Cart is powered on.
2. Ensure the shift switches are in the drive position (Fig. 3 A & B).



Fig. 2: Location of Throttle, Throttle Enable Switch, and Shift Switches

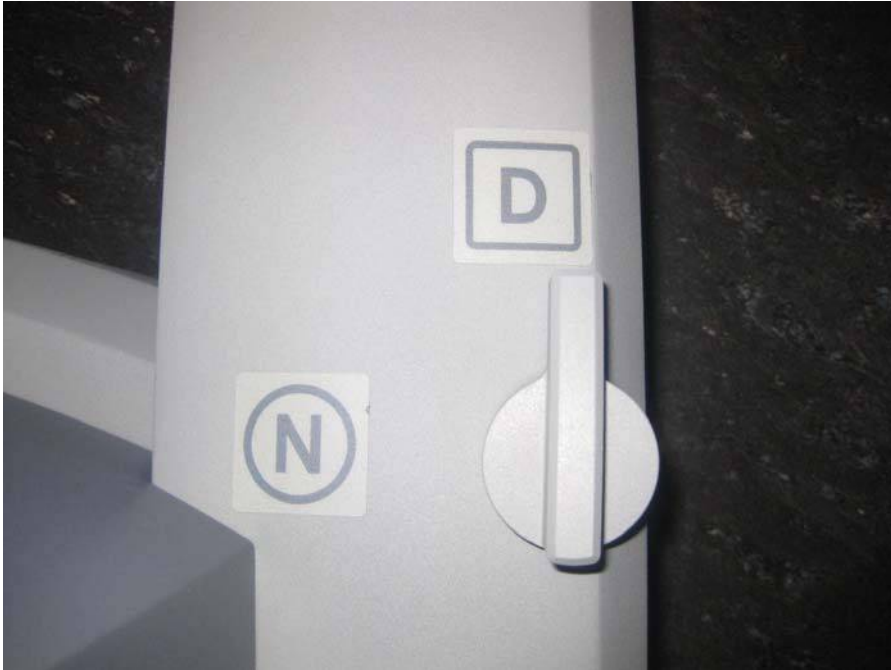


Fig. 3A: Drive motor engaged

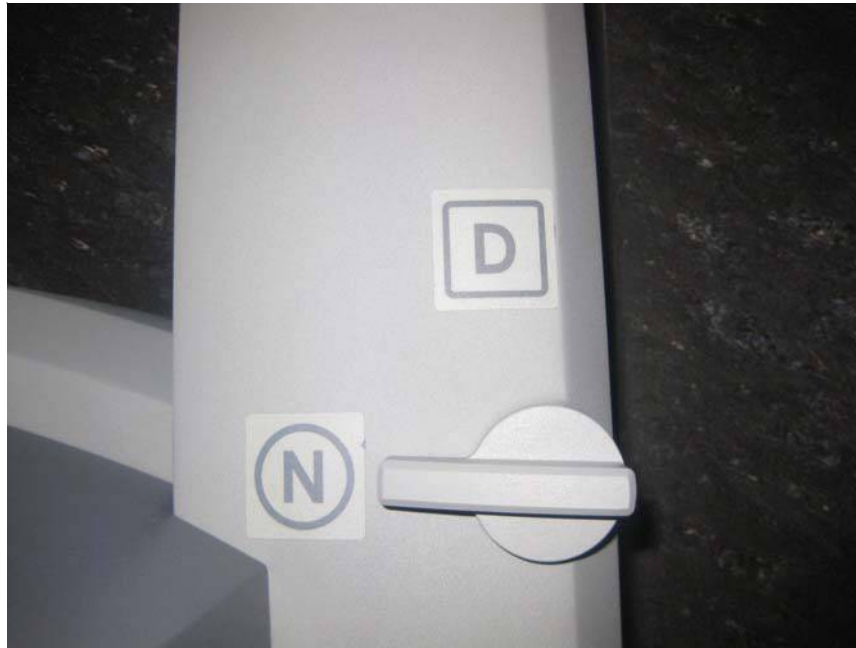


Fig. 3B: Drive motor disengaged

3. Throttle enable switch to be held and throttle rotated away from the operator or towards him / her depending on the intended direction of movement.
 - The Cart Power LED will flash green whenever the throttle enable switch is activated.
 - The drive speed of the cart can be controlled rotating the throttle to different extent in each direction.

The motor drive will not engage whenever cannulae or instruments are installed on the System. A yellow LED on motor drive interface labelled “Cannula installed: Cart Drive Disabled” will indicate when cannulae or instruments are installed and motor drive is non-operational. This has been done for safety purpose.

