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International Journal of Current Research
Vol. 7, Issue, 09, pp.20652-20657, September, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

REVIEW ARTICLE

ANAESTHETIC IMPLICATIONS ON CARDIORESPIRATORY AND HEMODYNAMIC PHYSIOLOGY IN MINIMAL ACCESS SURGERY – A REVIEW ARTICLE

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ARTICLE INFO

Article History:
Received 07th June, 2015
Received in revised form
19th July, 2015
Accepted 25th August, 2015
Published online 30th September, 2015

Key words:

Cardiorespiratory,
Hemodynamic Laparoscopy,
Intra-abdominal Pressure,
Carbon dioxide.

ABSTRACT

Laparoscopic surgical procedures aim to minimize the trauma of the open conventional procedures. Advantages of laparoscopy include smaller incisional sites, lower risks of wound complications, reduced postoperative pain and complications, improved recovery, shorter hospital stays, more rapid return to normal activities, and significant cost savings. Endoscopic surgery also involves complications. Apart from entry complications of laparoscopy, hemodynamic and cardiorespiratory alterations cannot be under estimated and pose a significant risks especially in patients with pre existing cardiac and respiratory ailments. Risks are associated with Laparoscopic Surgery especially when extended periods of carbon dioxide insufflation are used, and especially with the patient in the steep head-down position. In such circumstances, adverse haemodynamic and respiratory effects are more prone to occur. Cardiorespiratory changes associated with laparoscopy include those associated with tilting the patient to facilitate instrumentation and surgical exposure, and pressure effects of the instilled gas into peritoneum. The operative technique requires inflating gas into the abdominal cavity to provide a surgical procedure. An intra-abdominal pressure (IAP) of 10-15 mmHg is used. Carbon dioxide (CO2) is commonly used because it does not support combustion, is cleared more rapidly than other gases, and is highly soluble in blood. However, the disadvantage of CO2 is that the absorption of CO2 can cause hypercapnia and respiratory acidosis.

Citation: Muzzafar zaman, Aliya Shah and Akif Mutahar Shah, 2015. "Anaesthetic implications on cardiorespiratory and hemodynamic physiology in minimal access surgery – a review article", *International Journal of Current Research*, 7, (9), 20652-20657.

INTRODUCTION

Laparoscopic cholecystectomy is one of the most common procedure performed theses days by laparoscopic surgeons. It offers several advantages such as a reduction in stress response, postoperative pain, postoperative wound infection rate, intraoperative bleeding,short recovery time and better cosmetic appearance but alongwith can cause impairment of respiratory function and pulmonary complications (Medicine, 2013; Motew *et al*., 1973). LC reduces hospital stay but has no overall effect on postoperative mortality (Ivankovich *et al*., 1974). The risk factors for perioperative complications in patients undergoing LC can be estimated based on patient characteristics, clinical findings and the surgeon's experience (Andersson *et al*., 2005). The advantages should to be balanced with potential adverse effects caused by CO2 pneumoperitoneum.

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The physiological effects of intra-abdominal CO2 insufflation combined with the variations in patient positioning can have a major impact on cardiorespiratory function. In addition, the sequential effects of anesthesia combine to produce a characteristic hemodynamic response. A thorough understanding of these physiological changes is fundamental for optimal anesthetic care. Several anesthetic techniques can be performed for LC. General anesthesia using balanced anesthetic technique including intravenous drugs, inhalation agents and muscle relaxants is usually used. Short acting drugs such as propofol, atracurirm, vecuronium, sevoflurane or desflurane represent the maintenance drugs of choice. Preprocedure assessment and preparation, appropriate monitoring and a high index of suspicion can result in early diagnosis and treatment of complications (Medicine, 2013).

Hemodynamic alterations in laparoscopic surgery

In abdominal laparoscopic procedures hemodynamic alterations are a consequence of three processes

- the first one is the intra-abdominal pressure created by the pneumoperitoneum;

- the second one is the existence of an insufflation gas that is absorbed by the blood;
- the third one is the Trendelenburg or anti-Trendelenburg positioning of the patient.

Investigators have demonstrated significant alterations of cardiac performance after peritoneal insufflation during laparoscopic procedures (Motew *et al*., 1973). The pneumoperitoneum increases the abdominal pressure resulting in elevation of the diaphragm and can consequently compress both small and big blood vessels. The intra-abdominal pressure obtained during these procedures, which is usually 12mmHg, increases central venous pressure (CVP), heart rate (HR), systemic vascular resistances (SVR) up to a 65%, and the pulmonary vascular resistances can rise up to a 90%. Cardiac output (CO) can increase on a healthy patient in Trendelenburg position, but can also decrease to a 50% on patients in anti Trendelenburg position or with a low cardiovascular reserve. All those changes are usually well tolerated in healthy patients but it can cause significant degree of morbidity in patients with pre existing systemic diseases.

