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# JJMMC, DAVANGERE

## Anesthesia for laproscopic surgeries


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# Overview



- Introduction & History.
- Definition, IAP.
- Risks & Benefits.
- Alteration in physiology (System wise).
- Associated complications & treatment.
- Effect of position.
- Conduct of anaesthesia.
- Conclusion.

# Introduction

- Laparoscopic techniques offer shorter in-patient stay and reduced perioperative morbidity.
- risks associated with individual laparoscopic techniques or due to the physiological changes associated with the creation of a pneumoperitoneum.
- anesthetic techniques for laparoscopic surgery must be refined to anticipate these differences from open surgery.

# History




- traced back to the tenth century A.D
- Arabian physician Abulkasim(936 – 1013) used reflected light to inspect cervix.
- The term “laparoscopy” was coined by a Swedish physician Hans Christian Jacobaeus
- Richard Zollikofer of Switzerland promoted the use of Carbon dioxide for insufflating peritoneum.



# DEFINITION

- Laparoscopy is a “minimally invasive” procedure allowing endoscopic access to the peritoneal cavity after insufflation of a gas to create space between the anterior abdominal wall and the viscera.
- The space is necessary for safe manipulation of instruments and organs.

# What all gases can be used?



- *Air, oxygen, carbon dioxide, argon and heliu*
- *ideal gas for insufflation should be nontoxic, colourless, readily soluble in blood, easily ventilated through lungs, nonflammable and inexpensive*
- *most widely used gas for insufflation-CO2*

# Gasless laparoscopy….?

- Peritoneal cavity is expanded using abdomin wall lift obtained with a fan retractor.
- Gasless laparoscopy compromises surgical exposure and increases technical difficulty.
- Appealing for patients with severe cardiac or pulmonary disease.



# Intra-abdominal pressure(IAP)

- IAP is the steady pressure within the closed abdominal cavity.
- normal values of IAP are 0-5 mmHg.
- values more than 12-14 mmHg compromises venous return.
- Initial flow : 4-6 L/min.
- Maintenance : 200-400 ml/min.



## What are the benefits of laparoscopy?




- shortened recovery time and reduced mo
- reduced manipulation of the bowel and peritoneum, decreased incidence of postoperative ileus, early enteral intake and decreased requirements for iv fluids.

# Benefits cont'd….




- laparoscopic wounds are smaller when compared to open techniques.
- complications associated with postoperative pain and wound healing will be minimal.
- Particularly useful in obese patients in whom open procedures would be technically challenging.

# Are there any risks?




- Damage to solid viscera, bowel, bladder or blood vessels due to surgical instuments.
- Vascular injuries of large vessels.
- Venous gas embolism can result in catastrophic circulatory collapse.
- severity depends on the volume of CO2 injected, rate of injection, patient position, and type of laparoscopic procedure.




# Risks cont'd…..

- Pnuemoperitoneum can cause ventilation-perfusion mismatch.
- 'well leg compartment syndrome'.
- lower limb pain, rhabdomyolysis, and potentially myoglobin-associated acute renal failure.

# What happens on creating a pneumoperitoneum?



- As the volume of the abdomen increases, abdominal wall compliance decreases and intra-abdominal pressure (IAP) climbs.
- When the IAP exceeds physiological thresholds, blood flow in individual organ systems become compromised, potentially increasing patient's morbidity and mortality.

# What are the hemodynamic effects of pnuemoperitoneum in CVS?





# So what can be done?....

- Reduction in venous return and cardiac output can be attenuated by increasing circulating volume before the pneumoperitoneum is produced.
- Increased filling pressures can be achieved by fluid loading or tilting the patient to a slight head-down position before peritoneal insufflation.
- Pneumatic compression device & elastic bandages prevents pooling.

# What are the hemodynamic repercussions in cardiac patients?



- Patients (ASA class III or IV) who are volume depleted experience the most severe hemodynamic changes.
- Preoperative preload augmentation offsets the hemodynamic effect of pneumoperitoneum.
- Intravenous nitroglycerin, nicardipine, or dobutamine has been used to manage the hemodynamic changes induced by increased IAP.

# Reasons for arrythmias during laparoscopy….



1. Reflex increases of vagal tone may result from sudden stretching of the peritoneum.
2. Hypercarbia & hypoxia.
3. Gas embolism.
4. Lighter planes of anaesthesia.
5. Volatile anaesthetics

- Treatment consists of interruption of insufflation, atropine administration, inj. Lignocaine, Amiodarone and deepening of anesthesia after recovery of the heart rate.