Shift Switches

The patient cart can be moved without the use of the motor drive (for example, during a power loss) by rotating the shift switches (Figure 3B) to the neutral (N) position. The cart can then be moved manually. When the cart has been moved, shift switches should be placed in the drive (D) position to set the Patient Cart brakes.

For patient safety, the shift switches must be kept in the drive (D) position so that the motor drive remains engaged during surgery (See Figure 3A).

Vision Cart Positioning

The Vision Cart is placed adjacent to the Patient Cart, just outside of the sterile field, to allow the Patient Cart Operator to see the component displays (Fig. 4).



Fig. 4: Position of vision cart

- The Vision Cart should be close enough to the Patient Cart to allow unrestricted camera cable movement during surgery.
- Wheel locks are located on the rear wheels of the Vision Cart. These should be locked after the cart is positioned for surgery.

STEPS OF DOCKING

1. Position patient and OR table, including table tilt.
2. Position patient cart over patient.
3. Set patient cart brakes.
4. Docking the camera arm.
5. Docking the instrument arms.
6. Check system setup.

The patient table should be positioned according to surgeon preference (depending on the contemplated procedure) before docking the robotic arms. Once the arms are docked to the ports and instruments placed, patient position should not be changed. The pneumoperitoneum is created and the ports inserted by either the lead surgeon or the patient side assistant surgeon.

PORT PLACEMENT

The port positions vary from patient to patient, procedure to procedure and surgeon to surgeon. It is very difficult to form guidelines specific position of ports but broad guidelines are framed to maximise endoscopic view, instrument reach and to minimise external arm clashing.

6 ■ Robotic Surgery

Camera port is inserted keeping following principles in mind (Fig. 5):

- Should be in line with the target anatomy (TA).
- Should be at 10-20 cm distance from the TA.
- Should be in line with the center column of the patient cart.

A diagnostic laparoscopy is done after insertion of the camera port to look for safe entry, any adhesions and surgical feasibility.

A disposable 12 mm trocar cannula assembly is used as the camera port (Fig. 6 A & B). There are specialised camera arm cannula mounts (on the patient cart camera arm) corresponding to each validated third party cannula.

Working Ports

8 mm da vinci ports are inserted for robotic arms are inserted keeping in mind the following principles:

- >8 cm distance between the da vinci ports (Fig. 7A).
- 10-20 cm distance should be maintained between the dv ports and target anatomy (Fig. 7B)

