Lesson 254: PreAnesthetic Assessment of the Patient for Robotic Surgery

LEARNING OBJECTIVES
At the end of this activity, the participant should be able to:
1. Explain the difference between a robotic device and a computer-enhanced telemanipulator.
2. Summarize the advantages and disadvantages of laparoscopic surgery.
3. Summarize the advantages and disadvantages of robotically assisted surgery.
4. Name the 3 components of the da Vinci robotic system.
5. Describe challenges that are encountered by the anesthesiologist who uses a robotic device.
6. Recognize the scope of surgical cases performed with robotic assistance.
7. Outline the steps required to initiate a successful program for robotic surgery.
8. Identify the physiologic perturbations associated with the thoracic or abdominal insufflation of carbon dioxide.
9. Assess the issues surrounding access to the patient during robotically assisted surgery.
10. Construct an anesthetic plan for a patient about to undergo robotic surgery.

CASE HISTORY
Case 1: Prostatectomy
A 68-year-old man with localized prostate cancer was scheduled to undergo a robotically assisted laparoscopic prostatectomy and bilateral pelvic lymph node dissection. His medical history was unremarkable; he denied having had any prior surgeries. He had no known allergies and was not taking any medication. His weight was 77 kg, and his height was 190 cm.

Case 2: Lobectomy
A 74-year-old woman with a diagnosis of cancer in the upper lobe of her right lung was scheduled for a robotically assisted right upper lobectomy and a mediastinal lymph node dissection. Her medical history was significant for hypertension and heavy smoking. Her medications included captopril 25 mg per day and aspirin. Laboratory test findings were within normal limits, and electrocardiography showed normal sinus rhythm with a left bundle branch block. Computed tomography of the chest revealed a 3x3x3 cm mass of the right upper lobe. A pulmonary function test revealed mild obstructive disease with no major changes after bronchodilator therapy. The patient denied any history of chest pain or shortness of breath and described a physical activity level of 8 metabolic equivalents (METs). Physical examination revealed a 64 kg, 174 cm woman in no distress. Her chest examination was significant for the presence of occasional rhonchi. An examination of the airways assessed a Mallampati score of 2 with a thyromental distance of >6 cm.

PREANESTHETIC ASSESSMENT
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Technologic advances have undoubtedly changed the way medicine and surgery are practiced today. One of the most important recent developments in surgical practice has been the adoption of computer-assisted robots. Although robots have been around for the past 75 years, it is only recently that their use in surgery has dramatically increased.1 As the demand for minimally invasive procedures grows, the role of robotically assisted surgery increases, anesthesiologists will need to have a basic knowledge of robotic systems if they are to be able to this new tool improves adjustments in anesthetic management. Robotic surgery is one such technology that poses special considerations for the anesthesiologist. New developments in surgery have been identified by committee and by solicited inquiries from past course participants as an area that should be addressed to afford anesthesiologists a better understanding of how best to adapt their anesthetic management of patients.

TARGET AUDIENCE
Anesthesiologists

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History of Roboticly Assisted Surgery
Technically, a robotic device is a "powered, computer-controlled manipulator with artificial sensing that can be reprogrammed to move and position tools to carry out a wide range of tasks."2 The robotic systems used in surgery today are computer-assisted devices and not true robots because they lack independent motions or preprogrammed actions. A more accurate descriptor for these devices is computer-enhanced telemanipulator. The surgeon is "teleported to the operative site" and is able to manipulate surgical instruments as if he or she were in the surgical field. Thus, surgical robots perform tasks under the surgeon's control in what is referred to as a "master–slave" relationship. The robot does not replace the surgeon, but instead performs maneuvers and enhances the precision of the surgeon's hands.

