How to Manage the Operating Theater and the Surgical System for Robotic Surgery?

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The current cost of the da Vinci® Si™ robotic surgery system in Thailand is around 130 million baht and annual maintenance is 5 million baht. The high cost of purchasing and maintaining of the robotic system results in a limited number of centers and reduces surgical training opportunities. Siriraj Hospital administrators have committed to the continual financial support to developing a robotic surgical program to show that robotics will benefit the hospital, the advantages of 3D and HD vision in conjunction with the more precision of robotic motion without tremor as well as the over-rotated-movement of the endowrist beyond human hand make the over-expected surgery pos-sible and leading to faster surgical learning curves for surgeons.[1,2] Another essential task is the important education of the operating room nurses, because there is a significant difference between this modality and traditional surgery.[3] Therefore, the operating room nurse must be developing their knowledge about robotic-assisted surgery and become experts on patient preparation, system startup, draping, docking, instruments, troubleshooting and exchanging instruments. Each specific area of surgery has different patient positioning which needs the surgical team must understand within the context of the robotic platform. Most important is good communication between each of multidisciplinary team for successful outcomes.[4,5,6]

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Operating room setup

The operating room should be suitable size to accommodate all of the robotic components, with tension-free cable connections between carts and consoles (Fig 1). In addition, the room should be able to facilitate docking of the robot from several different positions depending on the type of surgery being performed. Challenges faced by nurses are the robot's size and operating personnel have to move to accommodate to this large mass[2].

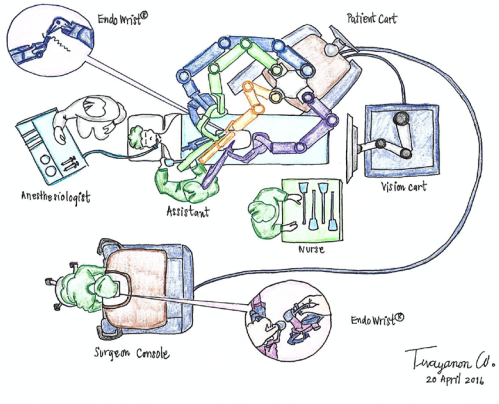

Fig 1. OR Configuration

Patient positioning

The goals of positioning are to maintain circulation; protect nerves, muscles and bony prominences from pressure injury; provide adequate exposure of the surgical site; maintain airway

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functioning; and provide the anesthetist adequate access to IV line and patient monitoring. Not only should the patient be protected from injuries, but the optimal position must also allow for safe docking of the robot as well as for access of the bedside surgeon to the surgical assistant ports[7]. In robotic surgery, extreme positioning is often used to optimize exposure. This type of positioning requires a collaborative effort from the entire surgical team to provide for patient safety[8]. For anterior transabdominal surgery, a patient is positioned in a modified lithotomy position using stirrups (Fig 2) and sequential pneumatic compression devices for DVT prevention. It is also crucial that nurses recognize the contraindications to mechanical prophylaxis e.g. dermatitis, arteriosclerosis[9]. Both arms are positioned alongside of the patient body and securely strapped. Operative table accessories are applied to secure the patient to the table. Air warming blanket is placed above the xiphoid for hypothermia prevention. The skin is prepped from the xiphoid to perineum to mid-axillary lines and draped.

For the surgery of retroperitoneal cavity such as adrenalectomy, a patient is positioned in lateral or flank with the surgical side up. The surgical side leg is bent slightly and secured by straps to the rails of the table. The lower leg is in flex position and pillows are placed between both legs. An axillary roll is placed to facilitated lung expanding and the arm is padded and secured. The upper arm is padded and secured to an arm board.[10] When flexing the table, the anesthesiologist should support the patient's head, and place several pillows or towels to avoid hyperextension of the cervical spine[11]. Safety straps or tape can be used over the hip. Air warming blanket is placed above the upper body and lower extremities for hypothermia prevention.