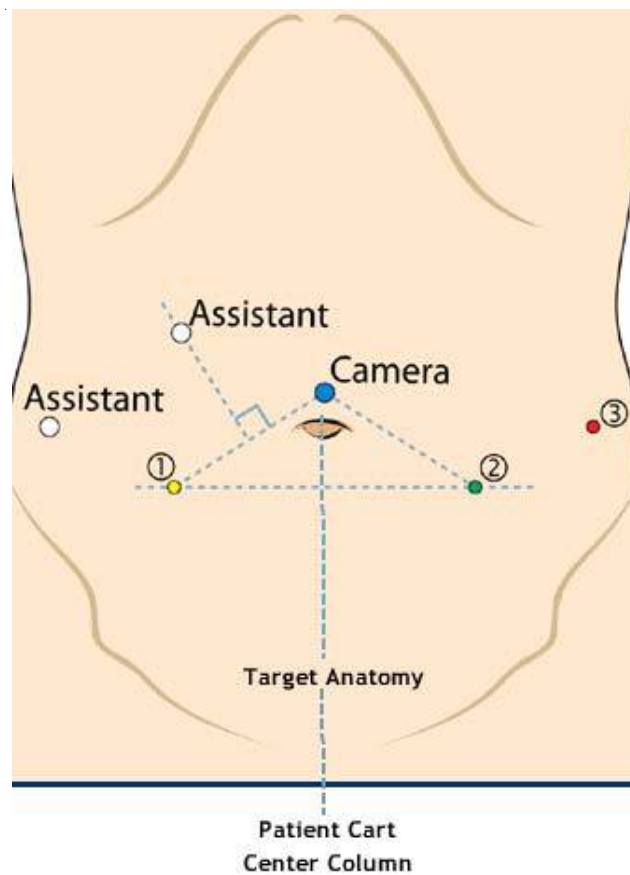


Fig. 5: Camera port positioning



Fig. 6A: Disposable 12mm trocar cannula assembly for camera port

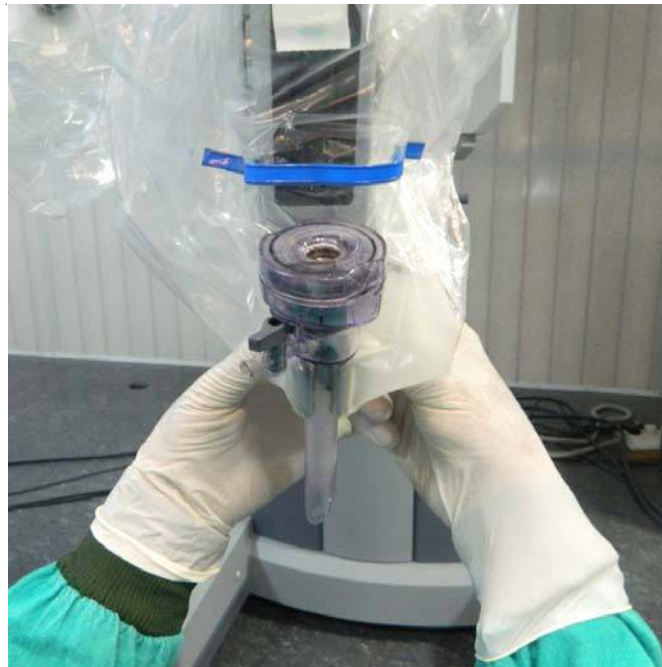


Fig. 6B: Camera port being mounted on the camera arm



Fig. 7A: Port placement

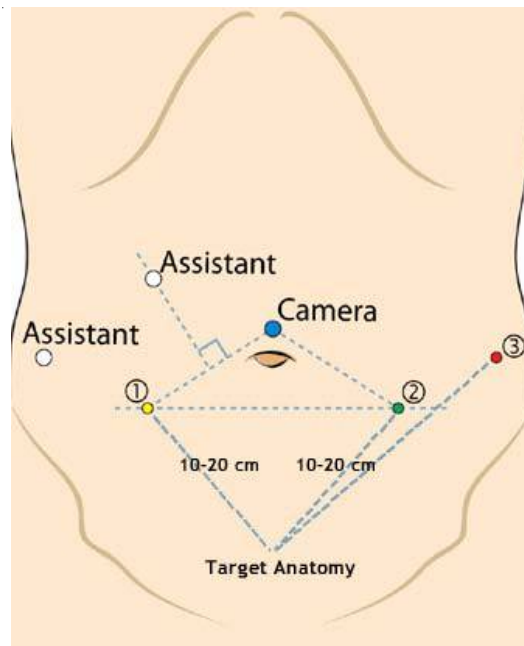


Fig. 7B: Port placement

10 cm distance from TA is good but 20 cm distance is better. Ports placed closed to the target anatomy impedes the view of the surgical site and makes the operation technically challenging. Conversely, ports placed >20 cm from TA makes it difficult to see or reach with robotic instruments.

Assistant port if needed is inserted 5-10 cm away from the da vinci ports in the desirable position. 5 mm or 10 mm ports can be used according to the intended function of the port.

Da Vinci provides 8 mm reusable cannulas with disposable seals for the robotic arms. They come with bladeless obturator for insertion.

These come in two lengths (Fig. 8):

- a. Short (11 cm cannula)
- b. Long (16 cm cannula) for high BMI patients.

Remote Center Technology

Remote center is the fixed point in the space around which surgical arm and cannula move. It helps in manoeuvring instruments/endoscopes in surgical site while exerting minimal force on the abdominal or thoracic wall (Fig. 9).

It is marked on the da vinci cannulae at a point to minimise stress to the patient. Remote center can be adjusted on patient side at the patient cart using the clutch button.

Positioning the Patient Cart

Once the patient is positioned and the ports are inserted, it is time to attach patient cart instrument arms to the patient in a process called docking. Before moving patient cart into position over the patient, it is important to align the OR table and the patient. Then push the patient cart over the patient using the motor drive on the cart.