Today's medical robotic systems can trace their origins to a desire by the US Department of Defense to decrease war casualties. The Department of Defense wanted a system that allowed combat surgeons rapid access to treat exsanguinating soldiers on the battlefield from a safe distance; thus, the concept of telerobotic surgery was born. The feasibility of these systems, initially designed for open surgeries, was demonstrated in an animal model; however, they were never applied to humans. In the early 1990s, researchers at the National Aeronautics and Space Administration Ames Research Center joined with others at the Stanford Research Institute (now called SRI International) to develop a telemanipulator for hand surgery. While government-backed agencies were working on telerobotic and telemanipulation, civilian surgical practice was advancing with the growth of minimally invasive laparoscopic techniques. The first laparoscopic cholecystectomy was performed in 1987. Since then, laparoscopy has gained widespread use and acceptance by see Lesson 254 page 54

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The convergence of the concept of telerobotic surgery and laparoscopic surgery eventually led to the development of 2 telemanipulative robotic systems that were approved by the Food and Drug Administration: the da Vinci surgical system (Intuitive Surgical, Sunnyvale, Calif) and the Zeus robotic surgical system (Computer Motion, Santa Barbara, Calif). In April 1997, the first robotically assisted surgery was performed by Jacques Himpenis, MD, and Guy Cardiere, MD, who used the da Vinci surgical system.

**Robotic Systems**

The 2 surgical robotic systems in commercial use today are still the Zeus and the da Vinci systems. Intuitive Surgical has acquired the Computer Motion company and will continue to support institutions that have a Zeus system. Thus, only the da Vinci system is commercially available now, and this lesson focuses mainly on that system.

The da Vinci surgical system comprises 3 distinct parts. The first part is a console where the surgeon sits to view and control the robot from a remote location. The surgeon’s hands attach to a place on the console where his or her hand motions are translated into the motions of surgical instruments. The surgeon’s fingers are connected via the console and robot to the surgical instruments. The console also has a 3-dimensional viewer. Sitting at the console, the surgeon can manipulate the robot and simultaneously look into the viewer to simulate the experience of being present in the operating field. The computer that runs the entire system is housed in the console.

The console also has other capabilities; these include specific adjustments of the video system and robotic arms and ergonomic adjustments. Motion scaling can be adjusted from a ratio of 1:1 up to 5:1. This means that 5 inches of hand motion can be translated into 1 inch of surgical instrument motion. The system can thus filter out hand tremors. Foot pedals on the console allow the surgeon to control electrocautery and ultrasonic instruments, adjust the focal point of the video camera, disengage the robotic instruments, and alternate between robotic arms as needed arises.

The second component consists of a tower that contains video equipment to record and display images of the surgical site onto 2-dimensional monitors for the convenience of the rest of the team in the operating room (OR). Other laparoscopic instruments, such as insufflators, are located on this tower.

Finally, the third component is the robot itself, which consists of 3 or 4 arms. The original da Vinci robot had 3 arms. The central arm held the video telescope while a right and a left arm performed maneuvers. Later, a 4-armed robot was added that is identical in functionality to the 3-armed robot. It can be positioned and locked into place, acting as a stationary retractor to assist the surgeon when needed.

Similarly, the Zeus system consists of a control console from which the surgeon remotely operates the robot’s 3 arms. The main differences between the 2 systems is that the Zeus uses a voice-activated camera, the robotic arms are attached to the OR table, and the robotic arms are capable of only 5 degrees of motion, versus the 7 degrees of motion in the da Vinci system.

**Initiation of a Robotic Surgery Program**

If a robotic surgery program is to be implemented and maintained successfully, the hospital administration must be committed to the ongoing financial support of the robotic system. The initial and recurring costs of running a robotic surgical program are significant. However, the potential growth in surgical volume and increased institutional recognition from the adoption of a robotic program may offset its costs. In addition to an increased surgical volume, new faculty may be attracted to join the institution. In today’s information age, patients are more educated about their options and often have a strong desire to seek out the most advanced therapies, making the existence of a robotic program a marketing tool.

Teamwork is essential to the success of a robotic program at any institution. It is necessary to ensure that the hospital administration and the surgical anesthesia and nursing departments are committed to the success of the program. The mere existence of a robotic system does not constitute a successful robotic program. Surgeons must be interested and technically capable of performing the operations. The challenges that must be overcome when a robotic program is initiated include increased operating times and the learning curve of the surgeons. Eventually, surgeons gain the experience to reduce operative times to comparable benchmarks for open and laparoscopic surgeries.

The nursing personnel must become familiar with setting up and troubleshooting the robotic equipment, the special instruments, and the surgical procedures. Accommodating the large robots in the OR is a challenge for the nurses and other personnel. Transporting the equipment in and out of the OR can be difficult, and its setup is complex. Nurses are trained to activate and calibrate the equipment. They also learn to drape the robot for sterility. The skills required for instrumentation and docking of the robot and troubleshooting the equipment are unique to this technology. With increased experience and surgical volume, the efficiency of the anesthesia, nursing, and ancillary OR staff will improve.