# What are the effects of pneumoperitoneum on respiratory system?



- Limitation of diaphragmatic and anterior abdominal wall movement causes decreased lung volumes, atelectasis and dead space ventilation.
- Functional residual capacity (FRC), already reduced by induction of general anesthesia, decreases even further, by 20 to 25 per cent, 5 min after abdominal insufflation.

# Cont'd



- Respiratory compliance decreases by 30 to 50% in healthy individuals.
- The respiratory resistance increases due to an increase in lung and chest wall resistance.
- Approximately 15 min after abdominal deflation, respiratory compliance and resistance return to pre-insufflation level.

# Cont'd



- Healthy patients tolerate pneumoperitoneum well, despite the respiratory changes.
- In obese, ASA III to IV patients and patients with pulmonary disease, superimposed pnuemoperitoneum could produce deleterious effects in pulmonary mechanics.

# Effect of pnuemoperitoneum on $PaCO_2$?



- $CO_2$ is absorbed from the peritoneal cavity and carried by blood through the systemic and portal veins and excreted via the lungs.
- Pneumoperitoneum increases pulmonary excretion of $CO_2$ ($VCO_2$) and $PaCO_2$.
- High increase in $VCO_2$ and $PaCO_2$ does not happen because of impaired peritoneal perfusion due to haemodynamic changes and enormous buffering capacity of the blood.

## $PaCO_2$..... Cont'd



- under general anesthesia, $PaCO_2$ progressively increases and reaches a plateau 15 to 30 min after beginning of $CO_2$ insufflation.
- the main mechanism of the increased $PaCO_2$ during $CO_2$ pneumoperitoneum is absorption of $CO_2$ rather than the mechanical ventilatory repercussions of increased IAP.
- Correction of increased $PaCO_2$ can be achieved by a 10% to 25% increase in alveolar ventilation.

# What is the role of Capnography during laparoscopy




- It serves as a non-invasive monitor of $PaCO_2$ during $CO_2$ insufflation.
- helps in detection of accidental intravascular insufflation of $CO_2$.
- $EtCO_2$ increases in Endo-Bron.Intubation, Sub. Cut.emphysema & capnothorax and decreases in Pneumothorax & $CO_2$ embolism.

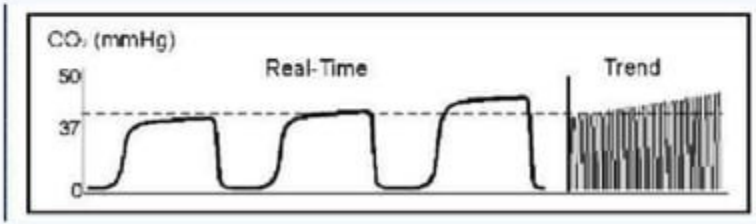
# Capnography during laparoscopy…




- Mean gradients ($\Delta a\text{-}EtCO_2$) do not change significantly during peritoneal insufflation of $CO_2$.
- lack of correlation between $PaCO_2$ and $EtCO_2$ is seen particularly in those with impaired $CO_2$ excretion capacity, and cardiopulmonary disturbances.

# Cont'd

- Hypercapnia can develop, even in the absence of abnormal $EtCO_2$.
- Postoperative intra-abdominal $CO_2$ retention can result in increased respiratory rate and $EtCO_2$ of patients breathing spontaneously.



# What are the physiological effects of carbon- dioxide?



- In awake, healthy individuals, breathing a g mixture containing $CO_2$ produces a feeling discomfort, acute distress with disorientation, dyspnea and anxiety.
- Narcosis occurs with a $PaCO_2$ greater than 90 mmHg.

# Physiological effects of carbon-dioxide cont'd…..



- 10-15 minutes after $CO_2$ insufflation due to reflex vasodilatation, an increase in ICP is seen.
- For each 1mmHg increase in $PaCO_2$, CBF increases 1.8ml/100g/min and cerebral volume increases 0.04ml/100gm.

# Physiological effects of carbon-dioxide cont'd…..



- $PaCO_2$ level has the regulatory effect on ventilation via central & peripheral chemoreceptors.
- The activation of receptors in the chemosensitive area results in stimulation of the inspiratory center.
- The chemosensitive area, located in the ventral surface of medulla, is extremely sensitive to hydrogen ions.