Fig. 8: Da Vinci cannula

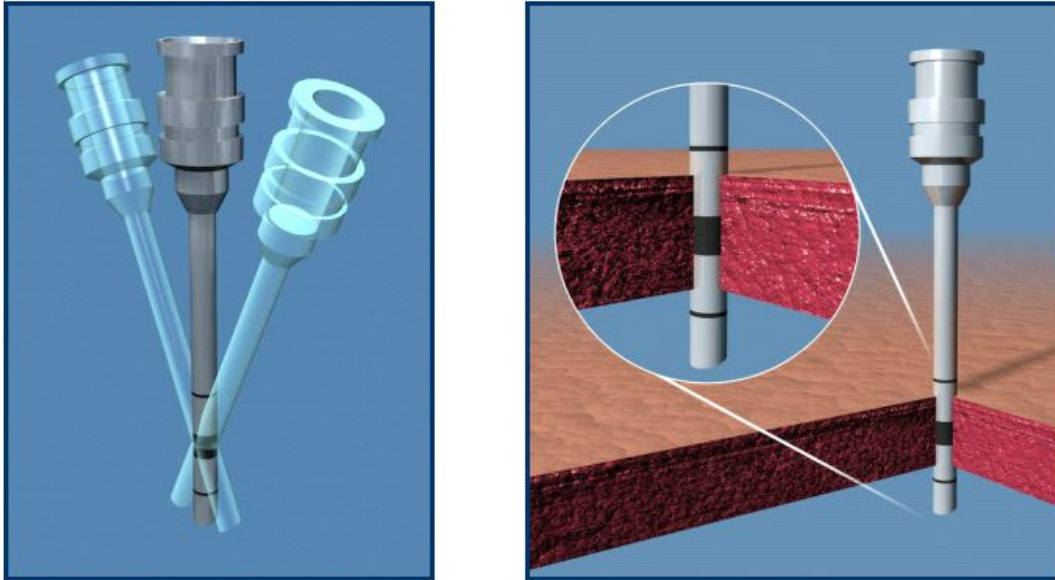


Fig. 9: Remote center technology

Motor drive can be used in integrated mode when patient cart is connected to the rest of the system or in standalone mode as well. The *shift switches* on the base of the patient cart need to be set in drive (D) position (Fig. 10). Then the cart can be moved by pressing the *throttle enable switch* and throttling either

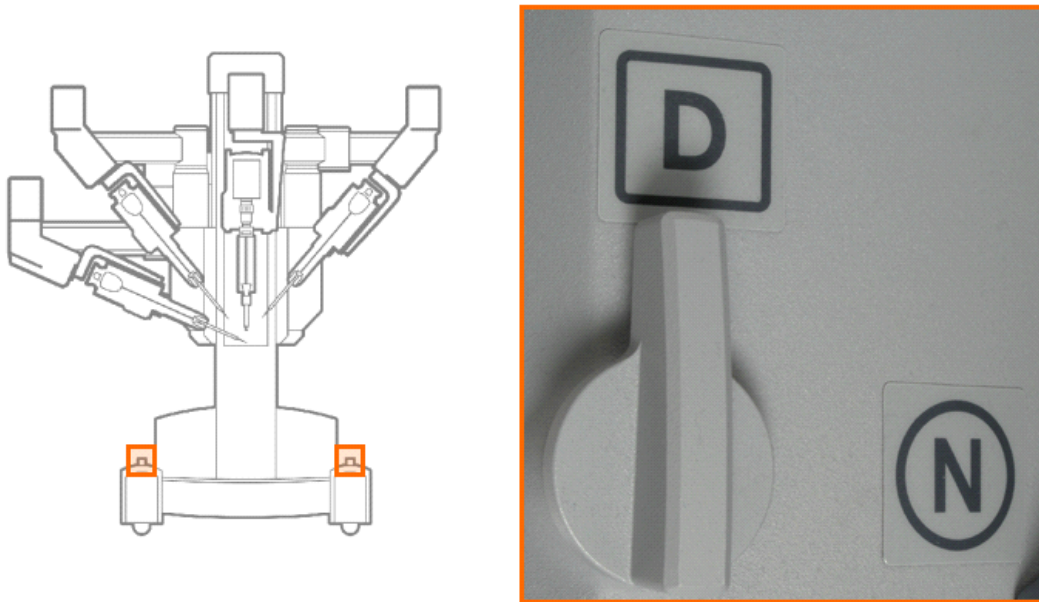


Fig. 10: Shift switch

forwards or backwards (Fig.11). It can be moved manually if the shift switch is set in neutral (N) position.

Two people should be used to move the cart, one pushes or pulls the cart and the second person verbally directs regarding the direction of movement. When the cart is in position, shift switch should be set to drive position (D) for locking the cart. Installing the camera or instrument arm locks the patient cart automatically for patient safety.

Care should be taken to align the camera port, target anatomy and the center column (Fig. 12).



Fig. 11: Throttle with throttle enable switch

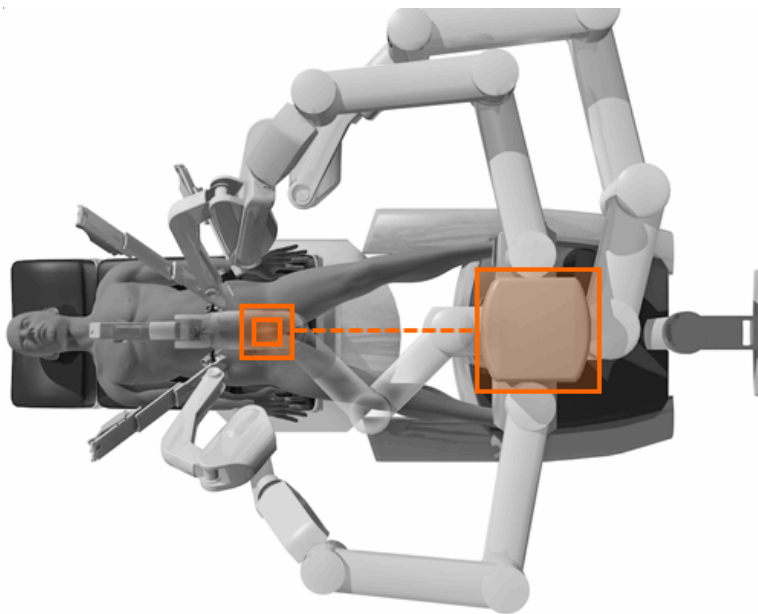


Fig. 12: Alignment of camera arm, target anatomy and center column of patient cart

