Gynecological laparoscopy : An anesthetic point of view

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Laparoscopic surgery is perceived as a "smaller" operation with "faster" recovery. However, this procedure results in considerable physiologic changes and intraoperative risks and thus, it does require "major" anesthesia. Increased intraabdominal pressure, neuro-humoral changes and intraperitoneal carbondioxide absorption lead to deterioration of cardiac index and other cardiovascular complications. They also increase the serious risks of hypoxemia, hypercarbia and pulmonary aspiration of gastric contents. Every step of anesthetic management must be crucially concerned including, the preoperative evaluation and premedication, the appropriate choice of anesthesia and the postoperative management. For outpatients, the short duration anesthetics is beneficial. Patients are discharged only when the criteria for ambulatory surgery discharge are reached. The major causes of the prolonged hospital stay are postoperative nausea, vomiting and pain which can be prevented by the use of low doses of droperidol and NSAIDs, respectively. Even though there are many newer drugs which have showed their effectiveness on these problems, the efficient "cost effective" anesthesia care should be considered in this era.

Key words: Anesthesia in laparoscopy.

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การผ่าตัดผ่านกล้องลาพาโรสโคปในปัจจุบัน ได้กลายเป็นอีกทางเลือกหนึ่งที่สำคัญสำหรับการ
วินิจฉัย หรือการรักษาโดยวิธีผ่าตัด ซึ่งมีข้อดีอย่างเด่นชัดในระยะหลังผ่าตัด แต่ในระหว่างการผ่าตัดมีอัตรา
เสี่ยงมากกว่าเมื่อเปรียบเทียบกับวิธีผ่าตัดเปิดหน้าท้อง เนื่องจากทำให้เกิดการเปลี่ยนแปลงของระบบ
ต่าง ๆ ที่สำคัญของร่างกาย ได้แก่ ระบบไหลเวียนโลหิตและระบบหายใจ อันเป็นผลจากการเพิ่ม
ความดันในช่องท้อง, การนอนในท่าศีรษะต่ำ (Trendelenberg), การเปลี่ยนแปลงทางฮอร์โมนของระบบ
ประสาทซิมพาเธติกส์ และการดูดซึมของก๊าซคาร์บอนไดออกไซด์ ปัจจัยต่าง ๆ เหล่านี้ทำให้มีอัตราเสี่ยง
ต่อภาวะการขาดออกซิเจน, ภาวะคาร์บอนไดออกไซด์คั่ง, การสำลักอาหารเข้าปอด และปัญหาการ
เพิ่มการทำงานของหัวใจ ดังนั้นการให้ยาระงับความรู้สึกต้องเล็งเห็นความสำคัญในการเตรียมผู้ป่วย,
การเลือกใช้วิธีให้ยาระงับความรู้สึกและยาสลบที่เหมาะสมและปลอดภัย, การเฝ้าระวัง และป้องกันผล
แทรกซ้อนในระหว่างผ่าตัด และการดูแลในระยะหลังผ่าตัด สำหรับผู้ป่วยที่มารับการผ่าตัดแบบผู้ป่วยนอก
จะต้องได้รับยาสลบที่มีระยะเวลาออกฤทธิ์สั้น มีผลข้างเคียงน้อย และการอนุญาตให้ผู้ป่วยกลับบ้าน
ต้องพิจารณาตามเกณฑ์มาตรฐาน แม้ว่าการผ่าตัดผ่านกล้อง ลาพาโรสโคปจะมีแผลผ่าตัดขนาดเล็ก
แต่อาการคลื่นไส้อาเจียนและอาการเจ็บปวดหลังผ่าตัด ก็ยังเป็นปัญหาสำคัญที่ทำให้ระยะเวลาการ
อยู่ในโรงพยาบาลนานขึ้น ซึ่งสามารถป้องกันและแก้ไขได้โดยการใช้ droperidol ขนาดต่ำ และ NSAIDs
ตามลำดับ อย่างไรก็ตามค่าใช้จ่ายและประสิทธิภาพในการให้ยาระงับความรู้สึก เป็นสิ่งที่ควรตระหนัก
เช่นกัน

Laparoscopy in gynecology for diagnostic and operative purposes offers a number of specific advantages to the patient. Apart from the anesthetic appeal, the shorter hospital stay, less postoperative pain and decreased postoperative morbidity reflect the trend towards the laparoscopic approach for a wide variety of abdominal operations.