**Advantages of Robotically Assisted Surgery**

Recently, an enormous push toward an increased use of minimally invasive surgery has taken place. The purported advantages of laparoscopically assisted surgeries include reduced postoperative pain, improved cosmesis (smaller incisions), shorter hospital stays, faster postoperative recovery, potentially lower costs, and improved patient satisfaction. Robotic-assisted surgery is an evolutionary step in the advancement of minimally invasive surgical procedures. Such technologic innovations have overcome the disadvantages inherent in commonly performed laparoscopic techniques. One advantage of computer-assisted robotic surgery over standard laparoscopy is improved visibility of the operative field with 3-dimensional imaging systems. The 3-dimensional images that the surgeon views occur naturally because each eye is linked to a separate camera. The human brain then processes each image, giving the surgeon depth perception. A synchronizer within the system maintains each frame from each camera in phase. A built-in safety feature of the system is an infrared sensor that crosses the plane of the viewer. The console will not move any of the robotic surgical arms or instruments unless the surgeon is in a position to view the surgical field. If the surgeon’s head moves out of the plane of the infrared sensor, the console will not follow commands. Another advantage of the robotic system is computer-assisted scaling, which improves the control of fine movements and reduces the fulcrum effect, which amplifies unwanted motions such as a hand tremor.

In addition, robotic systems allow a more ergonomically and anatomically correct control of instruments that closely mimics the movement of the human wrist (ie, 7 degrees of motion/freedom of robotic instruments, one’s arm extended at shoulder height can be used to mimic the following motions: The arm can move up and down in a vertical plane (1); move from side to side in a horizontal plane (2); extend forward to reach an object and then retract (3); rotate around its central axis as in supination and pronation of the hand (4). When a “wrist” is added, the wrist can be extended and flexed (5) and moved.

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**Figure 1.** The patient, in a steep Trendelenburg position, is placed for a prostatectomy; the robot is positioned between the patient’s legs.
laterally to the umbilical and radial sides (6). Finally, the hand (instrument) can open and close as if grasping (7).

Pitfalls and Limitations of Robotic Assisted Surgery

Despite the advantages of robotic surgery, there are some limitations that must be considered. Several pieces of equipment—each extremely bulky—require large areas of space within the OR. In smaller or older ORs, such space constraints may be the limiting factor in the adoption of robotic techniques. Another drawback is the large size of the robot itself, so that positioning of the robot’s arms is extremely important to prevent them from colliding with one another and with assistants and the patient.

Anesthesiologists must be aware that the overwhelming size of the robot may impair their ability to quickly access the patient. The staff must be trained and prepared to quickly detach and remove the robot from the patient in the event of an emergency. Patients also must be correctly positioned for surgery from the start because repositioning a patient is almost impossible once the robot has been stationed for surgery. In addition, current robotic systems lack tactile feedback from the instruments. Surgeons must therefore rely solely on visual cues to modulate the amount of tension and pressure applied to tissues to avoid organ damage.

Cost may be another limitation in the use of robotic systems, especially for smaller community hospitals. There is a large initial cost of approximately $1 million to purchase the robotic equipment and a recurring annual service contract fee of about 10% of the purchase price. Because each instrument in the da Vinci system has a finite life of 10 surgical procedures, the reordering of consumable instruments adds significant cost to the use of this system. Other cost considerations include an initial increased setup time in the OR, increased surgical operating times as individuals overcome the learning curve, and increased time for training of OR staff.