Docking the Camera Arm

Camera arm should be docked first after positioning the patient cart. Align the camera port, target anatomy and the center column of the patient cart. Use clutch button to change the angle of camera arm to match the angle of cannula so that it points to target anatomy (Fig. 13).

Stabilise the cannula at the port site with one hand pointing it towards the target anatomy. Bring cannula into the cannula mount on the camera arm and clip both wings shut to hold the cannula in place (Fig. 14).

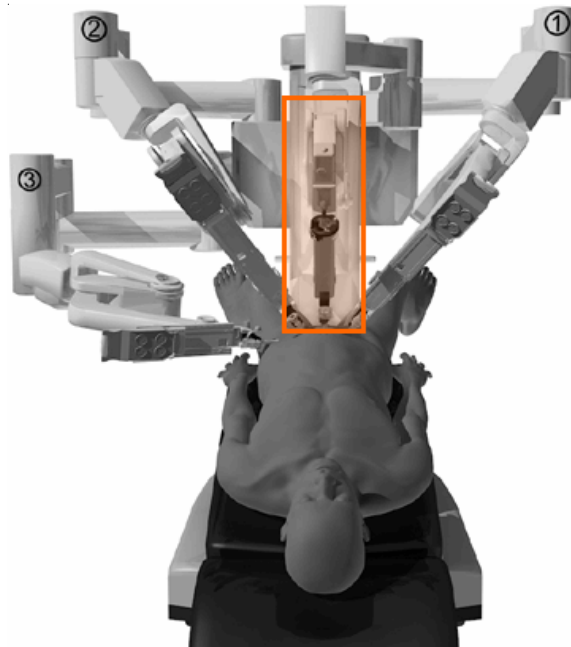


Fig. 13: Docking the camera arm

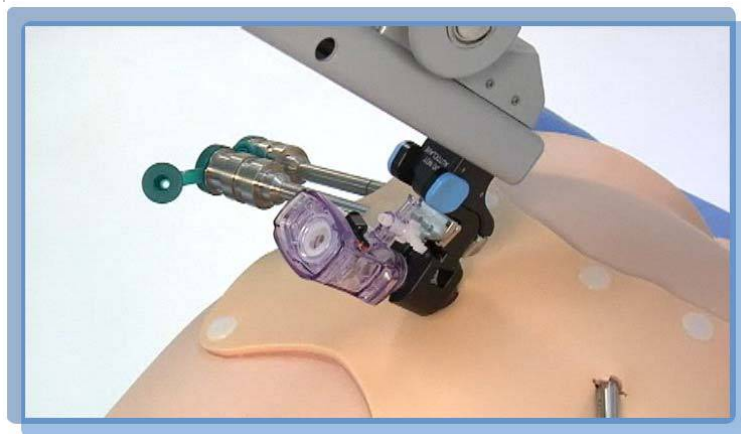


Fig. 14: Mounting cannula to camera arm

Camera arm setup joint #2 is placed opposite the instrument arm 3 (Fig. 15). Setup joints are numbered starting from the joint closest to the center column. Setting the system in this position allows maximum range of motion for all instrument arms.

There is a thick blue line and a blue arrow on setup joint #2 on the camera arm indicating the *sweet spot* (Fig. 16). Sweet spot should be aligned by lining up the blue arrow within the boundaries of blue



Fig. 15: Camera arm setup joint #2 facing opposite instrument arm 3

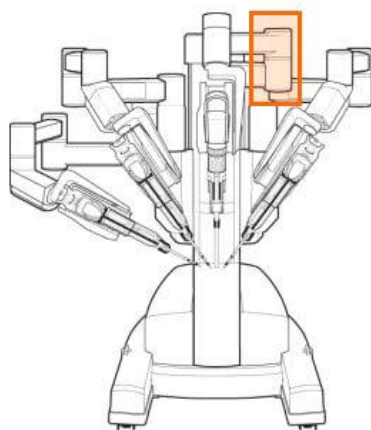


Fig. 16: Sweet spot and its alignment

line. Setting sweet spot gives patient cart arms maximum range of motion ensuring instrument and endoscope reach of all parts of target anatomy.