This review will focus on the physiologic consequences after creating a pneumoperitoneum in lithotomy and Trendelenberg position and will point out the anesthetic considerations both in the inpatient and outpatient gynecological laparoscopy.

Cardiopulmonary function in gynecologic laparoscopic surgery

Laparoscopic surgery is perceived as a "smaller" operation with "faster" recovery. Nevertheless, the procedure results in considerable alterations of the intraoperative cardiopulmonary physiology.

Cardiovascular function

The effects of abdominal distension from insufflation of carbon dioxide (CO_2) during surgery on cardiovascular system are due to the direct mechanical and compressive effects, the neurohumoral responses and the absorbed CO_2.

Increased intraabdominal pressure (IAP)

Increased intraabdominal pressure will have a biphasic effect on venous return. Initially, the venous return is temporarily increased due to compression of the abdominal vessels. Later, it is decreased due to the impeding of the venous return from the abdomen and lower limbs. The cephalad shift of the diaphragm due to abdominal distension will increase the pleural

pressure, causing an increase in cardiac filling pressure (increased CVP and PAOP). Moreover, the high pressure in pneumoperitoneum will directly compress the abdominal arterial tree which results in increasing of the systemic vascular resistance (SVR), particularly during the initial phase of CO_2 insufflation. The mean arterial blood pressure (MABP) also rises substantially, reflecting the increased afterload with an associated deterioration of the cardiac index (CI).[1]

$$CO = \frac{MABP - CPV}{SVR} \times 80 \text{ dynes}^{cm.sec-1}$$

Westerband et al.[2] reported a 30 % reduction of CI and a 79 % increase of SVR immediately after peritoneal insufflation to 15 mmHg. Ishizaki et al.[3] studied the safe upper limit of IAP at 8, 12 and 16 mmHg and found that the IAP of $\leq$ 12 mmHg was the threshold pressure with minimal effects on hemodynamic function.

Neuro-humoral responses

During the period of pneumoperitoneum, the plasma concentrations of dopamine, vasopressin, epinephrine, norepinephrine, renin and cortisol increase considerably. Hypercarbia and pneumoperitoneum cause stimulation of the sympathetic nervous system. This results in the release of catecholamines which restores the CI and increases MABP and SVR.

CO_2 absorption

Systemic absorption of CO_2 is biphasic pattern. The initial steep increase of CO_2 absorption due to the initial rapid CO_2 flow rate is followed by a reduction of absorption as a consequence of the compression of the peritoneal vessels.

The SVR may be altered due to the direct effect of the increased CO_2 (vasodilatation) and its indirect effect on the sympathetic nervous system (vasoconstriction).

Clinical implications

Generally, the hemodynamic effects of the pneumoperitonuem are well tolerated by healthy individuals. However, in cardiological compromised patients, careful evaluation is required because hypercarbia causes cardiac arrhythmias and direct pulmonary vasoconstriction which is poorly tolerated in patients with the preexisting pulmonary hypertension or right ventricular infarction.

Acute hypotension, hypoxemia and cardiovascular collapse in association with laparoscopy have been reported.[4,5] It is postulated that hypercarbia, increasing of vagal tone reflex, compression of the inferior vena cava, hemorrhage, and venous gas embolism are the causes of these conditions. Special care should be taken to use the slow and gradual abdominal insufflation with pressure under 20 mmHg. in order to lower the undesirable effects.[6]

Respiratory function

CO_2 Homeostasis

The insufflation of CO_2 into the peritoneal cavity increases the arterial CO_2 tension, which is managed by increasing minute ventilation. Tan et al.[7] found that the delivery of CO_2 to the lung increased by 30 % during the first 15 minutes but CO_2 did not further increase in the next 15 minutes. An appropriate increase of minute volume (12-16 %) or tidal volume (10 ml/kg) can maintain the acceptable $PaCO_2$ level in healthy patients but it may not be the case in ASA

III-IV patients.