# Physiological effects of carbon-dioxide cont'd…..



- $CO_2$, which easily crosses the blood-brain barrier, indirectly controls inspiratory centre by formation of carbonic acid, which dissociates to produce $HCO_3^-$ and $H^+$ & increase in the rate of respiration.
- The maximal stimulation is attained at a $PaCO_2$ level of about 100 mmHg. Any further increase results in respiratory depression.

# Physiological effects of carbon-dioxide cont'd…..



- $CO_2$ produces excitation of the sympathetic nervous system
- High levels of $CO_2$ influence the release of catecholamines from the adrenal medulla.

# Physiological effects of carbon-dioxide cont'd…..

- The cardiovascular effects of hypercarbia are the result of a balance between the direct cardiodepressant effect of $CO_2$ and increased activity of the sympathetic nervous system.
- Activation of the sympathetic nervous system by $CO_2$ in healthy individuals overcompensates for direct cardiodepression.



# Respiratory Complications:

## 1) $CO_2$ Subcutaneous Emphysema



- Accidental extraperitoneal insufflation.
- Any increase in $ETCO_2$ occurring after $ETCO_2$ has plateaued should suggest this complication.

# $CO_2$ Subcutaneous Emphysema cont'd….



- Temporarily STOP….!
- subcutaneous emphysema readily resolves once insufflation has ceased.
- resumed after correction of hypercapnia using a lower insufflation pressure.

# Respiratory Complications:

## *2) Pneumothorax, Pneumomediastinum, Pneumopericardium*



- **peritoneal cavity ---potential channels--- pleural and pericardial sacs.**
- **Defects in the diaphragm or weak points in the aortic and esophageal hiatus allow gas passage into the thorax.**
- **pleural tears occurs during laparoscopic surgical procedures at the level of the gastroesophageal junction.**

## ***Pneumothorax, Pneumomediastinum, Pneumopericardium cont'd……***



- For diffusible gas such as $CO_2$ without associated pulmonary trauma, spontaneous resolution of the pneumothorax occurs within 30 to 60 minutes.
- For capnothorax, treatment with positive end-expiratory pressure (PEEP) is an alternative to chest tube placement.
- If pneumothorax is secondary to rupture of preexisting bullae, thoracocentesis is mandatory.

# Respiratory Complications:

*3)Endobronchial Intubation*



- cephalad movement of the carina & diaphrag during pneumoperitoneum, leads to endobronchial intubation.
- Oxygen saturation decreases as measured by pulse oximetry ($Spo_2$) associated with an increase in plateau airway pressure & increase in $EtCO_2$ .

# Respiratory Complications:

## 4) Gas Embolism




- most feared and dangerous complication of laparoscopy.
- Early events, occurring with 0.5 mL/kg of air or less, include changes in Doppler sounds and increased mean pulmonary artery pressure.
- lethal dose of embolized $CO_2$ is approximately five times greater than that of air.

# Gas embolism cont'd…..




- Events occurring with 2 mL/kg of air include, tachycardia, cardiac arrhythmias, hypotension, increased central venous pressure, alteration in heart tones (i.e., millwheel murmur), cyanosis, and electrocardiographic changes of right-sided heart strain.
- Pulmonary edema can also be an early sign of gas embolism.

# How to diaganose gas embolism?

- Capnography is more valuable in providing early diagnosis of gas embolism. $Et_{CO_2}$ decreases in the case of embolism.
- $\Delta a\text{-}EtCO_2$ increases.
- Pulse oximetry is also helpful in recognizing hypoxemia.
- Aspiration of gas or foamy blood from a central venous line establishes the diagnosis.

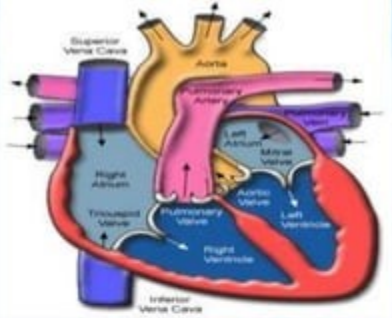


# How to treat gas embolism?



- Immediately stop insufflation and release the pneumoperitoneum.
- ventilate with 100% oxygen.
- patient is placed in steep head-down and left lateral decubitus (Durant) position.