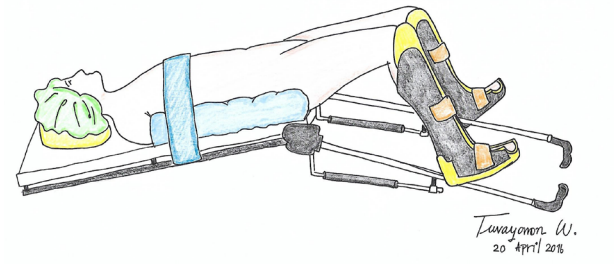

Fig 2. Modified lithotomy position using stirrups

It is important to make sure patient's face and endotracheal tube are free from adverse event during robotic arms movement. The robot size over the patient and the draping on both the robot and patient, make it difficult to access the patient intra-operatively. If it is necessary to reposition a patient, the RN circulator should verify that the robot is undocked from the patient before assisting the team with repositioning[8]. Cameras should be carefully monitored and light cable are never left directly on drapes or patient skin to avoid thermal burn injury for the patient.

Draping of Surgical System

First, the robotic components are fully connected and plugged into AC power and system power buttons are pushed for robotic startup. Draping is the next step to make the patient cart arms are sterile for surgery. The patient cart arm should be prepared for draping by moving each arm's insertion axis to vertical position (90°) (Fig 3). Draping of surgical system should be performed by 2 nurses, a scrub nurse and a circulating nurse. Draping should be systematic by moving from left to right or right to left. Scrub nurse should move the draped arm away from the undraped arm and prepare to drape the next arm. Make sure the drape is not too thigh because it may decrease the range of motion of the robotic arm. Draping procedure is by the following.

Instrument Arm

1) Scrub nurse opens the drape and grips the outside with finger and thumb. The other hand holds the lower drape over the instrument arm insertion axis. (Fig 3a)

Fig 3. The patient cart arm preparing for draping

2) Insert the base of sterile adapter and fit in-to the black molded piece by pushing both thumbs on the sterile adapter until it clicks into place. (Fig 3b)

3) Stretching the drape, move it back along the instrument arm. (Fig 3c)

4) Wrap white tape straps snugly around the instrument arm and confirm movement without tearing the drape. (Fig 3d)

Camera Arm

5) Camera arm draping: the camera arm has a carriage, so draping is different from the instrument arm. A scrub nurse uses one hand as shown above, and makes the drape through the carriage to create space for an endoscope pass through. Then firmly push in to place the camera arm sterile adapter. (Fig 3e)

6) Stretching the drape, move it back along the camera arm.

7) Seat the cannula mounts molding (Fig 3f) and secure tape around the camera arm.

8) Bend the blue flex-strips to create a clear path for endoscope insertion axis, and make sure the camera arm drape does not stretch or tear during endoscopic insertion. (Fig 3g)

Camera Head

9) Camera head draping: scrub nurse inserts a hand in to the open end of the drape and firmly holds the camera head sterile adapter. The circulating nurse attaches the camera head to the sterile adapter. Make sure to align the pin in the sterile adapter and fix the camera head pushing down and turn to lock it in place (Fig 3h).

10) A scrub nurse inverts a drape over the camera head and optical cable. The circulating nurse pulls the drape alone the cable. The cable on the sterile table should be in S shape (Fig 3i).

Monitor

11) Open the bottom draping and remove the paper insert. Hold the top of the drape with the other hand and drape over the monitor with the logo facing up (Fig 3j).

12) Move the drape back along the monitor arm. Secure tape around the arm and tighten the drawstring around the monitor arm (Fig 3k).

13) Press the drape to attach smoothly to the monitor surface (Fig 3l) and secure the Velcro straps on the sides and back of the monitor (Fig 3m).

Vision system setup

1) The illuminator

The light source is connected to endoscope by a single cable. During operation, the lamp gets very hot. After turn off the lamp, allow the internal fans to cool the lamp for 5 minutes before removing power to the illuminator.