Surgical Procedures Performed With Robotics

Although the da Vinci robotic systems were initially designed for cardiothoracic surgeries, an increasing number of other surgical procedures are being performed with robots. Most of the studies concerning robotically assisted surgeries address the safety and feasibility of these systems. Corcione et al studied the feasibility of robotically assisted surgery in 32 patients undergoing cholecystectomy, adenectomy, bilateral varicocelectomy, Heller’s myotomy; Nissen’s fundoplication, total splenectomy, colectomy, or bilateral inguinal hernia repair. The researchers were able to complete 29 of 32 procedures robotically, as initially planned. There were no mortalities, but the surgery was converted to an open procedure secondary to bleeding concerns in 2 patients and because of robotic malfunction in 1 instance. Corcione believes that more than 10 procedures are required to master use of the robot; however, this is a subjective observation and highly surgeon-specific. In addition, Corcione reported that his OR staff reduced setup times in robot positioning from 45 minutes in the first 15 procedures to about 20 minutes in the last 17 procedures. The safety and feasibility studies of Corcione et al have been duplicated by many others. Anvari et al reported no mortalities, no intraoperative complications, no conversions to open or laparoscopic procedures, and similar rates of blood loss when they compared robotically assisted laparoscopic colorectal surgery with conventional laparoscopic surgery. Unfortunately, for surgeons experienced in performing laparoscopic colon surgery, robotic assistance offers few advantages over conventional laparoscopic techniques because anastomoses in colon surgeries are stapled rather than hand-sewn. In addition, colon surgery often requires views of 4 quadrants in the abdominal cavity. Robotically assisted surgery limits access to multiple quadrants of the equipment size; therefore, to gain access to other quadrants, the time-consuming effort of manually readjusting the position of the robotic arms is necessary.

In addition to the types of surgery already mentioned, there are reported cases of robotically assisted general surgery, including gastrectomy, gastric bypass, and pancreaticoduodenectomy. Robotics has also been used in many cardiothoracic, gynecologic, neurologic, ophthalmologic, orthopedic, and urologic cases. Specific case reports include esophagectomy, thyroidecomy, lobectomy, pericardial window, coronary artery bypass graft, mitral valve surgery, atrial septal defect repair, fallopian tube anastomosis, retinal surgery, total hip and knee arthroplasty, radical prostatectomy and cystectomy with urinary diversion, pyeloplasty, and nephrectomy.

In a review of 358 laparoscopic radical prostatectomy (LRP) procedures and 322 robotically assisted laparoscopic radical prostatectomy (RALRP) procedures performed at City of Hope National Medical Center, in Duarte, Calif, no intraoperative or postoperative mortality occurred, and the complication rates for both types of surgery were comparable with those in the published data on radical prostatectomies. The mean operative times were 4.1 hours for LRP and 3.1 hours for RALRP. Mean estimated amounts of blood lost were 200 mL for LRP and 250 mL for RALRP. Anastomotic leak occurred in 13.6% of the LRP cases and 7.5% of the RALRP cases. The incidence of delayed hospital discharge due to ileus was 5.4% for the LRPs and 2.8% for the RALRPs. Postoperative blood transfusions were required in 2.3% of the LRP and 1.6% of the RALRP. The robot malfunctioned in 2 of the 322 robotically assisted cases. One case was converted to a laparoscopic prostatectomy. In the second case, the nonfunctioning robot was replaced with a functional robot.

With future developments in robotic systems, it is conceivable that all surgeries may eventually be performed with robotic assistance.

Anesthetic Concerns With Robotically Assisted Surgery

If they are to provide safe patient care, anesthesiologists must understand how robotically assisted surgery affects anesthetic management. Important issues related to and specific to robotic surgery include patient positioning, the duration of the procedure, the development of hypothermia, the hemodynamic and respiratory effects of a pneumoperitoneum, and occult blood loss.

Patient Positioning

During robotic surgery with the da Vinci system, the patient’s position on the OR table cannot be changed once the robot has been docked. Therefore, the robot should be docked only after the patient has been optimally positioned for surgery. Patient positioning varies with each surgical procedure, and the anesthesiologist should be cognizant of optimal placement before the robot is docked. Pelvic procedures, such as prostatectomy, are usually performed with the patient in the lithotomy and steep Trendelenburg positions (Figure 1), whereas surgery of the upper abdomen and diaphragm is best performed with the patient in the supine and reverse Trendelenburg positions. Thoracic procedures are commonly performed with the patient in the lateral position, with variations of the Trendelenburg or reverse Trendelenburg position according to the surgical site. Mediastinal surgeries often require the patient to be in the lateral position with lateral table tilt. In many laparoscopic surgical procedures, extreme patient positioning is required to take advantage of the gravitational effect that allows obstructing organs to be moved away from the surgical field. Because extreme positioning often increases the risk that the patient will slide off the OR table, restraints must be used. An effective method is to tape a foam egg-crate mattress to the OR table (Figure 2). Contrary to the usual placement of egg crates, the convoluted side of the foam faces down in contact with the OR table, while the smooth side is in contact with the patient; an appropriate amount of traction is generated to prevent patient movement.