Intraoperative changes

The CO_2 pneumoperitoneum, lithotomy, and Trendelenberg positions increase the risks of respiratory problems. The cephalad shift of the diaphragm decreases the functional residual capacity (FRC) and lung compliance. This may lead to hypoxemia due to V/Q mismatch, atelectasis, or bronchial intubation. Regurgitation and aspiration of gastric contents favored by steep head-down tilt, intraperitoneal gas insufflation and mechanical pressure have been reported even in fasting patients.[8]

Postoperative changes

Compared to the open surgery, the laparoscopic procedure causes less postoperative impairment of pulmonary function because it lessens postoperative pain. However, somatic or visceral afferents arising from the intraperitoneal viscera and abdominal wall exert an inhibitory effect on the phrenic nerve discharge and cause diaphragmatic dysfunction.[9] The other cause of the restrictive pulmonary function is shoulder pain which is due to diaphragmatic irritation caused by the residual gas.

Anesthetic management

Laparoscopy is a relatively minor abdominal operation but it requires "major" anesthesia. Therefore, complete preoperative evaluation is essential. This includes history, physical examination, and basic or specific laboratory investigations. Patients with coexisting problems require extreme precautions and some are contraindicated to this procedure.(Table 1)

Table 1. Contraindications for laparoscopic

surgery.[6]

Serious cardiac or pulmonary diseases
History of peritonitis or bowel adhesions
Diaphragmatic, ventral, umbilical or crural herniations
Extensive abdominal scarring from prior laparotomies
Severe obesity

Premedication

Premedication is employed to reduce apprehension and vagal activity. Benzodiazepines for sedation such as 5-10 mg. of diazepam, 7.5-15 mg. of midazolam orally, or narcotics for analgesia such as 50-100 μg. of fentanyl, 50-75 mg. of pethidine IV or IM can be given 0.5-1 hour before surgery. Preemptive analgesia can be achieved by NSAIDs such as 30-60 mg. of ketorolac, 50-100 mg. of diclofenac IV or IM or 500-1,000 mg. of naproxen orally. In patients with a history of peptic ulcer, 300 mg. of cimetidine or 150 mg. of ranitidine should be added. Atropine at the dose of 0.6 mg. IV shortly before gas insufflation is the author's preference to prevent bradycardia resulting from vagal reflex. In ambulatory cases, premedication with short-term activity is preferred.

General anesthesia

The choice of anesthesia for surgical laparoscopy is mostly limited to general anesthesia techniques. The patient's discomfort associated with the creation of the pneumoperitoneum and the operating position is the major reason. The cuffed endotracheal tube placement can minimize the risk of acid aspiration and can prevent complications arising from hypercarbia.

After intubation, the author advocates to decompress the intragastric pressure via a nasogastric tube or suction catheter. This will promote the intrapelvic surgical exposure and will decrease the incidence of regurgitation and nausea or vomiting. Maintenance of anesthesia is proceeded by the use of nitrous oxide, short to intermediate acting muscle relaxant and volatile anesthetics. Halothane anesthesia is not recommended, since it may cause cardiovascular depression and arrhythmias during the period of pneumoperitoneum. The additional analgesia is provided by IV administration of fentanyl or other short acting narcotics of which the proper dosage can be adjusted to reach the fast recovery and adequate analgesia. Monitoring should include blood pressure, heart rate and rhythm, breath sounds, oxygen saturation and end-tidal carbon dioxide. Careful monitoring and precaution of possible severe complications are needed throughout the procedure. (Table 2)

Conscious sedation

In situations in which diagnostic laparoscopy or laparoscopic tubal sterilization can be performed expeditiously, the conscious sedation combined with local infiltration can be chosen. This technique has the benefits of much lower expense, rapid recovery and lowered incidence of postoperative complications such as sore throat, muscle pain, nausea, and headache.

Beilin et al.[10] used 1 μg./kg. of fentanyl and 0.01 mg./kg. of flunitrazepam IV for this procedure. The patients had spontaneous ventilation with acceptable PCO_2 level and showed good cooperation.

