ANESTHESIA FOR LAPAROSCOPIC SURGERY

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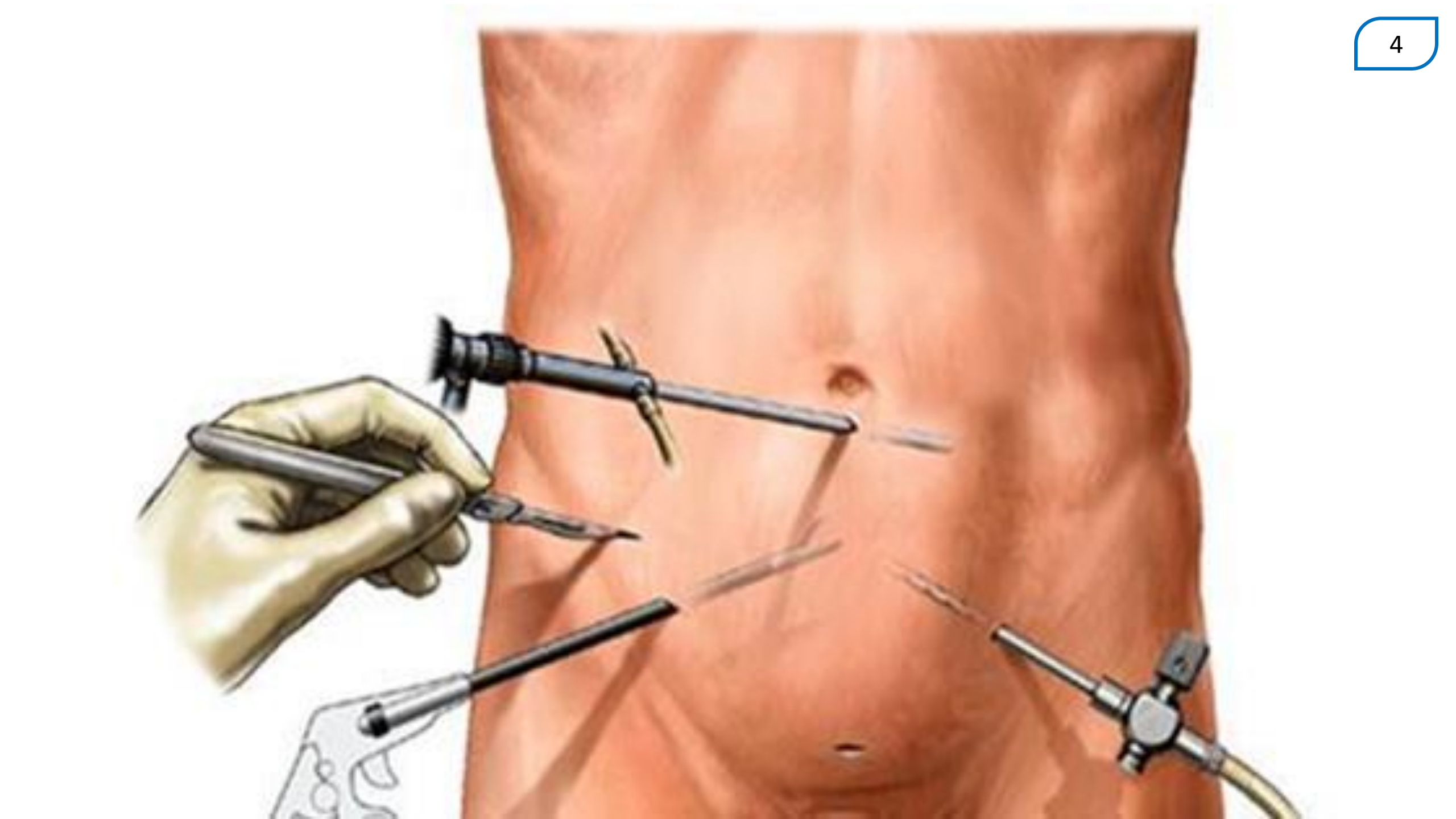
Fifth Lecture

Introduction :

Laparoscopy is the visualisation of the abdominal cavity through an endoscope. The laparoscopic approach has become a standard of care for many abdominal surgical procedures. It is a minimally invasive procedure Eg: appendectomy, inguinal hernia surgery, upper abdomen surgery, gynaecological procedures, urological procedures.

Advantages :

- Minimizes surgical incision and stress response .
- Decreases postoperative pain and opioid requirements.
- Earlier ambulation.
- Shorter hospital stays.
- Early return to normal activities and work.
- Earlier return of bowel function.
- Can be performed in wide range of patients.
- Reduces health costs.