Some procedures require the patient’s airway to be at a distance from the anesthesiologist and the anesthesia machine/monitor. Upper abdominal and thoracic surgeries...
are conducted with the OR table rotated 180 degrees away from the anesthesiologist and with the robot positioned cephalad above the patient (Figure 3). Mediastinal procedures require the OR table to be rotated 90 degrees away from the anesthesiologist. During such cases, access to the patient’s airway is nearly impossible; thus, field avoidance precautions must be taken. These cases are particularly challenging if one-lung ventilation is requested because frequent use of a fiber-optic bronchoscope may be necessary. It is imperative to ensure that the patient is properly positioned, with pressure points adequately padded, before the robot is draped and docked. The size and bulk of the robot over the patient and the significant draping on both the robot and the patient make it difficult to access the patient intraoperatively. Robotic-assisted surgeries are often lengthy procedures—especially for inexperienced surgeons. Thus, adequate padding of pressure points is essential to avoid impingement on tissue and nerves. Careful attention should also be given to preventing the robotic arms from coming in contact with the patient. Pressure or crush injuries may occur without constant vigilance. Always remember that cameras and sources of light should be carefully monitored and never left directly on drapes to avoid fires in the OR and thermal injury to the patient.

Physiologic Effects

Once the patient has been properly positioned, intraoperative considerations must be addressed. The physiologic perturbations that occur during robotic surgery are similar in laparoscopic and thoracoscopic procedures. Laparoscopic procedures are associated with phasic changes in hemodynamic parameters secondary to CO\textsubscript{2} insufflation. Increases in systemic vascular resistance, mean arterial pressure, and filling pressures and a 50% reduction in the cardiac index may occur after initial CO\textsubscript{2} insufflation.\textsuperscript{10} The cardiac index gradually increases and the systemic vascular resistance decreases 10 minutes after CO\textsubscript{2} insufflation.\textsuperscript{10,16} The central venous pressure and pulmonary capillary wedge pressures may increase during the pneumoperitoneum. Hemodynamic changes and pulmonary capillary wedge pressures may affect the patient’s position. Most studies have shown a 10% to 30% reduction in cardiac output in patients in the Trendelenburg\textsuperscript{10-13} and reverse Trendelenburg positions.\textsuperscript{14-17} The presence of a pneumoperitoneum affects many organs. It increases the cerebral blood flow\textsuperscript{14} and intracranial pressure.\textsuperscript{15} In the liver, it decreases the portal vein flow, hepatic vein flow, total hepatic blood flow, and flow through the hepatic microcirculation.\textsuperscript{18} Changes in the gastric microcirculation\textsuperscript{19} influence blood flow and mesenteric blood flow, and blood flow through the gastrointestinal microcirculation.\textsuperscript{18,19} A pneumoperitoneum produces a decrease in renal artery and renal vein blood flow, and a decrease in renal medullary and cortical flow.\textsuperscript{19,21} The respiratory system is greatly affected by CO\textsubscript{2} insufflation.\textsuperscript{18,20} A pneumoperitoneum can decrease pulmonary compliance by 30% to 50% in both healthy and obese patients.\textsuperscript{18,20} It reduces the functional residual capacity as a consequence of diaphragmatic elevation. Peak airway pressure during one-lung anesthesia is also increased.\textsuperscript{22} However, there are usually no significant changes in ventilation or perfusion in healthy patients.\textsuperscript{21} In patients with a poor preoperative respiratory status, the maintenance of normocarbia and acid–base status may be challenging. The main factors contributing to an increase in PaCO\textsubscript{2} and respiratory acidosis are the peritoneal absorption of CO\textsubscript{2}, increased dead space in patients with coexisting lung disease, increased metabolism, inadequate ventilation, subcutaneous emphysema, and CO\textsubscript{2} embolism. The same principles that apply in thoracoscopic surgery apply in robotically assisted thoracic surgery. A combination of patient position, one-lung anesthesia, and surgical manipulation alters ventilation and perfusion. Pulmonary shunting is the most important factor determining oxygenation during surgery. This shunt may be limited in the nonventilated lung by disease or hypoxic pulmonary vasoconstriction. The lateral position reduces shunting because the force of gravity decreases blood flow to the nondependent lung.

