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Era of Robotic Surgeries: Anaesthetic Considerations in Robotic Assisted Radical Prostatectomy

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Abstract
Robotic assisted radical prostatectomy is an emerging technique for the management of prostate carcinoma. The surgery requires steep trendelenburg position for a prolonged time and associated with wide range of physiological changes. Aim of this case report is to brief on thorough considerations of the risks, pre-operative preparation, intra-operative monitoring and post-operative follow-up which are necessary for the successful outcome of the robotic assisted surgeries.

Introduction

Over the two decades, the applications of robotics in urological surgeries have increased prodigiously. The potential advantages for patients include reduced pain, quicker recovery, shorter hospital stay, and smaller surgical incision.

The da Vinci Robotic surgical system comprises four components: a surgeon console; Endo Wrist instruments; Optical vision cart; Patient cart with four movable arms. The surgeon sits at the surgeon console and controls the Endo Wrist instruments that are attached to the patient cart. Anaesthesia personnel, surgical assistants, circulating nurses can see the procedure in the screen on the optical vision cart.

It requires pneumoperitoneum (12-15mmHg) in the steep trendelenburg position (30-40° head down). This position results in retraction of the bowel from the surgical field by the way of gravity and allows for an intra-abdominal workspace, which inturn causes many physiological changes.

The aim of this case report is to provide a brief background of the application of robotics in prostatectomy and its important implications for anaesthetists, as well as the unique challenges and complications associated with these procedures.

Case Report

A 65 year old male, Diabetic, Chronic smoker and obesity of class I, presented with LUTS – mild obstruction and decreased flow and further investigations revealed carcinoma prostate necessitating surgical removal. In pre-operative evaluation as patient falls under obese category he was evaluated for obstructive sleep apnoea, restrictive airway disease and difficult airway and advised cessation of smoking prior to surgery. Patient optimized under AHA/ACC guidelines because of the concerns of increased preload, afterload, elevated central venous pressure, pulmonary capillary wedge pressure, examined for glaucoma, corneal and conjuctival abrasion. Anxiety, Aspiration, Infection and Deep vein

thrombosis considered for which prophylactic measures were taken. Minimal starvation, oral carbohydrate drink and antibiotic initiation was ensured. Intra-operative period certain measures were taken during induction to alleviate drastic hemodynamic change, proper positioning to avoid neuropraxia, pneumatic compression device for DVT, restricted fluid therapy to avoid cerebral, vocal cord and facial edema. There was continuous neuromuscular monitoring to avoid sudden movement of the patient which might lead to severe injury to structures by the docked arms. Steps were taken to avoid hypercarbia, hypoxia, acidosis and hypothermia. Intra-operative period was uneventful. Factors contributing to post-operative respiratory distress such as stridor, laryngeal edema ruled out to avoid re-intubation. Strict post-operative nausea and vomiting prophylaxis was given and ensured adequate analgesia. Post-operative Atelectasis was taken care by early enforced mobilization, breathing exercises and Incentive spirometry. Early enteral nutrition helped in preventing paralytic ileus. Early removal of all tubes and drains were done. Assessed for neuropathies and adequate urine output to rule out acute kidney injury till post-operative day 3 and was discharged.

Discussion

Pre Operative Concerns

Cardiac Evaluation:

- Patient should be assessed for any cardiac symptoms, signs and metabolic equivalent of tasks.
- For accepting the patient for surgery, American Heart Association/ American College of Cardiology guidelines should be followed.
- Detailed evaluation of the medications taken. If patient is on beta-blockers, it should be continued.

Obesity:

- Height, weight and Basal metabolic index should be calculated. If BMI more than 30, accompanied physiological changes should be considered such as Obstructive Sleep Apnea, difficult intubation, restrictive pulmonary disease, difficult vascular access, delayed gastric emptying.

Pulmonary Evaluation:

- Should be assessed for associated lung conditions like bronchial asthma, tuberculosis or recurrent infections.
- History of smoking to be evaluated.

Neurological Evaluation:

- Should be assessed for raised intracranial pressure, as the position will accentuate it.
- For shunted patient, shunt patency should be assessed.

Ocular Assessment:

- In view of likely increase in intraocular pressure, patient should be evaluated for pre-existing ocular pathology.

Renal Assessment:

- As renal insufficiency is exacerbated due to patient positioning and fluid restriction, renal function should be optimized pre-operatively.

Gastro-Intestinal Risk:

- To minimize the regurgitation and to decompress bowel inorder to avoid fecal contamination, if injury occurs – laxatives or enema should be used.

Intra-Operative Concerns:

General Issues:

Adequate preparation before final positioning should be done as it is difficult to reposition after docking. Preparation such as,

- Endotracheal tube should be well secured with the circuit with adequate extension due to the risk of accidental extubation. In addition, steep trendelenberg position with CO2 pneumoperitoneum can reduce the length of the trachea. The distance from the vocal cord to the carina was reduced by 1cm compared to pre-positioning
- Intravenous peripheral catheter and monitoring should be placed, assessed for

patency before positioning as hand will be tucked, restricting the access.

- Continuous neuromuscular blockade and its monitoring should be done, as any patient movement stresses port site and also the risk of internal injury is high.
- The steep trendelenburg position increases the risk of patient sliding off the operating table, hence restraining devices should be used to avoid it. It should be done in a way by protecting the pressure points.
- During positioning potential sites of injury especially face, pressure points and peripheral nerves should be adequately protected.
- In case of emergency situations, including cardiac arrest, management may be challenging as the robot presents as a barrier to resuscitation. Thus, the operating team should be familiar with an emergency drill that allows the rapid removal of the robot.