Limitations :

- Reduced range of motion and instrument dexterity
- Two-dimensional view of the operative field
- Physiologic changes
- Extreme positions
- New complications

SURGICAL TECHNIQUES :

- Intraperitoneal insufflation of CO_2 to create pneumoperitoneum
- Carbon dioxide is used because it is noncombustible and more soluble in blood Vs (N_2O or Helium)
- An abdominal wall lift system (gasless laparoscopy):
- Avoids the cardiopulmonary effects of CO_2 pneumoperitoneum
- Very difficult in obese patients
- Provides a tent like working space limited to specific quadrant
- Increases operating times and surgical costs
- The initial access necessary for CO_2 insufflation could be achieved either through

SURGICAL TECHNIQUES :

- A blind insertion of a Veress needle
- A trocar inserted under direct vision.
- Upon confirmation of appropriate placement, a variable flow electronic insufflator that automatically terminates gas flow at a preset intraabdominal pressure (IAP) is used to achieve pneumoperitoneum.
- It is standard of care to maintain the IAP below 15 mm Hg
- A video laparoscope, inserted through the port, allows visualization of the operative field.

PHYSIOLOGIC EFFECTS :

Cardiovascular Effects :

The hemodynamic changes during laparoscopy are due to:

- The mechanical and neuroendocrine effects of pneumoperitoneum
- The effects of absorbed CO2
- Patient positioning
- Patient factors such as cardiopulmonary status and intravascular volume
- The type of surgical procedure

PHYSIOLOGIC EFFECTS :

Cardiovascular Effects :

- **These effects are:**

♦ Increased SVR and MAP

♦ Variable change (increased or no change) in cardiac filling volumes

♦ Variable change (decreased or no change) in cardiac index

♦ Cardiac dysrhythmias (brady or tachycardia)

PHYSIOLOGIC EFFECTS :

Pulmonary Changes :

- Diaphragm elevated
- Decreased lung volumes
- Decreased lung compliance
- Uneven gas distribution
- Cephalad displacement of carina

PHYSIOLOGIC EFFECTS :

Splanchnic, Renal, Cerebral and Intraocular :

- Increased cerebral perfusion and intracranial pressure
- Decreased splanchnic blood low
- Reduced renal perfusion and urine output
- Decreased femoral vein low
- Increase in intraocular pressure

ANESTHETIC MANAGEMENT :

Preoperative Assessment :

- A full preoperative assessment should be carried out
- Careful attention should be paid to the cardiovascular and respiratory systems
- The probability of conversion to an open procedure should be considered when choosing the anaesthetic technique
- Pneumoperitoneum is undesirable in patients with increased ICP and in patients with ventriculo peritoneal shunts
- Glaucoma is a contraindication to laparoscopic pelvic procedures

Intra-op Management :

Choice of Anesthesia :

Regional anesthesia :

Shorter laparoscopic procedures, such as diagnostic laparoscopy,

which requires lower IAP and minimal head down tilt

Intra-op Management :

Choice of Anesthesia :

General anesthesia :

Balanced general anesthesia with tracheal intubation and mechanical ventilation with acceptance of higher end tidal carbon dioxide levels remains the best practice for minimally invasive surgical procedures.

Intra-op Management :

Airway and Induction :

♦ Placement of a cuffed oral tracheal tube (COTT), neuromuscular relaxation, and positive pressure ventilation.

♦ Bag and mask ventilation before intubation should be minimized to avoid gastric distension and the insertion of a nasogastric tube may be required

♦ Use of LMA is controversial due to increased risk of aspiration and difficulties encountered when trying to maintain gas transfer while delivering the higher airway pressure required during pneumoperitoneum

♦ Propofol is considered the sedative–hypnotic drug of choice for induction of anesthesia

Intra-op Management :

Maintenance of Anesthesia :

- Best with newer inhaled anesthetics
  - Ease of titratability
  - Exert some neuromuscular blocking effect
  - Provide faster emergence as compared to TIVA
- Nitrous Oxide
  - Has amnestic and analgesic properties, as well as it reduces the requirements of inhaled and intravenous anesthetic drugs and facilitate recovery.
  - However, its use during laparoscopic procedures has been controversial as a result of concerns regarding its ability to diffuse into bowel lumen, causing distension and impaired surgical access as well as increased PONV

Intra-op Management :

Analgesia :