Normocarbia is usually easily maintained during one-lung anesthesia because of the high solubility of CO\textsubscript{2}. Frequent, robotically assisted surgeries require insufflation of CO\textsubscript{2} into the chest (CO\textsubscript{2} pneumothorax), which increases airway pressure during one-lung anesthesia. Continuous insufflation of CO\textsubscript{2} into the chest improves the surgical field by further collapsing the lung and shifting mediastinal structures away from the surgical site. Insufflation of the chest is usually achieved when the intrathoracic pressure is 10 mm Hg. As the intrathoracic pressure rises during chest insufflation, there can be a decrease in both venous return and compliance of the heart that may result in hypotension and hemodynamic instability. At the same time, higher airway pressures develop in the dependent lung, and ventilation can become difficult. As CO\textsubscript{2} is insufflated and absorbed, the rate of elimination must also increase—a difficult task during one-lung anesthesia because minute ventilation may already be maximized. Another important consideration during robotic thoracic procedures is that violation of the contralateral pleura may occur and result in occult blood loss and a tension pneumothorax in the dependent portion of the chest. It may present as hemodynamic instability and close-to-impossible ventilation of the dependent lung. Immediate discontinuation of CO\textsubscript{2} insufflation is mandatory to alleviate the tension pneumothorax.

During surgery, the fraction of inspired oxygen (FiO\textsubscript{2}) should be kept at 1.0 and the airway pressure kept below 30 cm H\textsubscript{2}O, if possible. Ventilation should be adjusted to maintain the Paco\textsubscript{2}, around 40 mm Hg, and arterial blood gas monitoring should be considered. The application of positive end-expiratory pressure to the dependent lung, or continuous positive airway pressure to the nondependent lung, may assist in oxygenation.

Case Management

Case 1

With the patient in the preoperative holding area, a 16-gauge peripheral venous cannula was placed. The patient was then brought to the OR, where standard American Soci- ety of Anesthesiologists (ASA) monitors were placed. The patient’s trachea was intubated, and a 20-gauge right radial arterial catheter was inserted. His arms were secured in the anatomic position at his side, with adequate padding. The patient was then placed in a steep (35 degrees) Trendelenburg position.\textsuperscript{12,17} However, there are no new developments with CO\textsubscript{2} to a pressure of 15 mm Hg. A camera port was placed supraumbilically. The da Vinci robot was then positioned, and 4 trocars are inserted.
were inserted into the peritoneal cavity. A fifth trocar was placed and used by the surgical assistant as an irrigation and suction port. Dissection of the prostate and seminal vesicle was completed in 2 hours and 35 minutes, after which the urethra and bladder neck were anastomosed in 20 minutes. Removal of the prostate gland and closure of the trocar sites completed the operative portion of the procedure. The total surgical time was 3 hours and 10 minutes. Anesthesia was maintained with a 50:50 mixture of air and oxygen, isoflurane, vecuronium, and intermittent boluses of fentanyl (total of 100 mcg) titrated to hemodynamic response. Hemodynamic stability was maintained within 20% of the preoperative values. The estimated blood loss was 200 mL, and the patient received 1,600 mL of crystalloid. The patient’s trachea was extubated in the OR. Postoperatively, the patient experienced minimal pain, which was adequately controlled with hydromorphone. The patient ambulated and was given a clear liquid diet later in the evening. He was discharged to home on the first postoperative day. It must be noted that this case had the benefits of a surgeon experienced in robotic surgery and a healthy patient.

**Case 2**

The patient was prepared for surgery by the placement of an 18-gauge venous catheter and standard ASA monitors. After preoxygenation, anesthesia was induced with propofol 1.5 mg/kg, fentanyl 5 mcg/kg, and rocuronium 0.6 mg/kg. A 37-French left-sided, double-lumen bronchocatheter was placed; correct positioning was confirmed by fiber-optic bronchoscopy. A 20-gauge cannula was inserted to the right radial artery and a second 16-gauge I.V. catheter placed. Correct positioning of the endotracheal tube was confirmed, and the table was moved to a 30-degree reverse Trendelenburg angle.