2) The endoscope

Endoscope has a left and right optical channel to capture the image. Heat from fiber optic channel helps to minimize fogging at the endoscopic tip. Set the degree of endoscope lens selection (0 and 30 degrees) is suitable for the

Fig 3a-3d. Instrument arm draping procedure

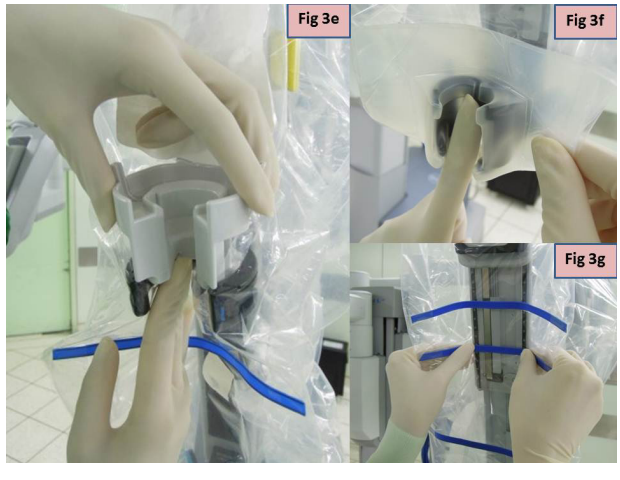

Fig 3e-3g. Camera arm draping procedure

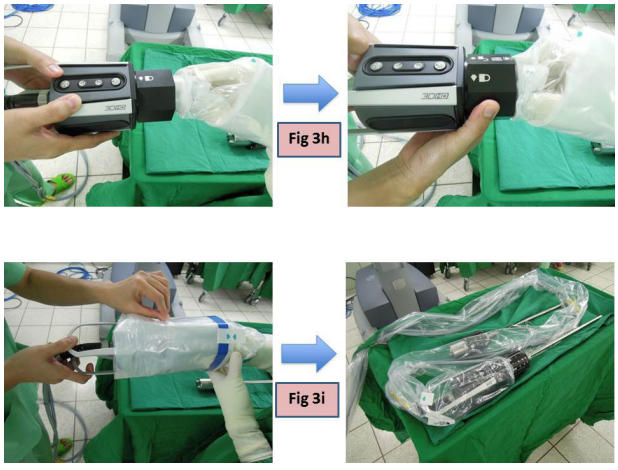

Fig 3h-3i. Camera head draping procedure

operation (Fig 4a). The temperature of the endoscopic tip may exceed 41° during use. Avoid contact with the skin, tissue and clothing when laminators are turn on and do not attempt to clean the endoscopic tip by dipping it in tissue because tissue will be damaged by the heat.

3) The camera head

The 3D camera head contains two HD cameras (right and left channel). Each camera consists of three chips camera control unit (CCU) to integrate for the surgeon to produce the 3D image, increase resolution and set aspect ratio. Before installing endoscope on the camera head, inspect the glass surface in the light port located at the camera which should be clean to ensure a bright and clear image (Fig 4b).

4) The calibration process

The calibration of robotic surgical system begins with orientation of the endoscope with the camera head. For the angle of the endoscope, must calibrate the scope in both orientation (30 degrees up & down scope) to make sure it is ready for use. The calibration process is sensitive and must successful in each orientation in which you will use it.

5) The white balance

The camera needs white balancing at the start of each procedure and anytime the vision system is changed. Make sure the lamp intensity is set to 100% before processing. Point the endoscope at the white object and ensure it covers the entire view. Do not use gauze because it does not have enough appropriate background for white balancing process (Fig 4c).

6) 3D calibration

Insert the endoscopic tip inside the endoscope alignment target (Fig 4d), and use the proper hole and orientation which is appropriate with tip angle. When the target crosshairs are visible on the touchscreen use auto/ manual 3D calibration system. If you choose manual system, you must focus the image target crosshairs by touch the arrow on the touchscreen to move the green crosshairs until aligned with the magenta crosshairs (Fig 4e).

7) Addressing image quality

(1) Correction of overly bright image: Set the video setting by tapping the touch screen, to decrease the brightness to desired level.