Hemodynamic Changes:

- Due to increase in intra-abdominal pressure, there is compression of aorta which causes increase in Mean arterial pressure, Systemic vascular resistance (SVR) and afterload therefore reduced stroke volume, which inturn causes slight decrease in cardiac output and cardiac index.
- Due to the positioning, there will be increase in central venous pressure, mean pulmonary arterial pressure and pulmonary capillary wedge pressure which inturn decreases the heart rate.
- In patients with impaired myocardial function, the increased preload may precipitate cardiac failure.
- In patients with Ischemic Heart Disease and impaired myocardial contractility, the increase in cardiac work and myocardial oxygen consumption may lead to further complications.
- There is increased risk of cardiac arrhythmias and Bradycardia due to reflex increase of vagal tone caused by peritoneal stretch which can be treated by Inj.Atropine and by deepening the plane of anaesthesia.
- Reduction in renal blood flow, portal and splanchnic blood flow due to the pneumoperitoneum.

Respiratory Changes:

- The trendelenburg position and pneumoperitoneum pushes the abdominal contents cephalad which causes decrease in Functional residual capacity.
- Decrease in lung compliance from 60mL/cmH2O to 28ml/cmH2O has been noted due to steep trendelenburg position and chest binders.
- Reduce compliance causes increase in Ventilation-Perfusion mismatch, increase in inspiratory pressures with an increased risk of barotrauma.
- Tidal volume 6-8ml/kg and a positive end-expiratory pressure of 4-7cmH2O are recommended for the prevention of atelectasis and the maximal airway pressure should be kept under 35cmH2O.
- Prolonged inspiratory duration can produce better gaseous exchange, oxygenation and lower PaCO2 levels. (I:E of 2:1 or 1:1 than regular 1:2).
- CO2 insuffulation causes hypercapnia, which can be treated by increasing minute ventilation.

Neuromuscular Effects:

- The steep trendelenburg position and hypercarbia secondary to CO2 pneumoperitoneum increase cerebral blood flow and intracranial pressure. Hence, steep trendelenburg position is contraindicated in patients with pre-existing intracranial hypertension or patent ventriculoperitoneal shunts.
- Increased risk of peripheral nerve injury such as brachial plexus, common peroneal

nerve, sciatic nerve, lateral femoral cutaneous nerve and obturator nerve injury.

- Usage of shoulder brace due to excessive pressure over the acromioclavicular joint and excessive arm abduction can cause brachial plexus injury.
- Prolonged lithotomy and insufficient leg support padding can cause lower limb peripheral nerve injury.
- Steep trendelenburg and lithotomy are associated with reduced lower limb perfusion leading to lower limb compartment syndrome. The use of intermittent pneumatic compression device can also be a factor but it cannot be avoided due to the risk of deep vein thrombosis.

Physiological effects of pneumoperitoneum in the Trendelen position

Cardiovascular system[7,8,9]
↑ systemic vascular resistance, ↑ mean arterial pressure
↓ renal, portal, splanchnic flow
Respiratory system[10]
worsens ventilation-perfusion mismatch
↓ pulmonary compliance, ↑ peak airway pressures
↓ functional residual capacity
hypercarbia, respiratory acidosis
Central nervous system[11]
↑ intracranial pressure
↑ cerebral blood flow
Endocrine system[10]
↑ catecholamine release
activation of renin-angiotensin system → ↑ vasopressin

Ocular Changes:

- Increase in Intra-ocular pressure on average of 13mmHg. Factors contributing to it are surgical duration in steep trendelenburg position and increase in the arterial CO2 partial pressure (PaCO2), causes choroidal vasodilatation.
- Injuries range from corneal abrasions to ischemic optic neuropathy.
- Chemosis and conjuctivaledema may lead to corneal abrasion and can be minimized by restrictive fluid therapy.

Fluid Therapy:

- Unrestricted fluid therapy may lead to facial and neck oedema.
- Airway oedema increases the risk of respiratory complication and may need reintubation. Hence, patient should be examined for head and neck swelling and cuff leak test should be performed prior to extubation.
- Cerebral oedema can cause delayed awakening and confusion. So, Fluid administration to be restricted to 2 litres.

Gas Related Complications:

- Lesser incidence of venous gas embolism is seen in RARP than with open prostatectomy. So, careful monitoring during insufflation and during the dissection of the dorsal venous plexus is needed.
- Subcutaneous emphysema is a common complication but self-resolving.
- Pneumothorax and Pneumomediastinum should also be considered and hypercarbia should be corrected to avoid increase in the work of breathing.

Deep Vein Thrombosis:

- Due to the increased abdominal pressure, compression of inferior vena cava and iliac vessels causes reduced lower limb venous flow leading to increase in the risk of deep vein thrombosis.
- Can be prevented by the usage of the pneumatic compressive devices and prophylactic administration of low-molecular weight heparin.

Gastric Regurgitation:

- Steep trendelenburg position and pneumoperitonium increases the risk of regurgitation of the gastric contents.

Others:

- Increased risk of bleeding.
- Hypothermia.

- Robotic malfunctioning.
- Surgical injury.
- Delayed emergence.

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