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Anesthesia Concerns in da Vinci Robotic Laparoscopic Hysterectomy

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Introduction

Advanced Technology is changing the diagnostic and therapeutic trends in modern medicine. One of the latest developments to surgery is 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] because of their special advantages over traditional laparoscopic surgeries. Robotic surgery is used in several specialties including urology, gynecology, general surgery, cardio-thoracic, pediatric, and otolaryngology surgery. These surgeries have been proven to have smaller incisions, less scarring and less recovery time. The da Vinci robotic hysterectomy is revolutionizing the way hysterectomies are performed. They have been documented to be more effective, quicker to perform, and dramatically less invasive than a traditional surgical hysterectomy.

As most of the surgeons are still in the learning phase of this tool, it is important that anesthesiologists should be aware of the potential complications while providing safe patient care.

History

The era of robots in surgery commenced in 1994, when the first AESOP (Automated Endoscopic System for Optimal Positioning, a voice controlled camera holder) prototype robot was used clinically and then marketed as the first surgical robot ever in 1994 by the US FDA. Since then many robot prototypes have been developed. In April of 1997, the first robotic assisted surgery was performed by Jacques Himpen and Guy Cardiere using the da Vinci surgical system. The ZEUS® Surgical System was introduced in 1998. Zeus was the system used to perform the first fully endoscopic robotic surgery and the initial beating-heart, totally endoscopic coronary bypass procedure.

The Da Vinci robotic surgical system was approved by FDA in July 2000 for general laparoscopic surgery, in November 2002 for mitral valve repair surgery and was cleared for use in gynecologic surgery in the U.S in 2005. In January 2009, Dr. Todd Tillmanns reported the results of the largest multi-institutional study on the use of the da-Vinci robotic surgical system in gynecological and oncological surgeries. In January 2009, the first all-robotic-assisted kidney transplant was performed at Saint Barnabas Medical Center in Livingston, New Jersey by Dr. Stuart Geffner [2]. In September 2010, the first robotic operation at the femoral vasculature was performed at the University Medical Centre Ljubljana by a team led by Borut Geršak [3,4].

Types of robots used for surgeries

Robot, taken from the Czech word Robota, meaning forced unintelligent labor.

Robotic systems used in surgery today are computer assisted devices and are not true robots. They offer significant advantages such as three-dimensional view, visibility of difficult to reach areas, easier instrument manipulation and the possibility of remote site surgery [5]. In 1985 a robot, the PUMA 560, was used to place a needle for a brain biopsy using CT guidance [6].

As on today two surgical robotic systems are in use, these are Zeus Surgical System (Computer Motion, California, USA) and da Vinci Surgical System (Intuitive Surgical, California).

The da Vinci surgical System consists of three parts:

1. The control console where the surgeon sits to view the operative field and operates the robotic arms performing the surgery.

2.An instrument tower containing video equipment to display an image of the operative field for the whole team, and Carbon dioxide (CO_2) insufflating equipment.

3. The robot with three arms (four arms in the new version).

The ZEUS® Surgical System consists of a surgeon control center and three table-mounted robotic arms for endoscopic surgery.

The main difference between the da Vinci and the Zeus systems is that the Zeus System uses a voice activated camera which can move in or out, based on the surgeon's voice command, and the robotic arms are attached to the table itself [7].

Anesthetic concerns in robotic assisted surgeries

Though anesthesia for robotic hysterectomy is almost similar to anesthesia for conventional laparoscopic surgery, there is special anesthetic implications because of the requirement of low-lithotomy, steep Trendelenburg positions and prolonged surgical time with intraperitoneal CO_2 insufflations producing negative physiological effects. Intraoperative access to the patient becomes difficult because of the size and bulk of the robot over the patient and the significant draping on both the robot and patient. There is a risk of trauma if the robotic arms come in contact with the patient.