(2) Correction of dark image:

- May be endoscope is far away from the surgical field. If possible, move the endoscope closer to the tissue.
- Check the connection of the light cable to the illuminator to make sure it is secure.

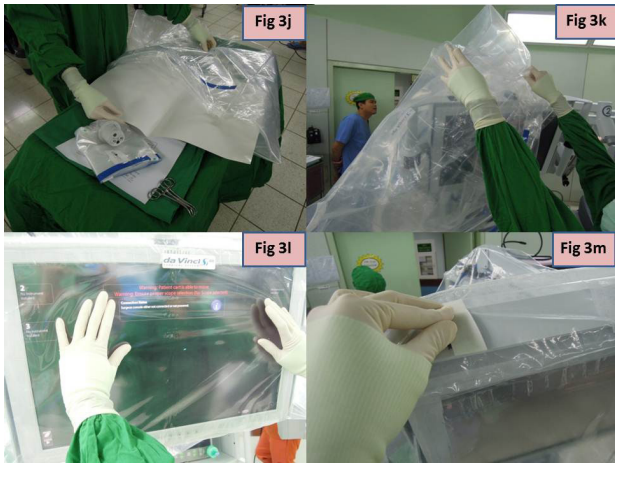

Fig 3j-3m. Monitor draping procedure

Fig 4a-4c. Endoscope calibration and white balancing procedure

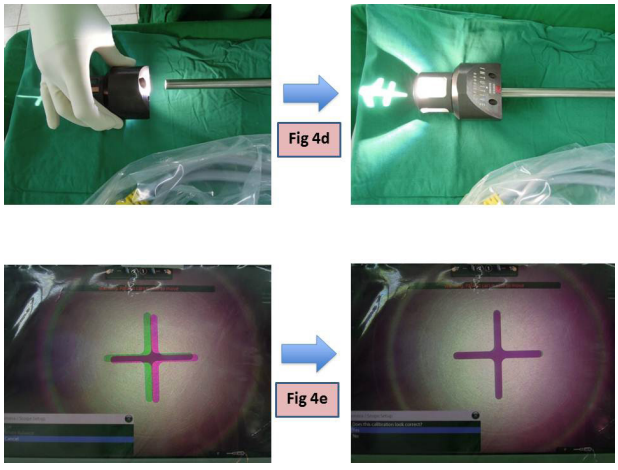

Fig 4d-4e. Endoscope alignment target for 3D calibration

- Clean the tip of endoscope. Diminished light may be because blood or protein have accumulated on the endoscopic tip.

Abdominal access and Docking

Key to a successful of robotic procedure is port placement. The targets of port placement are to maximize range of motion of instruments and avoid patient cart arm collision. Port placement varies by procedure, patient position and experience of surgeon. The principle of port placement should follow these steps.

1) Align the camera port patient cart tower and target anatomy in a straight line.

2) If possible, place the camera port and instrument port 10-20 cm away from the target anatomy.

3) Between ports, maintain at least 8-10 cm spacing (Fig 5a).

4) Accessory port should be at least 5 cm away from other ports.

After abdominal access is obtained, docking is the process of moving the patient cart in the sterile field. Communications are very important when docking the patient cart which is operated by two persons. One-person drives the patient cart while another one guides the driver to approach the patient and to avoid confusion during docking. The patient cart tower must line up in a straight line with the camera port and target anatomy (Fig 5b).

Fig 5a-5b. Port spacing and patient cart fower position

CONCLUSION

The technology of robotic assistance has overcome the limitations of conventional laparoscopy, such as better visualization and more ergonomic instrument control. Nursing personnel must become familiar with setting up and troubleshooting the robotic equipment. The complexity of robotic setup. Not only the surgeon needs, but also the nurse needs to learn the complexity of robotic setup, for preparing the robot for surgery. Starting with turning on the robot, calibrate the endoscope, and drape instrumentation and docking for sterility. With increased experience improved efficiency of nurses will occur. No matter, the advanced technologies cannot replace the humans. Moreover, humanized care is always made by the human heart and human being.

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