- Opioids remain an important component of a balanced general anesthetic technique
- But opioids should be used sparingly because of concerns of opioid related adverse effects
- The use of regional techniques such as subdural, epidural, and transversus abdominis plane block, can be utilized as opiate-sparing techniques, particularly in laparoscopic techniques where larger incisions are required.
- Wound infiltration with local anesthetic and intraperitoneal levobupivacaine reduces postoperative pain and opiate requirements.
- Dexamethasone has also been suggested before induction to reduce subsequent opiate analgesia requirements

Intra-op Management :

Fluid Management :

- Remains one of the most controversial topics in perioperative management.
- Maintenance of optimal intravascular volume or cardiac filling is critical in improving perioperative outcomes
- Intraoperative fluid therapy should be specific to patient characteristics and the type of surgical procedure.
- Traditional indicators used to guide fluid therapy (e.g., HR, BP, CVPs, and urine output) are not reliable.
- Dynamic indicators, such as stroke volume or systolic or pulse pressure variation, are preferred

Intra-op Management :

Nausea and Vomiting Prevention :

- ♦ Patients undergoing laparoscopic surgery are at a greater risk for PONV
- ♦ Aggressive multimodal antiemetic prophylaxis is necessary in this high-risk population.
- ♦ Dexamethasone at induction and 5-HT3 antagonists at the end of surgery
- ♦ Optimal hydration, minimal opioid use, and aggressive pain control

Intra-op Management :

ANESTHETIC MANAGEMENT :

Postoperative Considerations :

Pain :

- ♦ Compared to open surgical procedures, pain after laparoscopic procedures is considered to be less intense and of shorter duration.
- ♦ Pain will usually be maximal during the first 2 h post-procedure and a prolonged duration of significant discomfort is rare.
- ♦ Postoperative shoulder-tip pain after laparoscopic surgery is common but may be reduced if the surgeon expels as much gas from the peritoneal cavity as possible
- ♦ Optimal pain therapy for patients undergoing laparoscopic includes the use of multimodal analgesia techniques.

ANESTHETIC MANAGEMENT :

Postoperative Considerations :

Pulmonary :

- Many studies report a lower incidence of pulmonary complications after laparoscopic approach as compared with open procedures.
- In patients with significant respiratory dysfunction and restricted CO2 clearance, impaired postoperative ventilation from residual anesthetics and neuromuscular blockade in the immediate postoperative period may delay removal of absorbed CO2 and cause significant hypercapnia.

ANESTHETIC MANAGEMENT :

Postoperative Considerations :

Venous thrombosis :

♦ Increased IAP and reverse Trendelenburg position have been reported to cause venous stasis that could increase the potential for deep vein thrombosis and pulmonary embolism

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

- Those related to creation CO2 pneumoperitoneum
- Surgical instrumentation
- Patient positioning

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Hemodynamic Complications :

Bradyarrhythmias :

- attributed to increased vagal tone following peritoneal stretching

Tachyarrhythmias :

- may be due to hypercapnia as a result of intraperitoneal CO2 insufflation.
- Alterations in arterial blood pressure
- Although rare, acute cardiovascular collapse can occur

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Treatment of Hemodynamic Complications :

- Confirm that the IAP has not exceeded 15 mm Hg
- Rule out vascular injuries
- Supportive therapy including
- Reduction in anesthetics,
- Fluid administration, and
- Pharmacologic interventions

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Pulmonary Complications :

Hypoxemia :

- Patient related factors
- Low inspired oxygen concentrations
- Hypoventilation
- Ventilation–perfusion mismatch :
  - Endobronchial intubation
  - Atelectasis
  - Capno(pneumo)thorax
  - Pulmonary embolization
- Reduced cardiac output
- Anemia

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Pulmonary Complications :

Hypercarbia :

- Increased CO2 absorption
- Decreased alveolar ventilation
- Increased carbon dioxide production :
  - Obesity, malignant hyperthermia, fever, thyrotoxicosis
- Rebreathing of carbon dioxide :
  - Defective carbon dioxide absorber
  - Malfunctioning valves

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Cardiopulmonary Complications :

Prevention :

- Use lower intraabdominal pressure (10–12 mm Hg).
- Limit position change.
- Early use of vasodilators and betablockade to control hypertension.
- Monitoring :
  - Arterial line for continuous blood pressure.
  - Hemodynamic monitoring using pulse contour analysis.
  - Transesophageal echocardiography.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Subcutaneous Emphysema :

- Can occur from inadvertent extraperitoneal insufflation in the subcutaneous, preperitoneal, or retroperitoneal tissue
- Can involve the abdomen, chest, neck, and groin.
- The CO2 can track to the thorax a mediastinum, thereby resulting in capnothorax or capnomediastinum.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Subcutaneous Emphysema :

- Predictors of subcutaneous emphysema include :
  - operative time of >200 minutes and
  - use of six or more surgical ports
- In most cases, no specific intervention is required, and the subcutaneous emphysema resolves soon after the abdomen is deflated.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Capnothorax :

- Rare, it is a potentially life-threatening complication.
- It is most common in procedures near the diaphragm.
- Causes :
  - Inadvertent peritoneal breach.
  - Misdirected Veress needle.
  - Gas tracked through facial planes from the neck and thorax into the mediastinum and pleural space.
  - Passage of gas through the pleuroperitoneal hiatus.
  - Passage of gas through congenital defects (foramen of Morgagni).