When intra-abdominal pressure reaches 15mmHg, because of excessive insufflations or because the patient activates the abdominal wall muscles (due to a lack of muscle relaxants that causes an increase of the abdominal wall resistance to the insufflations, cough or tube rejection), a compression of vena cava can occur, causing a blood return reduction and a decrease in the cardiac output. The diaphragm elevation will raise intra thoracic pressure and will in turn reduce the cardiac output. The lower cardiac output can be compensated in a healthy patient by increasing the heart rate and arterial pressure, obtaining a stable hemodynamic status; but if an acute hemorrhage occurs, the patient turns fast in to an unstable state .Cardiovascular collapse and asystole cases in healthy patients have been described previously and attributed to deep vagal reflexes due to sudden insufflations.

The carbon dioxide pneumoperitoneum induce the gas absorption leading to a hypercapnia tendency. If pulmonary ventilation is not enough to eliminate the CO_2 absorbed from the pneumoperitoneum, then hypercapnia appears and the resultant acidosis can depress myocardial function and predispose to arrhythmia and cardiovascular collapse. Cardiovascular collapse during laparoscopic procedures in young patients undergoing gynecological laparoscopy has similarly been documented (Ivankovich *et al*., 1974).

Carbon dioxide has also direct effects on the heart; it causes arrhythmia and probably decreases contractibility. It is because of these reasons that Helium has been recommended as insufflation gas in patients with cardiac risk or respiratory disability to eliminatethe use of CO_2. Gaseous embolism through an open vessel can produce severe hemodynamic alterations, which can produce a cardiovascular collapse by venous return blockade. Anti-Trendelenburg position increases the severity of the embolism and its repercussions delaying its treatment. Positioning is essential for the final hemodynamic result during laparoscopy. On upper abdominal procedures, where patients are on anti-Trendelenburg position, the venous return decreases because of the remaining blood on the inferior extremities. In healthy patients hemodynamic stability use to be maintained, just with the exception of hemorrhage, which can suddenly decompensate that stability. It's highly recommended that pre- hydration of the patient with 500-1000ml of saline solution before the beginning pneumoperitoneum should be done . Patients that underwent intestinal cleaning use to suffer a loss of liquids, which shows up when they are positioned on anti-Tredelnburg, combined with the pneumoperitoneum and the vasodilators effects of the anaesthetic drugs.

When laparoscopic surgery is performed on the inferior abdomen, like in gynecology or pelvic surgeries, Trendelenburg position is required; it increases the venous return and compensates blood loss. However, heart patients can dramatically increase the cardiac preload. Moreover, the respiratory changes produced by the diaphragm's elevation, caused by an excessive intra abdominal pressure on Trendelenburg position, will raise intra thoracic pressure. That fact, in combination with the higher inspiratory pressures required, will increase the cardiac impedance, or in other words the cardiac after load.

Respiratory alterations in laparoscopy

The changes in the mechanical properties of the respiratory system as a result of pneumoperitoneum are related to two main factors:-

- shifting of blood flow to the pulmonary circulation and
- compression of the lung bases by raising the dome of the diaphragm.

Increased pressure within the abdomen increases the intrathoracic pressure by pushing the diaphragm upward, thus decreasing respiratory system compliance, which in turn results in reduced lung volumes and increased airway pressures. These changes predispose patients to airway closure and collapse of dependent lung regions (atelectasis) (Andersson *et al*., 2005). Atelectasis can be prevented by positive end-expiratory pressure or treated by inflation maneuvers. Obese patients have a greater risk of atelectasis than non-obese patients. Preventing atelectasis is important for all patients, but is especially important when caring for obese patients. The use of high positive end-expiratory pressure (10 cm H_2O) in patients undergo laparoscopic bariatric surgery resulted in improved respiratory function and oxygenation in obese patients as reported by Talab *et al.* in 2009.

