Anesthetic Considerations in Robotic Assisted Gynecologic Surgery

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The robot's costs range from $1 million to $2.5 million for each unit, and while its disposable supply cost is normally $1,500 per procedure, the cost of the procedure is higher.

Robotic surgery has been criticized for its expense, with the average costs ranging from $5,607 to $45,914 per patient.

Additional surgical training is needed to operate the system. The learning phase is intensive and surgeons must perform 150 to 250 procedures to become adept in their use.

Numerous feasibility studies have been done to determine whether the purchase of such systems are worthwhile.

RS can take up to twice as long as traditional surgery—prolonged OR timing & anesthesia in steep Trendelenburg position.
The revolution started with the development of the silicone chip and its origins are in Silicon Valley in the USA.

RAS device was first developed and marketed by two companies: Computer Motion Inc., which developed the Automated Endoscopic System for Optimal Positioning (AESOP) robotic device, a voice-controlled camera arm for laparoscopic surgery, enhanced a few years later by the telemanipulator system named ‘ZEUS’.

Intuitive Surgical Inc. marketed its da Vinci® Surgical System, which became highly successful and carried the day.

In 2003, the two companies merged under the name Intuitive Surgical Inc., which solved legal problems over patent rights.
The first robot-assisted surgical procedure was a laparoscopic cholecystectomy in 1997.

The first GYN surgeries performed with the da Vinci system was a tubal reanastomosis in 1999.

Advantages of RAS include improved precision and enhanced accuracy of movement → potential benefits for patients.

Compared to conventional laparoscopy, RAS help the surgeon perform complicated procedures in limited space with ease: severe adhesions, scarring, and difficult anatomical conditions.
Anesthetic considerations for RAS
Patient Positioning

Patient positioning is the most critical part of any robotic-assisted surgery.

Once the surgery begins, the patient cannot be moved to any other position during the entire robotic part of the procedure → importance of proper positioning.

The steep Trendelenburg position provides the optimal exposure of the pelvis and the lower abdomen.
Physiological sequences of steep Trendelenburg position

Cephalic displacement of the diaphragm by abdominal contents and pneumoperitoneum can decrease pulmonary compliance and functional residual capacity, cause pulmonary edema, and exacerbate ventilation/perfusion mismatch.

The changes are even more prominent in obese or those with lung disease.
ETT tube displacement $\rightarrow$ one lung intubation

Upper airway edema.

Brain edema

Increased ICP and IOP, it may be associated with vision loss.
CONCLUSIONS: IOP reached peak levels at the end of steep Trendelenburg position (T5), on average 13 mm Hg higher than the preanesthesia induction (T1) value. Surgical duration and ETco2 were the only significant predictors of IOP increase in the Trendelenburg position (T4–T5).
Pneumoperitoneum

✓ Lung compliance can decrease by more than 50%
✓ Decrease in mean pulmonary arterial pressure
✓ Decrease in pulmonary capillary wedge pressure.
✓ Increase in peak inspiratory pressure
✓ Increase in plateau pressure
✓ Elevation in ETCO$_2$

Patients with COPD are less efficient in eliminating excessive CO2 → postoperative respiratory acidosis, requiring prolonged mechanical ventilation.
Pneumoperitoneum

✓ Pneumoperitoneum with Trendelenburg position cause 2-3-fold increases in left ventricular filling pressures and decrease CO.

✓ SVR and MAP also increase, whereas renal, splanchnic, and portal flows decrease.

✓ Activation of the renin-angiotensin system increases the levels of vasopressin.
Anesthesiologist related issues

The anesthesiologist must be ready to deal with the stressed always learning surgeons, and the long duration of most procedures.

Invasion of the anesthetic workspace with the robot. The size of the robot might interfere with the ability to quickly access the patient.
**Patient Positioning**

- Once the procedure begins, the position can’t be changed.
- Bilateral peripheral intravenous access is generally advised before positioning.
- AL as indicated.
- During the steep Trendelenburg position, shifting the patient’s trunk often leads to nerve injury from stretch and compression.
- Lower extremity acute compartment syndrome after lithotomy position have been reported.

- During RAS, the trocars and instruments are fixed, so the prevention of patient sliding becomes all the more important.
- Many fixation devices are associated with nerve injuries and compartment syndrome.
✓ Because any intraoperative movement can be catastrophic, muscle relaxation is critical for success.
✓ Neurostimulator is recommended.
✓ Rocuronium may be reversed with sugammadex.
✓ Other complications include unrecognized surgical injury, occult blood loss, and risk of hypothermia
Cardiopulmonary Complications
Atelectasis

PEEP improves intraoperative oxygenation and lung mechanics, but impedes the venous return, and decreases CO, but these effects are negated by the Trendelenburg position.

Subcutaneous Emphysema

It occurs frequently with the steep Trendelenburg position and increases CO2 absorption. Ideally, hyperventilation is the solution to the, but in the steep Trendelenburg position, hyperventilation is limited by high inspiratory pressure. Pressure control ventilation may counteract this effect.
Gas embolism

Sudden increase followed by a rapid drop in ETCO2
tachycardia
Hypotension
Diminished breath sounds
Cyanosis
Classic cardiac murmur (mill-wheel murmur)
ECHO

Rapid removal of pneumoperitoneum
Hyperventilation with oxygen
Left lateral decubitus and Trendelenburg positions
CPR
Cardio stimulators
Fluid resuscitation
Aspirating the embolus via CVP or needle insertion
directly into the right ventricle
Adjust the ventilator to prevent hypercarbia and acidosis.
✓ Cardiac arrhythmias and vagal reactions secondary to peritoneal distention during insufflation or viscus manipulation and diminished cardiac preload secondary to caval compression can contribute to a catastrophic outcome and asystolic cardiac arrest.

✓ Hypoxia or hypercapnia can result in cardiac arrhythmias.

✓ The American Association of Gynecology reported an incidence of 1:2,500 cases of asystole and arrest during RAS.
Uncontrolled bleeding!!!

Infrequent, but life threatening complication
If urgent laparotomy is necessary to bleeding control 10 mins usually required to disassemble the manipulators.
Extubation

Extubation should be postponed until face, neck and airway edema are resolved to prevent compromised airway.

Caution: temporary brain edema
Agitation on awakening
Prolonged awakening
Comparison of TIVA vs. balanced anesthesia based on volatile anesthetics.

Postoperative pain
The single study found no difference in pain intensity between two groups.

Yoo 2012

Nausea and vomiting
Two prospective studies are available. In both studies TIVA was associated with lower incidence of nausea and vomiting than in VA groups.

Ozdemir 2013
Yoo 2012
Comparison of TIVA vs. balanced anesthesia based on volatile anesthetics.

Intraocular Pressure
TIVA was associated with lower IOP than VA.
No ocular complications seen in either group.

Yoo 2014

No differences in adverse outcomes were reported.
Adequate pain management and vomiting prophylaxis
Thank you for your time!