# How Durant position helps?




- Head-down position keeps a left-ventricular air bubble away from the coronary artery ostia (which are near the aortic valve) so that air bubbles do not enter and occlude the cornonary arteries.
- Left lateral decubitus positioning helps to trap air in the non-dependent segment of the right ventricle, preventing it entering the pulmonary artery & also prevents the air from passing through a patent foramen ovale.



# Treatment of gas embolism cont'd…

- A central venous or pulmonary artery catheter may be introduced for aspiration of the gas.
- External cardiac massage may be helpful in fragmenting $CO_2$ emboli into small bubbles.
- Cardiopulmonary bypass of blood has been used successfully to treat massive $CO_2$ embolism.
- Hyperbaric oxygen treatment should be strongly considered if cerebral gas embolism is suspected.

# Respiratory Complications:

## *5) Aspiration of Gastric Contents*



- Patients undergoing laparoscopy is at more risk.
- However, the increased IAP results in changes of the lower esophageal sphincter that allow maintenance of the pressure gradient across the gastroesophageal junction and that may therefore reduce the risk of regurgitation.
- Head-down position helps to prevent any regurgitated fluid from entering the airway.

# What are the effects of pneumoperitoneum on CNS physiology?



- elevated IAP causes an increase in intra-cerebral pressure (ICP) by limiting cerebral venous drainage.
- the increase in ICP may lead to cerebral oedema
- clinical studies have suggested that cerebral perfusion pressure is maintained by the increase in mean arterial pressure that occurs with elevated IAP.

# Effect of pneumoperitoneum on CNS physiology cont'd….



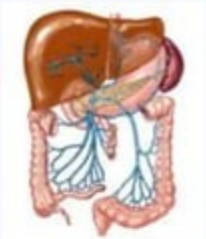
- Temporary neurological dysfunction that patients often experience on emergence from prolonged laparoscopic procedures, particularly those requiring extended periods of steep Trendelenburg positioning is due to cerebral oedema.

## What are the effects of pneumoperitoneum on Renal physiology?



- An IAP of 20 mm Hg will reduce GFR by 25%.
- Mechanism for this is postulated to be an impaired renal perfusion secondary to the combined effect of reduced renal afferent flow due to impaired cardiac output and reduced efferent flow due to raised renal venous pressure.
- Diminished RBF is a potent trigger for RAAS.

# Effect of pneumoperitoneum on splanchnic physiology



- Initially with an IAP <10 mmHg venous return from splanchnic vessels increase leading to a transient increase in Cardiac output.
- Persistent IAPs over 20 mm Hg will cause a reduction in mesenteric and gastrointestinal mucosal blood flow by up to 40% with progressive tissue acidosis.

# What are the problems with positioning during laparoscopy?



- Extreme positions place the patient at risk of movement on the table.
- patient should be securely positioned with vulnerable pressure points and eyes being protected throughout the procedure.
- No significant changes in shunt fraction or dead space ventilation occurs even in a $10^0$ - $20^0$ head up or head down position.

# Problems due to positioning cont'd….



- In trendelenburg position functional residual capacity and ventilation-perfusion (V/Q) mismatch are worsened.
- with cephalic movement of the lungs, the tracheal tube may migrate endobronchially.
- Prolonged steep Trendelenburg position increases the risk of cerebral oedema and upper airway oedema which may present with stridor after operation..

# Problems due to positioning cont'd….



- Nerve compression due to overextension of the arm must be avoided.
- Shoulder braces should be used with great caution and must not impinge the brachial plexus.

# Problems due to positioning cont'd….



- '**well leg compartment syndrome**'.
- compartment syndrome of the lower limbs presents after operation with disproportionate lower limb pain, rhabdomyolysis, and potentially myoglobin-associated acute renal failure leading to significantly increased morbidity and mortality.

# Positioning cont'd….



- Risks may be mitigated by moving the patient's legs at regular intervals during surgery, and using heel/ankle supports instead of calf/knee supports (Lloyd–Davies stirrups).
- A pulseoximeter can be placed on the great toe throughout surgery to assess the adequacy of pulsatile flow to distal areas of the lower limbs.

# Positioning cont'd….



- In the reverse Trendelenburg position, the extreme 'head-up' posture results in reduced venous return, leading to hypotension and potentially myocardial and cerebral ischaemia.
- Particularly vulnerable are the elderly, hypovolaemic patients, and those with pre-existing ischaemic heart disease or cerebrovascular disease.