Remember that overextending or not extending the camera arm enough will limit the instrument range of motion.

Align the camera arm clutch button, 3rd setup joint and the center column (Fig. 17). Strive to maintain the sweet spot and alignment of the camera arm throughout the docking process.

Docking of Instrument Arms

After docking the camera arm, instrument arms are positioned in place so as to allow maximum range of motion of the arms. It is done in following steps:

- Position the instrument arm with the arm number and sterile adaptor facing forwards (Fig. 18)
- Allow approximately 45 degree angle between each arm (Fig. 19). Note that the position of instrument arm 3 can vary according to patient body habitus and the procedure. After positioning, ensure that the arms will not collide with the patient or interfere with each other.
- Dock the instrument arms by bringing them to the cannula using the port clutch button. Bring the instrument arm to the cannula and lock the wings of the quick click cannula mount on the arm to clip the arm to the cannula (Fig. 20).

Confirm that the remote center of the port is present at the desired place in the abdominal wall. Remember to stabilise the cannula with one hand at the port site while docking the instrument arm.

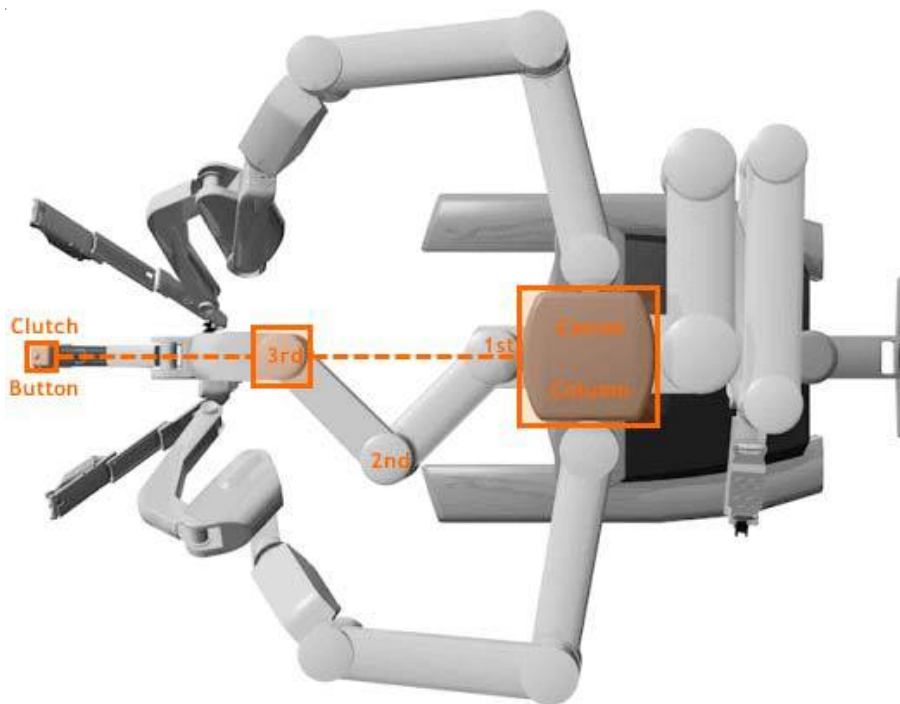


Fig. 17: Alignment of camera arm clutch button, 3rd setup joint and the center column