When compared to preinsufflation values, abdominal insufflation to 2.26 kPa caused a significant (31%) decrease in respiratory system compliance, a significant (17%) increase in peak and plateau (32%) airway pressures at constant tidal volume with significant hypercapnia, but no change in arterial O_2 saturation in obese patients undergoing laparoscopic gastroplasty. Respiratory system compliance and pulmonary insufflation pressures returned to baseline values after abdominal deflation. Positive end expiratory pressure (PEEP) prevents the upward shift of the diaphragm during laparoscopy, limits the deliterious effects of surgery on respiratory mechanics, and improves oxygenation.

However, no consensus has been reached regarding the ideal level of PEEP during laparoscopic surgery. A PEEP of 10 cm H2O had better oxygenation both intraoperatively and postoperatively in the PACU, lower atelectasis score on chest computed tomographic scan, and less postoperative pulmonary complications than a PEEP of 0 cm H2O (ZEEP) and 5 cm H2O in patients undergo undergo laparoscopic bariatric surgery (Talab *et al*., 2009). Likewise, a PEEP of 10 cm H2O produced beneficial effects in the elasticity, as well as in the resistance, of the respiratory system in patients undergoing cholecystectomy video-laparoscopy procedures. The use of a recruitment maneuver (RM) re-expanded atelectasis and improved oxygenation in obese patients undergoing laparoscopic procedures (Almarakbi, 2009).

RMs and PEEP were both required to prevent rapid reoccurrence of atelectasis, especially when a high-inspired oxygen fraction was used. Oxygenation may be a poor indicator of the extent of lung collapse as oxygenation has not been found to correlate with atelectasis formation during pneumoperitoneum). Advanced Laparoscopy End-expiratory lung volumes are commonly used in clinical practice to denote functional residual capacity during mechanical ventilation. Futierae *et al* in 2010 (Futierae, 2010) investigated the effects of RM after application of PEEP on changes in end expiratory lung volume (EELV), respiratory mechanics, and oxygenation in healthy weight and obese patients undergoing laparoscopic surgery. They found that pneumoperitoneum worsened the reduction in EELV and respiratory mechanics produced by anesthesia induction, with no major effect on oxygenation. A PEEP of 10 cm H2O combined with RM induced sustained improvements in EELV, gas exchange, and respiratory mechanics, and may be useful in counteracting the detrimental effects of pneumoperitoneum, especially on lung volume reduction in healthy weight and obese patients (Futierae, 2010).

Both conventional volume-controlled ventilation and pressure-controlled ventilation (PCV) were found to be equally suited for patients undergoing laparoscopic gynaecologic surgery. However, a higher lung compliance and lower peak airway pressures, plateau pressures, and airway resistance were observed with PCV in laparoscopic gynaecologic surgery patients. Patients with pulmonary dysfunction are at high risk for complications; pre-op screening with pulmonary function tests is of the utmost importance for these patients. Changes in pulmonary mechanics are well tolerated in morbidly obese patients when proper ventilator adjustments are maintained (Nguyen and Wolfe, 2005). Sprung, 2003 showed that arterial oxygenation during laparoscopy could not be improved by increasing either the tidal volume or respiratory rate. In morbidly obese patients with chronic obstructive pulmonary disease and hypertension, the 20° reverse Trendelenburg position during laparoscopic gastric banding surgery improved respiratory mechanics (respiratory compliance, airway resistance and peak inspiratory pressure) and oxygenation without any apparent adverse effects on haemodynamics.

On the other hand, PaO2 was significantly lower and the alveolar-arterial oxygen difference (A-aDO2) was higher in overweight (BMI 25–29.9 kg/m2) and normal weight (BMI 18.5–24.9 kg/m2) patients who underwent totally endoscopic robot-assisted radical prostatectomy in the Trendelenburg position. Whereas pneumoperitoneum did not have any significant effect in normal weight patients, A-aDO2 decreased to below baselines values in overweight patients after prolonged (1.5 hours) pneumoperitoneum.

The kidney position can lower the vital capacity by another 5–10%. Most of this decrease is thought to result from reduced movement of the ribs and diaphragm. Although vital capacity and FRC are reduced in the lateral decubitus position, better ventilation–perfusion matching results from increased perfusion in the dependent lung and corresponding increase in ventilation from the stretched dependent hemidiaphragm. However, general anesthesia in the lateral decubitus position causes an increased mismatch in ventilation–perfusion ratios compared to that in awake subjects. Complications from the lateral decubitus position include pressure injuries (ischemic), muscular and ligamentous strain, whiplash-like injury to the cervical spine, neurologic injuries, and ocular complications (corneal abrasions, pressure effects, dependent edema, and blindness).