# Conduct of anaesthesia



- The most common technique used for laparoscopic surgeries is General anaesthesia.
- protects against gastric acid aspiration, allows optimal control of $CO_2$, and facilitates good surgical access.

# Pre-anaesthetic check up



- Pneumoperitoneum stresses cardiovascular and respiratory system more.
- Lee cardiac risk index can be used for quantification of cardiac risk.
- For patients with heart disease the postoperative benefits of laparoscopy must be balanced against the intraoperative risks.

# Pre-anaesthetic check up

- In a patient with poor pulmonary reserve preoperatively like individuals with COPD more extensive preoperative evaluation including PFT is advisable.
- Pulmonary function tests (PFT) identify patients who are likely to experience hypercarbia and acidosis.



# Pre-medication



- **Anxiolytics**

Inj. Midazolam 1-2 mg iv.

- **Antiemetic**

Inj. Promethazine 12.5-25 mg im.

Inj. Ondansetron 4 mg iv.

Inj. Ramosetron 0.3mg iv.

# Pre-medication cont'd..



- **Antacids**

Inj. Ranitidine 50 mg iv.

Inj. Pantoprazole 40 mg iv.

- **Pro-kinetic drugs**

DM & Pregnancy.

Inj. Metoclopromide 10 mg iv.

- **Preemptive analgesia with NSAIDs.**
- **Atropine to prevent vagally mediated bradyarrhythmias.**

# Monitoring

## 1.Routine Patient Monitoring Include

- *Continuous ECG*
- *Intermittent NIBP*
- *Pulse oximetry (SpO2)*
- *Capnography (EtCO2)*
- *Temperature*
- *Intraabdominal pressure*

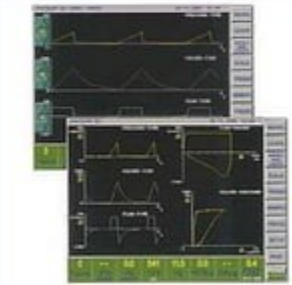



## 2. Optional Monitoring Include

- *Pulmonary airway pressure*
- *Oesophageal stethoscope*
- *Precordial doppler*
- *Transoesophageal echocardiography*

# Monitoring cont'd…..

- Effects of pneumoperitoneum on the respiratory system can be assessed using by information available on work stations such as peak and plateau airway pressures, delivered tidal volumes, and observing dynamic  flow-volume loops.



# Monitoring cont'd….

- Pressure-based indices of preload such as central venous pressure may be misleading while commercially available minimally invasive devices such as the oesophageal Doppler monitor may provide more accurate assessments of preload.

# G.A. for laproscopic surgery



- bag and mask ventilation before intubation should be minimized to avoid gastric distension.
- insertion of a nasogastric tube may be required to deflate the stomach-improve surgical view, avoid gastric injury on trochar insertion.

# Induction



- Propofol : 2-2.5 mg/kg.
- Thiopentone : 4-6 mg/kg.

Advantages of propofol:

1. significantly quicker recovery
2. an earlier return of psychomotor function compared with thiopental or methohexital.
3. incidence of nausea and vomiting is markedly less than other IV anaesthetics.
4. because of its pharmacokinetics, it is superior to barbiturates for maintenance of anaesthesia

# Induction



- Midazolam : 0.1- 0.2 mg/kg.
- Midazolam is safe and effective for induction even in patients with severe aortic stenosis.
- Etomidate : 0.3-0.45 mg/kg.
- Good choice in cardiac patients as there is no change in HR, MAP, PCWP, CVP, SV, CI, PVR & SVR.

# Inhalational agents



- Maintaining deep level of anaesthesia with agents like Halothane, Isoflurane & Sevoflurane blunt the haemodynamic response to pneumoperitoneum.
- Nitrous oxide causing nausea & vomiting is controversial. But it may distend the bowel, in patients with intestinal obstruction.
- Once adequate depth of hypnosis is achieved, use of vasoactive drugs such as esmolol or labetalol may be more appropriate to treat hypertension.

# Muscle relaxants

- Prevents high intra-abdominal and intra-thoracic pressures due to pneumoperitoneum.
- Decreases PIP, thereby minimizing effects on haemodynamics, risk of pneumothorax and respiratory dead space.
- Muscle paralysis reduces the IAP needed for the same degree of abdominal distention.