Table 2. Anesthetic considerations for surgical laparoscopy.

Preparation and monitoring
- Adequate IV access
- NIBP, EKG, SpO_2, $ETCO_2$
Anesthetic technique
- General endotracheal anesthesia with neuromuscular blockade
- Consider antiemetic agent
Potential intraoperative complications
- Vagally mediated bradycardia
- Perforation of viscus
- Hemorrhage
- Venous gas embolism
- Pneumothorax, pneumomediastinum
- Subcutaneous emphysema
Postoperative care
- Nausea, vomiting
- Shoulder pain

In the Department of Obstetrics and Gynecology, Faculty of Medicine, Chulalongkorn University, the diagnostic gynecological laparoscopy can be performed under 75 mg. of pethidine and 10 mg. of diazepam IV. Uerpairojkit et al.[11] studied the ASA physical status I-II patients who received this combination for conscious sedation. According to their study, mild hypoxemia occurred especially after sedation and was improved during the surgical manipulations. Significantly higher arterial oxygenation and no evidence of hypoxemia were observed in patients with oxygen supplementation throughout the procedure. The arterial CO_2 continuously rose according to the period of intraperitoneal CO_2 insufflation, but this did not cause any clinical problems in such a short procedure. However, careful monitoring for cardiopulmonary problems is recommended.

Ambulatory anesthesia

The preparation process should be aimed at reducing the common postoperative problems such as nausea, vomiting, pain, and slow recovery. With the availability of new shorter-acting agents, we can accelerate the recovery times or "home readiness" after short ambulatory procedures.

Propofol has recently become the IV induction agent of choice for outpatient anesthesia because of its rapid emergence and low incidence of postoperative nausea and vomiting. The intermediate acting nondepolarizing muscle relaxants, e.g. atracurium and vecuronium, have minimized problems related to the inadequate reversal after short procedures. Short-acting analgesics, e.g. remifentanil, sufentanil and alfentanil, have also facilitated faster recovery.

The newer halogenated volatile anesthetics, e.g. isoflurane, sevoflurane and desflurane, permit a more rapid onset and termination of their clinical effects. In addition, they provide a greater degree of intraoperative hemodynamic stability.

The laryngeal mask airway (LMA) causes a lower incidence of postoperative sore throats and hemodynamic changes during induction and emergence. Unfortunately, the LMA does not protect the airway against aspiration, therefore, extreme precautions and experience are required.

Recovery and discharge of the ambulatory anesthesia patient

Immediate postoperative care should be further maintained for the airway, ventilatory and

circulatory system because of the remained effect of sedatives or anesthetics. An appropriate scoring tool to evaluate for home-readiness is needed for safe discharge of the patients.[12] (Table 3)

In addition to the establishing discharge criteria, the patients must be given verbal or written discharge instructions, including contact telephone numbers in the event of emergencies. Patients should be cautioned against performing functions that require complete recovery of cognitive abilities.

Postoperative nausea and vomiting (PONV)

Patients undergoing gynecological laparoscopy are considered at high risk for developing PONV with an incidence of 20-80 %.[13] The peritoneal stretching stimulates the vagal mediated impulse and triggers the vomiting center. This delays patient discharge and causes unexpected hospital admission. Risk factors of PONV include a history of motion sickness or previous PONV,specific phase of the menstrual cycle, inadequate hydration status, obesity, and opioid analgesic therapy. Droperidol and ondansetron have been demonstrated to be more effective for prophylaxis of PONV than metoclopramide.[14] Ondansetron becomes beneficial for its lack of sedation effect and its effective antiemesis[15], but it costs about 10 times more than droperidol. Lower doses of droperidol (0.625 – 1.25 mg. IV) are effective, without significant increasing of oversedation and extrapyramidal side effects.[16] Combination of these

Table 3. Criteria for ambulatory surgery discharge.