Intraoperative anesthesia management

Laparoscopy patients should undergo a preoperative evaluation identical to that for patients undergoing the equivalent open procedure. Depending on the surgeon's experience with these procedures, the anesthetic plan should anticipate the possibilities of significant bleeding and conversion to an open procedure. Routine intraoperative monitoring (EtCO2, pulse oximetry, BP, airway pressure) should be adequate for the expected physiologic changes encountered in most patients. The anesthesiologist should continually monitor the insufflating pressure being used and should be alerted if an unusual amount of CO2 is required.

During laparoscopic cholecystectomy, patients with chronic cardiopulmonary disease may require careful intraoperative arterial blood gas monitoring of absorbed carbon dioxide. With extended periods of insufflation and higher pressures, faster CO2 absorption occurs and arterial carbon dioxide levels may reach harmful levels. Measurement of EtCO2 allows the physician to manipulate ventilation as needed Cardiovascular monitoring should be appropriate for the planned procedure, based on the patient's clinical status. Central venous and pulmonary arterial wedge pressure measurements are biased during laparoscopy because of transmission of intraabdominal pressure to the mediastinal space. Use of TEE in high-risk patients allows for more accurate assessment of cardiac volumes. TEE for hemodynamic monitoring may be useful in the prevention and recognition of cardiovascular complications. Femoral venous flow augmentation with intermittent sequential pneumatic compression reverses perioperative cardiac depression and overcompensates for the state of peripheral venous stasis induced by pneumoperitoneum during laparoscopic surgery in the head-up tilt position. When laparoscopic procedures are performed in an ambulatory setting, the choice of induction and maintenance anesthetic agents reflects the need for prompt awakening and rapid recovery. The anesthetic management of laparoscopic surgery includes minimizing hemodynamic changes which may occur due to the pneumoperitoneum and patient's position. In laparoscopic surgery, nitrous oxide (N2O) is often avoided, to prevent bowel distension if the procedure becomes prolonged. Nitrous oxide accumulates in the CO2 pneumoperitoneum during laparoscopy when N2O is used as an adjuvant for inhaled anesthesia. Accumulated N2O in a CO2 atmosphere may be dangerous because it can lead to excessive dilatation of the bowel. The risk of CO2 and N2O gas embolism is also a concern because the consequences of such embolization may differ from those with the same volume of CO2 alone. N2O diffuses into the abdominal cavity and will diffuse into CO2 bubbles and emboli, increasing their size and potential for an obstructive event.

Adequate muscle relaxation is required during laparoscopy so that spontaneous respiratory efforts do not impair the surgical procedure or increase the gradient for embolic gas to enter the central circulation. Despite the limited surgical incision(s) of laparoscopic procedures, postoperative muscle pain remains a problem. These problems have not been eliminated by avoiding succinylcholine or by using other anesthetic regimens. PaCO2 should be maintained within its normal range during pneumoperitoneum in the Trendelenburg position. For example, rSO2 increased in conjunction with the increase in PaCO2 during pneumoperitoneum in a steep Trendelenburg position in patients undergoing daVinci robot-assisted laparoscopic prostatectomy. Watanabe *et al.* found that remifentanil (0.2μg/kg/min) may suppress the cardiovascular changes caused by pneumoperitoneum in laparoscopic cholecystectomy patients. Through an epidural catheter placed between T10-12, 0.2% ropivacaine was infused continuously at 6 mL/hr. With a pneumoperitoneum, as opposed to an epidural anesthetic, remifentanil significantly suppressed the tachycardia, but not the hypertension caused by the pneumoperitoneum).

Esmolol infusion can also be used to provide hemodynamic stability during laparoscopy.No ventilation technique for laparoscopic surgery has proved to be clinically superior to any other. Both conventional volume-controlled ventilation and pressure-controlled ventilation were found to be equally suited for use in patients undergoing laparoscopic gynaecologic surgery (Oğurlu *et al.,* 2010). Stationary positioning of the patient over long periods of time during laparoscıpic surgery may place the patient at risk for neuropraxia, rhabdomyolysis, compartment syndrome, and pressure ulcers. Neuromuscular and pressure injury becomes more likely with increasing surgical duration, hence the need for appropriate padding and support, especially during laparoscopic nephrectomies. Hypotension, decreased cardiac output Hemorrhage Acidosis Pneumothorax Pneumomediastinum Endobronchial intubation Subcutaneous emphysema Airway obstruction Retroperitoneal CO2 Venous stasis Venous CO2 embolism Increased sympathetic activity secondary to increased CO2 Bradycardia, increased vagal tone Cardiac arrest Regurgitation and aspiration .