Fig. 18: Positioning of instrument arm

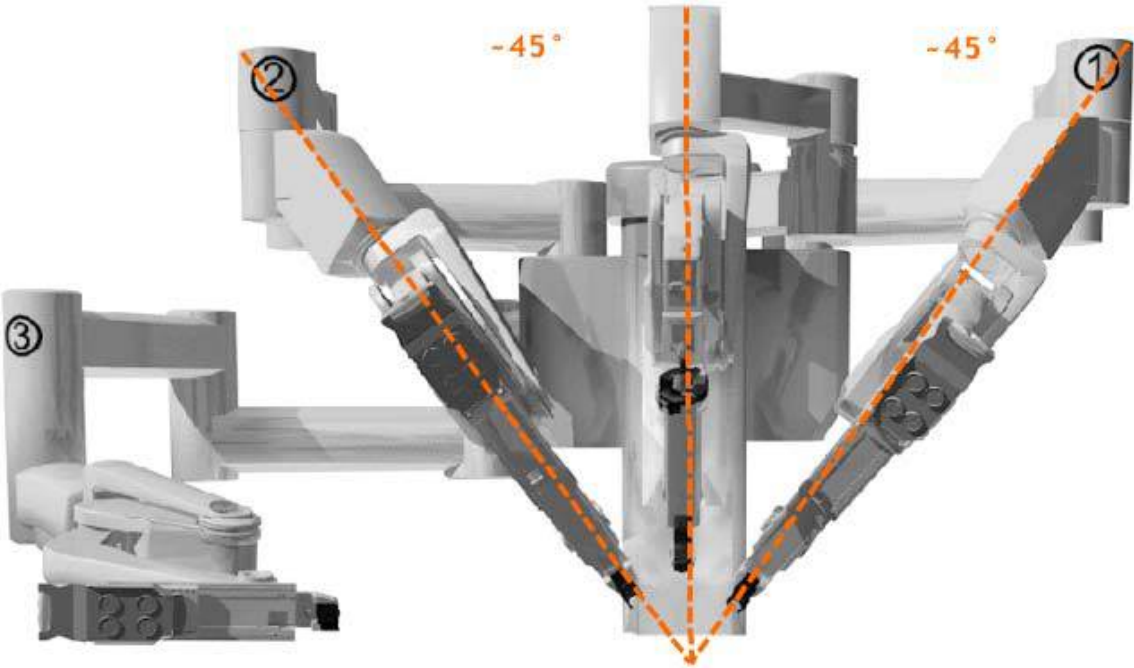


Fig. 19: Alignment of instrument arms with respect to camera arm and each other



Fig. 20: Example of mounting instrument arm on to the cannula

Check System Setup

After docking the instrument arms, check the arm setup. Start by confirming that the sweet spot of the camera arm is in right position (i.e. arrow is pointing towards the thick blue line). If needed, move the arm back into position taking care to stabilise the cannula at the port site.

Next, check the alignment of the camera port, target anatomy and the center column of the patient cart.

Now check the instrument arm setup. Separate the instrument arms to maximise the range of motion (Fig. 21).

Check the setup joint angles to minimise potential collisions. The angle at the setup joint 2 should be approximately 90° (Fig. 22). Figure 23 depicts the correct method of docking the patient cart.

Endoscope Insertion and Removal

First, insert the endoscope into the cannula keeping the intuitive logo on the camera head facing the camera arm. Place the body of the endoscope into the camera arm sterile adaptor making sure that the body of endoscope is fully connected (Fig. 24). Give it a gentle turn to ensure it is locked in place.

Next, secure the camera cable using the camera cable clip and drape the cable across the instrument arm (Fig. 25).