Postanesthesia discharge scoring system (PADSS)[12]

(10 = total score ; score ≥ 9 needed for discharge)		
vital signs	2	= within 20 % of preoperative value
	1	= 20-40% of preoperative value
	0	= 40 % of preoperative value
ambulation and	2	= oriented and steady gait
mental status	1	= oriented or steady gait
	0	= neither
pain or nausea/	2	= minimal
vomiting	1	= moderate
	0	= severe
surgical bleeding	2	= minimal
	1	= moderate
	0	= severe
intake/output	2	= has PO fluids and voided
	1	= has PO fluids or voided
	0	= neither

antiemetics might be more effective in severe cases. Avoiding over-stretching of the peritoneum, propofol-based anesthesia and adequate postoperative analgesia can also reduce the incidence of PONV.

Pain after laparoscopy

Pain after laparoscopy is significantly less and shorter than after laparotomy and hence, earlier discharge from the hospital is possible. On the other hand, rapid dischange can lead to failure of recognition and treatment of the pain which increases after the first few postoperative hours. After discharge, pain control may be inadequate because of the lack of medical care and postoperative visits.

Timing and pattern of pain

Pain may occur in the upper or lower abdomen, back or shoulders. It may be transient or persist for as much as 3 days.Complaints of pain at any site are greatest after the operation, and usually decrease within 24 hours, whereas shoulder pain, negligible on the first day, becomes significant on the following days.

Mechanism

Rapid distension of the peritoneum causes tearing of blood vessels, traumatic traction of nerves and releasing of inflammatory mediators.[17] Pathological studies have shown peritoneal inflammation and neuronal rupture. There has been a linear correlation between abdominal compliance during laparoscopy and the severity of postoperative pain. Shoulder pain from excitation of the phrenic nerve has a statistically significant correlation with the persistent pneumoperitoneum and the width of the persistent gas bubble.[18]

Pain relief
Local anesthesia

Pain after laparoscopy can be significantly reduced by local anesthesia. The theory of "preemptive analgesia" by which anesthesia is given before tissue injury and inflammatory mediators release should be applied by local anesthetics at the site of skin incision, rectus sheath and mesosalpinx for tubal ligation. Application of local anesthetics under the diaphragm is suggested to reduce the severity of shoulder pain.[19]

NSAIDs

The severity of postoperative pain after laparoscopy may be related to the concentrations of prostaglandin and other inflammatory mediators which increase locally after peritoneal stretching or tubal manipulation and ligation. NSAIDs appear to be effective for total pain in the late postoperative period but not for shoulder pain.[20] Balanced analgesia with a combination of narcotics and NSAIDs leads to better pain relief with a lower incidence of nausea and vomiting. Administration of NSAIDs one hour before laparoscopy or earlier produces the maximum effect after the operation. However, it is better to avoid using NSAIDs in patients with the risk of coagulopathy or renal insufficiency.

How to decrease pain ?

Postoperative pain after laparoscopy can be successfully reduced by a combination of simple measures, such as maximum evacuation of the insufflated gas, application of local anesthetics to skin and muscle wounds or to the fallopian tube at the time of clipping and avoiding over- stretching of the peritoneum by high-pressure CO_2 insufflation.

Administration of a short-acting intraoperative opioid may reduce the immediate surgical and referred pain effectively whereas NSAIDs ameliorate the later inflammatory pain.

Conclusions

The increasing popularity of gynecological laparoscopy challenges the new anesthetic techniques. The advantages of shorter hospital stay, less postoperative pain, and faster return to normal activities have to be weighed against the increased intraoperative risks of the cardiopulmonary changes commonly found among the poor functional class patients (ASA class III-IV). General anesthesia with controlled ventilation is required for surgical laparoscopy to avoid hypercarbia and its consequences. An anesthetic technique implying cardiovascular stability, vagal reflex precaution, antiemetic effects, and intraoperative and postoperative analgesic effects is crucial for successful operation. Sedation can be safely used for diagnostic laparoscopy under careful cardiopulmonary monitoring and oxygen supplementation during and after the procedure. New anesthetic agents with a shorter duration are successfully used for rapid "home readiness". However, the author advocates to implement cost containment measures to achieve the most effective outcomes of our health care system.

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