Intraoperative surgical complications

During laparoscopy, positional changes may significantly decrease venous return, causing low cardiac output and hypotension. This condition can be prevented by fluid loading and promptly reversed by deflation and table deflection.

The changes listed above may lead to myocardial ischemia in patients at risk. In the rare event of catastrophic hemodynamic collapse during laparoscopy, several possible causes should be considered: bleeding, subcutaneous emphysema, pneumothorax, pneumomediastinum, diaphragmatic tears, and gas embolism. Although the use of CO2 for pneumoperitoneum reduces the probability of a massive pulmonary embolism, it is a potentially fatal complication and should be considered in case of intraoperative hemodynamic deterioration, (Slodzinski and Merritt, 2008). Initial therapy during a catastrophic event includes releasing the pressurized pneumoperitoneum (i.e., conversion to an open procedure). For pneumothorax, a thoracentesis should be performed.

If massive embolization occurs, N2O, if employed, should be discontinued immediately and cardiopulmonary resuscitation should be performed. The patient should be placed in the left lateral position. Attempts at embolus retrieval should be made through central venous access, if available. If these measures are not sufficient, cardiopulmonary bypass may be necessary (Joris, 2005) During laparoscopy, hemorrhage can be obvious or occult (e.g., retroperitoneal), and may be encountered intra-operatively or in the postoperative period. Bleeding complications are an important subset of 'non-biliary' injuries, and can cause death on the operating table if not recognized and treated in time. Bleeding complications are the most frequent cause of procedure-related mortality in laparoscopic cholecystectomy (after anaesthesia-related deaths).

Intra-operative bleeding usually falls into one of the following four patterns: vessel injury, slippage of clips/ligatures of the cystic artery, liver bed bleeding, and miscellaneous. Vessel injuries are usually the most dramatic and occur either during insertion of the first trocar or during dissection/retraction, and were rarely seen before the advent of laparoscopic surgery. The insertion of the pneumoperitoneum needle and the first trocar is considered by many to be the most dangerous step in laparoscopic cholecystectomy, as it is essentially a 'blind' step. As this initial step is common to all laparoscopic operations, it has been reviewed extensively by various authors. As mentioned earlier, the majority of bleeding complications occur in this phase of the operation. Although the most commonly injured vessels are the epigastric vessels, injury can also occur to the major intra-abdominal vessels (aorta, vena cava, iliac vessels), in 0.04% to 0.18% of patients (Geraci *et al*., 2006). None of the "no entry" techniques for laparoscopy (trocar entry after creation of pneumoperitoneum, trocar entry without prior insufflation, or various modifications of the open technique of port placement) are free from the risk of complications (Kaushik, 2010). Bleeding complications are divided into major and minor depending on the need for conversion, additional surgical procedures, or blood transfusions. Thus, any bleeding that requires a laparotomy is considered major, irrespective of the vessel injured or the timing (intra-operative or postoperative). Similarly, any bleeding that needs an additional surgical procedure (wound exploration and ligation of bleeder) or blood transfusion is also considered to be major, whereas bleeds controllable by pressure or packing, or abdominal wall haematomas that do not require any additional manoeuvres, can be classified as minor bleeds (13). Major and minor complication rates for laparoscopic renal surgery have ranged from 1-6% and 6-17%, respectively. Vascular, bowel, and ureteral injuries are reported as the most commonly encountered intraoperative complications. A key component to decreasing the incidence of surgical complications is proper patient selection and identification of preoperative risk factors. Potential preoperative risk factors, such as prior operations, increased age, increased body mass index, poor renal function, and anomalies in renal vasculature, are of crucial importance to proper preoperative risk stratification. Also, the urologist must be facile with current laparoscopic techniques in order to minimize complications, (Elsamra and Pareek, 2010). In a study (Colombo *et al*., 2008 of patients who underwent laparoscopic nephrectomy, nephroureterectomy, laparoscopic partial nephrectomy, and adrenalectomy, age greater than 65 years predicted a longer hospital stay, but was not an independent risk factor for complications (Colombo *et al*., 2008). In addition, patients with baseline elevated creatinine were at higher risk of postoperative renal deficiency.