The right lung was passively deflated and one-lung anesthesia initiated at an FiO2 of 0.5. Five small incisions were placed in the chest wall, and the robot was docked into position from above the patient’s head. Three robotic ports were inserted—one for the camera and 2 for the robot arms. The 2 remaining incisions included 2 size 12 thoracoports to allow the surgical assistant to aid with suctioning, retraction, and the placement of stapling devices. After placement of the ports, insufflation of the thoracic cavity with CO2 was started at an intrathoracic pressure of 10 mm Hg. An increase in airway pressure to 29 cm H2O and a 20% reduction in mean arterial blood pressure were noticed.

Surgical dissection, identification, and isolation of the pulmonary vessels and airway took 95 minutes. Mediastinal lymph nodes were next dissected in 25 minutes. The pulmonary vessels were ligated and the specimen was retrieved. Estimated blood loss at this point was 100 mL. The surgeon then checked for hemostasis and excluded air leaks. Once correct positioning of the drainage chest tube had been confirmed by the surgeon, the lung was reexpanded under thoracoscopic vision. The incisions in the chest were closed, the patient was returned to the supine position, and the OR table confirmed, and the table was moved to a 30-degree reverse Trendelenburg angle.

Robotic surgery with telerobotic assistance has led to steeper learning curves for surgeons. Anesthesiologists must be aware of such advances and adjust their practices to provide safe patient care.

**References**


Lesson 254: PreAnesthetic Assessment
Of the Patient for Robotic Surgery

Post-test

1. Instruments for laparoscopic surgery and robotically assisted surgery share which of the following characteristics:
   a. There are 7 degrees of freedom in both systems.
   b. They afford excellent tactile feedback.
   c. They are used in minimally invasive surgery.
   d. They are equally able to minimize and dampen hand tremor.

2. Robotic enhancement of dexterity offers the following advantages:
   a. computer programs that filter out hand tremors
   b. modulation of the amplitude of surgical motions by downscaling—translating such motions into a smooth and precise surgical maneuver
   c. restoration of proper hand–eye coordination and allowing the surgeon to assume an ergonomically correct position
   d. all of the above

3. Which statement is true regarding robotically assisted surgery?
   a. Robotic surgery, like laparoscopic surgery, has been around since 1987, and its uses and efficacy have been well established.
   b. Mostly studies of feasibility have been conducted, while almost no long-term follow-up studies have been performed.
   c. A patient’s position can be changed at any time during surgery once the robot is attached to the patient.
   d. The cost of acquiring a robotic system is minimal.

4. All of the following are limitations of a robotically assisted device, except:
   a. its large size and bulkiness, which often restrict access to the patient by the bedside surgeon and anesthesiologist
   b. the lack of tactile feedback provided by the system
   c. the capability to exert considerable force on tissues with minimal effort by the surgeon at the operating console
   d. the lack of visual perception of depth, which is restored by a double optic system that provides a separate image for each eye (resulting in a true 3-dimensional image)

5. The da Vinci surgical robot comprises all of the following, except:
   a. a surgeon console that is controlled by the surgeon
   b. a surgical cart that directly performs the procedures
   c. a vision system
   d. a readily moveable table

6. Which of the following statements is incorrect regarding minimally invasive surgery?
   a. Laparoscopic procedures result in increased hospital stays.
   b. Incisions are smaller.
   c. The risk for infection is reduced.
   d. Postoperative immune function is improved.

7. The most likely change in pulmonary compliance caused by pneumoperitoneum is:
   a. related to cardiac output
   b. an increase in compliance of >20%
   c. a decrease in compliance of 30% to 50%
   d. no change in compliance

8. Initially, robotically assisted surgery was designed clinically for which type of surgery:
   a. intracranial
   b. all types of laparoscopic procedures
   c. urologic
   d. cardiothoracic

9. A 10% to 30% reduction of cardiac output is seen with:
   a. both the Trendelenburg and reverse Trendelenburg positions
   b. only the reverse Trendelenburg position
   c. only the very steep Trendelenburg position
   d. neither the Trendelenburg nor the reverse Trendelenburg position

10. Robotic surgery to date has demonstrated all of the following, except:
    a. the ability to perform a laparoscopic cholecystectomy with the patient and operating surgeon separated by 14,000 km
    b. the ability to perform a procedure in a human patient aboard a space station
    c. the feasibility in an animal model of treating the injuries of combat soldiers
    d. an increase in operating times compared with laparoscopic procedures

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