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Capnothorax :

Diagnosis :

- High index of suspicion.
- Increased ETCO2 and reduced ETCO2 with hypotension.
- Decreased oxygen saturation.
- Increased peak airway pressures.
- Hypotension.
- Unequal chest expansion and air entry.
- Bulging of hemidiaphragm seen through the endoscope.
- Conirmed on thoracic ultrasound and/or chest xray.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Capnothorax :

Management :

- ♦ Stop surgery and deflate the pneumoperitoneum.
- ♦ Continue supportive treatment with hyperventilation and positive end expiratory pressure.
- ♦ Treat according to the severity of cardiopulmonary compromise :
  - Minimal compromise—treat conservatively with close observation.
  - Moderate to severe compromise—place intercostal cannula or temporary drain.
  - Reaccumulation of capnothorax—place chest drain.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Hypothermia :

♦ The incidence of hypothermia during laparoscopic procedures is similar to that of open abdominal operations.

♦ Heat loss during laparoscopy occurs mainly by convection :

- Dry CO_2 exiting the cylinder at 21°C and being insufflated into a peritoneal cavity with a large surface area.

- Therefore, heating and humidifying CO_2 to a physiologic condition has been proposed, particularly in prolonged surgical procedures.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Related with Positioning :

♦ Laparoscopic surgery often involves the extremes of the Trendelenburg or reverse Trendelenburg position with significant physiological effects.

♦ Trendelenburg position may lead to

- Facial, pharyngeal, and laryngeal edema, which might lead to upper airway obstruction including laryngospasm.
- Ischemic optic neuropathy and postoperative blindness
- Brachial plexus injury

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Related with Positioning :

- Well leg compartment syndrome' is a rare syndrome induced by the combination of impaired arterial perfusion to raised lower limbs, compression of venous vessels by lower limbs supports, and reduced femoral venous drainage due to the pneumoperitoneum.

♦ In the reverse Trendelenburg position, the extreme 'head-up' posture results in reduced venous return, leading to hypotension and potentially myocardial and cerebral ischemia

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Complications from surgical instrumentation:

♦ Injury of major intraabdominal vessels (i.e., aorta, common iliac vessels, or inferior vena cava)

♦ Uncontrollable hemorrhage requires immediate conversion to an open procedure to control bleeding and repair the vascular injury.

♦ Gastrointestinal tract perforations, hepatic and splenic tears, and mesenteric lacerations.

♦ Bladder or ureter injury

- Bladder injury may be suspected by sudden deflation of the abdomen, pneumaturia (gas bubbles in the urinary bag), and hematuria.

ANESTHETIC MANAGEMENT :

INTRAOPERTIVE COMPLICATIONS :

Complications from surgical instrumentation:

Prevention :

- Placement of the Veress needle and trocars using a minilaparotomy approach
- Stomach injuries can be reduced by gastric decompression prior to surgery
- Bladder decompression

ANESTHETIC MANAGEMENT :

Laparoscopic Procedures During Pregnancy :

- Laparoscopy can be safely performed during any trimester of pregnancy when operation is indicated
- Gravid patients beyond the first trimester should be placed in the left lateral decubitus position or partial left lateral decubitus position to minimize compression of the vena cava
- CO2 insufflation of 10-15 mmHg can be safely used for laparoscopy in the pregnant patient. The level of insufflation pressure should be adjusted to the patient's physiology

ANESTHETIC MANAGEMENT :

Laparoscopic Procedures During Pregnancy :

♦ Intraoperative and postoperative pneumatic compression devices and early postoperative ambulation are recommended prophylaxis for deep venous thrombosis in the gravid patient

♦ Fetal heart monitoring of a fetus considered viable should occur preoperatively and postoperatively in the setting of urgent abdominal surgery during pregnancy

♦ Tocolytics should not be used prophylactically in pregnant women undergoing surgery but should be considered perioperatively when signs of preterm labor are present