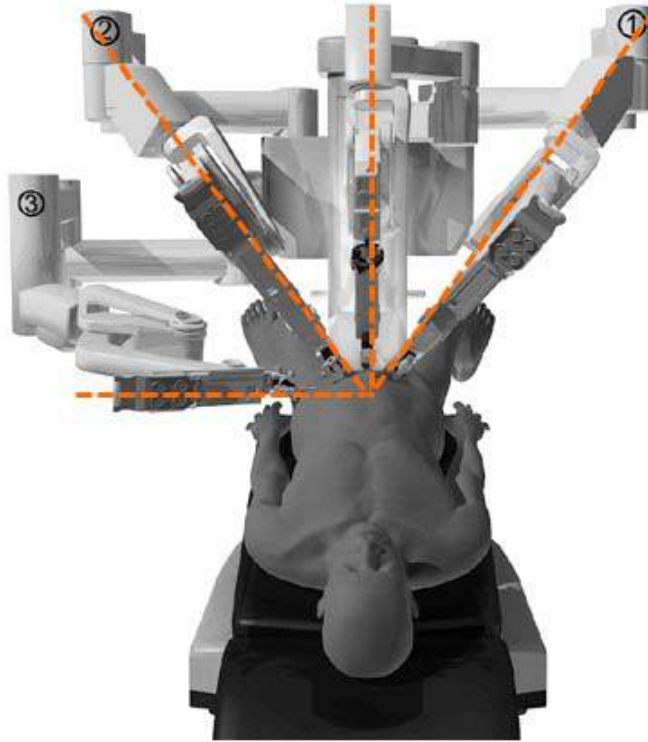


Fig. 21: Relative positions of the instrument arms

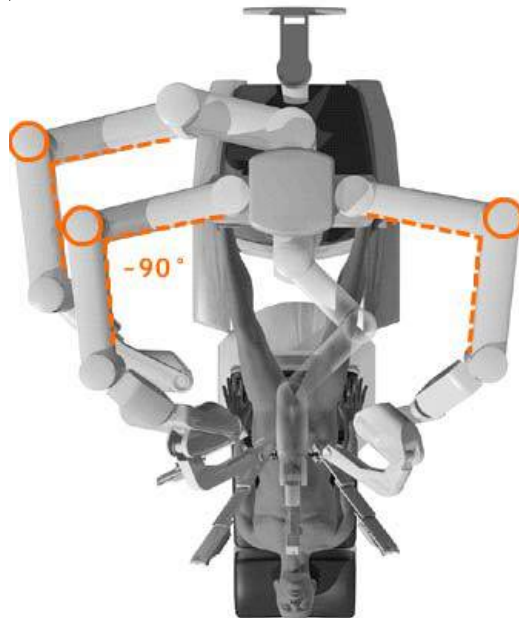


Fig. 22: Figure showing right angle at setup joint 2



Fig. 23: Depiction of the correct method of docking of patient cart



Fig. 24: Endoscope insertion into camera arm sterile adaptor of the camera arm

Push the endoscope into the cannula by pressing the camera arm clutch button till it is past the cannula tip towards the target anatomy. Press the clutch button again to lock the camera assembly into place.



Fig. 25: Camera cable clip highlighted

To remove the endoscope, remove the camera cables from the clip on the camera arm. Then unlock the endoscope by opening the two latches on the camera arm sterile adaptor. Then remove the endoscope.

Instrument Insertion

Begin by straightening the instrument tip. Insert the instrument into the cannula (Fig. 26). Slide the instrument housing into the sterile adaptor (Fig. 27) sandwiching the instrument housing and the instrument arm between both hands. Press the arm clutch button and push the instrument into the surgical field, keeping the tip under endoscopic vision.

If there is any resistance while inserting the instrument, one should stop and check for the reason. When the LED lights turn blue (Fig. 28), the surgeon can take control of the instrument and start operating.

Instrument Removal and Guided Tool Change (GTC)

For removing the instruments, surgeon should straighten the instrument tip and open the jaws of the instrument to ensure it does not hold any tissue (Fig. 29). Then press the release levers on the instrument housing and simply pull off the instrument (Fig. 30).

Removal of the instrument should be done with utmost care and with complete knowledge of the operating surgeon so as to prevent any inadvertent injury to the tissues.

Guided Tool Change

This feature helps in aligning a new instrument in the same position as the previous one removed. It adapts the replaced instrument tip just short of the position of previously placed instrument tip.



Fig. 26: Inserting the instrument into the cannula



Fig. 27: Sliding the instrument into sterile adaptor on the instrument arm



Fig. 28: LED turning blue indicating proper insertion



Fig. 29: Straightening the instrument tip and opening of jaws of the instrument before removal



Fig. 30: Pressing the levers to remove the instrument



Fig. 31: LED blinking alternately white and green indicating activation of Guided Tool Change

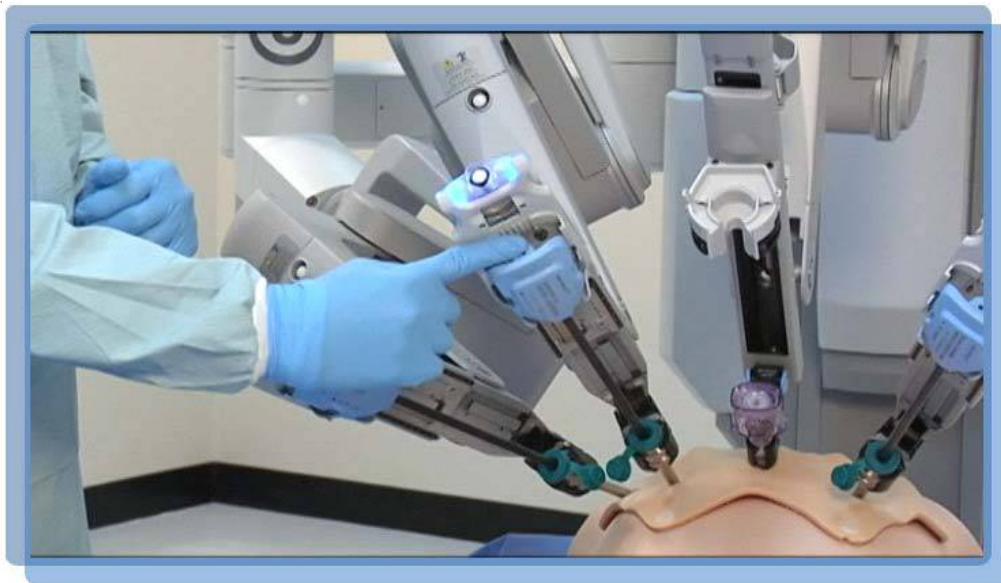


Fig. 32: Pushing the instrument with one finger

When this feature is activated, the LEDs on the instrument arm alternately blink white and green (Fig. 31). Just push the instrument with one finger (Fig. 32) and GTC will guide it into correct position. Stop as soon as you encounter any resistance.

This function is disabled when there is a change in the position of instrument arm during changing the instrument. This is because the position memory of the instrument arm is reset when the position is changed.