# G.A. for laproscopic surgery cont'd…

- Succinylcholine 1-2mg/kg iv.
- Non depolarizing muscle relaxants

Vecuronium 0.04-0.05mg/kg or Atracurium: 0.5mg/kg,
Rocuronium: 0.6-1mg/kg iv.

- **Reversal :**
  - Inj. Neostigmine : 0.05 mg/kg IV
  - Inj. Glycopyrolate : 0.01 mg/kg IV

# Intra operative complications

- Injury from surgical instruments.
- Arrythmias
- Congestive cardiac failure & cardiac arrest.
- Gas embolism.
- Pneumothorax & pneumopericardium.
- Subcutaneous emphysema.
- Gastric aspiration.



# Use of L.M.A



- remains controversial.
- There is increased risk of aspiration.
- Difficulties are encountered when trying to maintain effective gas transfer while delivering higher airway pressures required during pneumoperitoneum.

# Use of Proseal LMA



- Several randomized controlled trials assessing the use of Proseal LMA (PS-LMA) vs COTT, with data advocating the use of PS-LMA as effective and efficient for pulmonary ventilation in laparoscopic surgery has been published.

# Pressure control Vs volume control..



- The use of pressure controlled modalities affords higher instantaneous flow peaks, minimizing peak pressures, and have been shown to provide improved alveolar recruitment and oxygenation in laparoscopic surgery.
- Volume control modalities use constant flow to deliver a pre-set tidal volume and ensure an adequate minute volume at the expense of an increased risk of barotrauma and high inflation pressures.

# About PEEP…

- Various studies support that a PEEP of 5 cm $H_2O$ should be considered essential during laparoscopic surgeries to decrease intraoperative atelectasis.
- Addition of titrated levels of PEEP can be used to minimize alveolar de-recruitment.
- But must be used cautiously as increasing PEEP may further compromise cardiac output.

# Analgesia




- Up to 80% of patients will require opioid analgesi at some stage perioperatively.
- Subdural, epidural, and more recently transversus abdominis plane block, are increasingly utilized as opiate-sparing techniques.
- Wound infiltration can be done with local anaesthetic.

# Antiemetics



- Laparoscopy is associated with high incidence of postoperative nausea and vomiting.
- This may worsen pain, and extend the period of hospital admission for patients.

# Antiemetics cont'd….



- General measures such as deflating the stomach, avoiding known emetogenic drugs and ensuring good quality postoperative analgesia decreases PONV.
- Multi-modal regime such as ondansetron, cyclizine, and dexamethasone seems effective.

# Regional anaesthesia in laproscopic surgery

- Epidural anaesthesia may be an alternative for general anaesthesia.
- It provides excellent postoperative analgesia and lower incidence of postoperative nausea and vomiting.
- In hyperbaric spinal anaesthesia the level of block can migrate in the cephalad direction, causing hypotension and bradycardia.

# Regional anaesthesia cont'd…

- Success with regional anaesthesia requires a relaxed and cooperative patient, a supportive staff and a skilled surgeon.
- However, laparoscopic procedures conducted under regional anaesthesia require expertise.

# Local anaesthesia in laproscopic surgeries

- Laproscopic hernia and some gynaecological procedures like laparoscopic sterilization can be performed under local anaesthesia.
- Some patients may not be able to relax the abdominal muscles because of discomfort from pneumoperitoneum and some would only tolerate a lower IAP (4-6 mmHg).
- May require deeper sedation or conversion to general anaesthesia.

# Postoperative management

- 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.
- This may be reduced if the surgeon expels as much gas from the peritoneal cavity as possible.

# Postoperative management

- All patients should receive supplemental oxygen.
- This helps to mitigate the effects of pneumoperitoneum on respiratory function.
- Alveolar recruitment techniques, using short-term continuous positive airway pressure or high flow oxygen delivery systems may be used.



# Conclusion

- Pre-op evaluation of cardio-pulmonary status.
- Slow insufflation with IAP 12-14 mmHg.
- Positioning.
- Intra-operative monitoring.
- Aware of intra-operative complications.
- The proportion of surgical cases performed laparoscopically will continue to increase and anaesthetists must safely manage the specific physiological alterations and challenges that laparoscopy presents.

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