Recently, in patients with a BMI less than 25 kg/m2 and greater than 40 kg/m2 who underwent laparoscopic radical nephrectomy or laparoscopic partial nephrectomy, no statistically significant difference was found for estimated blood loss, operative time, hospital stay, number of open conversions, or complications. However, a trend toward increased operative time and intra-operative complications (not statistically significant) was noted in patients with increased BMI .Surgical experience appears to be directly related to the complication rate, with at least 50 laparoscopic cases required to achieve proficiency (Vallancien *et al*., 2002). In addition, 80% of all major complications of laparoscopic surgery occurred among the surgeon's first 100 cases. Short intensive courses may increase the surgeon's experience, confidence, and competency in advanced laparoscopic procedures (Pareek *et al*., 2005).

Postoperative risks

Postoperative nausea and vomiting (PONV) occurs in 40–70% of patients undergoing laparoscopic cholecystectomy. Female patients have a 1.5-3 times greater incidence of PONV than males, due to increased plasma progesterone levels during their menstrual cycles. Antiemetics used to prevent PONV after laparoscopic cholecystectomy include antihistamines (dimenhydrinate), phenothiazines (perphenazine), butyrophenones (droperidol), benzamides (metoclopramide), dexamethasone, and serotonin-receptor antagonists (ondansetron, granisetron, tropisetron, dolasetron, and ramosetron). Knowledge regarding prophylactic antiemetic therapy is necessary to effectively manage PONV in female patients.

In laparoscopic cholecystectomy, before or following induction of anesthesia, dexamethasone alone or in combination with a serotonergic antagonist (granisetron, ondansetron) to prevent nausea and vomiting is well established. Dexamethasone alone was found as effective as 4 mg ondansetron and 3 mg granisetron . Dexamethasone, in combination with a serotonergic antagonist, significantly reduced the incidence of PONV more than promethazine and granisetron monotherapy.

In women undergoing ambulatory gynaecological laparoscopy, prophylactic low-dose granisetron and promethazine together were more effective in reducing PONV than promethazine or granisetron alone (Gan *et al*., 2009) Risk factors for postoperative PONV after laparoscopic cholecystectomy include pain, dizziness, ambulation, oral intake, and analgesics (opioids). Avoiding these risk factors would result in less PONV for patients undergoing laparoscopic surgery.

Conclusion

Laparoscopic surgical procedures aim to minimize the trauma of the interventional process. Advantages of these procedures include smaller incisional sites, lower risks of wound complications, reduced postoperative pain and complications, improved recovery, shorter hospital stays, more rapid return to normal activities, and significant cost savings. Cardiorespiratory changes associated with laparoscopy include those associated with tilting the patient to facilitate instrumentation and surgical exposure, and pressure effects of the instilled gas into peritoneum. Endoscopic surgery also involves complications, Risks Associated with Laparoscopic Surgery especially when extended periods of carbon dioxide insufflation are used, and especially with the patient in the steep head-down position.

In such circumstances, adverse haemodynamic and respiratory effects are more prone to occur. Traumatic injuries associated with blind trocar insertion may injury viscera and blood vessels, leading to severe hemorrhage and morbidity. Depending on the surgeon's experience, the anesthesiologist should anticipate the possibility of significant bleeding and/or conversion to an open procedure. Laparoscopy patients should undergo a preoperative evaluation identical to that of patients undergoing the comparable open procedure. When laparoscopic procedures are performed in an ambulatory setting, the choice of induction and maintenance anesthetic agents reflects the need for prompt awakening and rapid recovery.

In the anesthetic management of laparoscopic surgery, hemodynamic changes may occur due to the pneumoperitoneum and/or patient's position. In laparoscopic surgery, N2O is often avoided, to prevent bowel distension if the procedure becomes prolonged. A continuous infusion of bupivicaine via epidural catheter or IV remifentanil or esmolol may suppress the cardiovascular changes caused by the pneumoperitoneum during laparoscopic surgery. In laparoscopic surgery, no ventilation technique has proved to be clinically superior to any other. Both conventional volume-controlled ventilation and pressure-controlled ventilation have been found to be equally suited for use in patients undergoing laparoscopic gynaecologic surgery. Prophylactic antiemetics should be used to prevent PONV after LC, especially in female patients. The death rate during operative laparoscopy is 0.1 to 1 per 1000 cases and the incidence of hemorrhage and visceral injury (the most lethal complications of laparoscopic surgery) is 2 to 5 per 1000 cases. Good surgical technique and early recognition and management of such cases are keys to prevent complications due to laparoscopy. Experience and skill of the anaesthesia and surgical teams continue to be key factors to ensure optimal result.

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