Major problems during peri operative period

There are a number of peri operative factors that need to be considered in robot-assisted surgeries. The major problems with most Robotic procedures (The 5 P's) are:

- Positioning
- Pain
- Problems with a pneumoperitoneum

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- Problems with pressures related injuries
- Paralysis

As we know Trendelenburg position along with abdominal insufflations results in increased pressure and blood volume in the head. In addition to increasing the ICP, an increased Pe′co2 during steep Trendelenburg positioning causes choroid vasodilatation and an increase in intraocular pressure [8]. Furthermore, swelling of the face, eyelids, conjunctiva, and tongue are common due to steep Trendelenburg positions. Swelling of the soft tissues around the airway is also a concern.

Raised intra abdominal pressures reduces thoraco pulmonary compliance and lung volumes leading to atelectasis and ventilation perfusion mismatch making arterial blood gas monitoring crucial [9]. With insufflations pressures higher than 15 mmHg, urine output and glomerular filtration rate could also be impaired [10].

Robotically assisted surgeries are often lengthy procedures, thus adequate pressure point padding is essential to avoid tissue and nerve impingement, especially in lithotomy position. Pressure injuries or paralysis may occur if constant vigilance is not exercised.

Practical Guidelines

Robotic surgeries last for more time than usual. It is important that the attending anesthesiologist must be alert as the patient should not be moved once the robotic arms are engaged. Following guidelines need to be followed for proper access and monitoring safety of the patient:

1. Proper pre anesthetic check up is a must. This will help in assessment of patient for anesthesia as well as counseling of the patient before undergoing not a well known surgical procedure. This should include; Basic Lab work and/or advanced tests. A thorough eye examination in high risk patients to rule out Glaucoma is recommended in certain cases.

2. Venous access should be easily accessible for the anesthesiologist. The intravenous and arterial lines should have extension tubing's long enough in order that they be accessed and controlled from a distance.

3. It is preferred to have bilateral peripheral venous access, as in some circumstances it provides an alternative access.

4. Post Operative Vision Loss can be prevented by applying Eye ointment, tape/tegaderm over eyes and limited use of fluids.

5. An appropriate size Foleys catheter to monitor urine output and a wide bore nasogastric tube to deflate the stomach are must before induction of anesthesia.

6. Since extreme positioning often increases the risk of patients sliding off the OR table, restraints must be used.

7. Cameras and light sources should be carefully monitored and never left directly on drapes to avoid operating room fires and thermal injury to the patient.

8. Monitoring during the surgery should include ECG, end tidal CO_2 concentration, pulse oximeter, intra-arterial pressure, bispectral index (BIS), temperature monitoring and urine output.

9. 5 cmH_2O of positive airway pressure will help in maintaining arterial oxygenation.

10. Communication with the surgeon is very essential.

11. Resuscitation could be an issue in case of an emergency and co ordinate team work by surgeon, anesthesiologist and the assisting staff is essential.

General anesthesia of an adequate depth with controlled ventilation is the technique of choice. It allows for elimination of carbon dioxide (CO_2) and prevents patient movement. This can be achieved with a muscle relaxant and/or volatile anesthetic. Opiates as well as NSAIDS can be used to provide intra and post operative analgesia.

The attending anesthesiologist must be alert and it is important that the patient should not be moved once the robotic arms are engaged. In case of emergency the surgical team should be capable of quickly disengaging the robot from the patient before backing the cart away from the operating room table and the anesthesiologist should be able to gain access to the patient as quickly as possible. Invasion of the anesthetic work space is almost unavoidable and anesthesiologists must be aware that the overbearing 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.

Future for Robotics

Robotic surgery is going to have a great future in medicine, where new issues need to be addressed. Anesthesiologists should be ready to accept the challenges of technical difficulties and prolonged operative time until surgeons become accustomed to robotic technology. They should be ready to tackle new challenges related to intra operative care of the patient. Doubtless, an anesthesiologist is going to play a key role in the success and future of robotic assisted surgeries.

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