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EDITORIAL VIEW **ANESTHESIA & ROBOTIC SURGERY**

The anesthetists' concerns regarding robotic surgery

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ABSTRACT

Advancement of technology has great impact on medical field. With all its pros and cons its use can be practiced with minimizing the risk and maximizing its benefits for the wellness of patient. With all the goodness that it offers to the surgery; its demand for environment and changes in the physiology of patient remains concerning for the anesthetist and surgical team.

Despite the progression, it's huge space occupying size and its extra costly investment makes it difficult for usual setups to initiate it's use for common man.

The robotic system has been used in a range of specialist areas, including bariatrics, general surgery, & cardiothoracic and urological surgeries and gynecological surgeries. Here we discuss various issues faced by the anesthetist to accommodate the concerns of robot assisted surgeries for the better outcome of the patients.

Keywords: Anesthesia; Robotic surgical procedures; Education; Training; Pakistan

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Recently, with the advancement of technology and modernization in the field of medicine, aiming for minimal invasion and maximum outcomes, robot-assisted surgical techniques have been implemented. Robots are designed to replicate optimal anatomical conditions in the human body, maintaining physiological integrity, minimizing human error, and performing various complex procedures with greater precision, flexibility, and control to prevent any idiopathic conditions.[1] These techniques require additional surgical training & their can be complications related to the limited range of instruments motion or access and a suboptimal two dimensional view.

Robots were initially developed by NASA for exploration and were later utilized in the medical field in 1985 for brain biopsy procedures to prevent trauma due to hand tremors. With further advancements, they were gradually introduced for major surgical procedures, allowing for smaller incisions, reduced pain, limited blood loss, quicker recovery, shorter hospital stays, improved cosmetic results, and reduced wound complications.[2]

The robotic system introduced at Jinnah Postgraduate Medical Center, Karachi, is the VERSIUS, a small modular and portable robot by CMR Surgical, operational since November 2023, enabling the surgeon to control instruments remotely from a master console.[3] The personnel involved in the operating theater are limited to a surgically scrubbed assistant, the anesthetist, and some surgical staff. At Jinnah Postgraduate Medical Center, Karachi, various general surgical laparoscopic procedures, such as cholecystectomy, hernia mesh repair, gastric bypass surgery, urological surgeries (prostatectomy, nephrectomy, and cystectomy), and gynecological procedures (hysterectomy & myomectomy), are now being conducted with robot-assisted technology.

Robotic docking requires the patient to be positioned correctly for accurate use of the robotic arms. Bulky robotic arms can cause damage to the surrounding structures. Major hemorrhage can be insidious. Communication can be difficult whilst the surgeon is in the master console.

The anesthetist's considerations in robot-assisted operations remain a crucial concern. Due to the bulky robotic machinery surrounding the operating table, the anesthesia workstation must be placed at a distance from the patient, making it the responsibility of the anesthetist and technician to ensure monitors, IV lines, and catheters are positioned preoperatively, with tubing length and wires secured to prevent any displacement or kinking before, during, and after the operation.[4] With the induction of anesthesia and positioning of robots for the surgery, the patient is not easily accessible to the anesthetist. In case of any emergency, the staff is trained for early detection and prompt detachment of the robot from the patient.

The patient is positioned before the placement of robotic surgical arms, usually in the steep Trendelenburg position, which pushes the diaphragm upward, causing endobronchial migration of the endotracheal tube, reducing functional residual capacity and pulmonary compliance, thus leading to decreased arterial oxygenation and atelectasis.[5] This necessitates the application of positive end-expiratory pressure with pressure-controlled ventilation, maintaining a tidal volume of 6-8 ml/kg with an increased respiratory rate for adequate minute ventilation.[6]

The Trendelenburg position increases intraocular pressure and intracranial pressure and may lead to facial and orbital edema. Patients in such a position are prone to sliding, which may cause nerve injuries or blood flow obstruction, potentially resulting in ischemic optic neuropathy or corneal abrasion.[7] Taping the eyes closed, securing the patient to the operating table, and padding pressure points are generally practiced to avoid any trauma or injury.

With the head tilted down and insufflation of carbon dioxide during laparoscopic robotic surgery, central venous pressure, pulmonary artery pressure, and pulmonary capillary wedge pressure are increased, resulting in decreased heart rate with a slight decrease in cardiac output and cardiac index, due to increased systemic vascular resistance and afterload and decreased stroke volume.

Carbon dioxide insufflation during robotic laparoscopic surgery can lead to increased intra-abdominal pressure, affecting respiratory and cardiovascular function, resulting in hypotension, decreased lung compliance, and causing abdominal compartment syndrome. This requires careful monitoring to optimize the lowest effective CO_2 insufflation pressure, providing an adequate surgical field and lowering the risk of abdominal compartment syndrome, maintaining approximately 12-15 mmHg according to the patient and procedure. Ensuring positioning to prevent increased abdominal pressure, fluid management by monitoring input of colloids and crystalloids with losses from urine output, blood loss, and insensible losses, monitoring vital signs, ventilation adjustments, and preoperative assessment for any risk of abdominal compartment syndrome like obesity or any pre-existing abdominal pathology.

The pneumoperitoneum caused by CO_2 insufflation, with prolonged procedure time and high intra-abdominal pressure, forces CO_2 into the bloodstream, while the ventilation-perfusion mismatch with inadequate ventilation leads to CO_2 retention, resulting in respiratory acidosis, cardiovascular complications, and sympathetic activation leading to increased heart rate and blood pressure, cerebral vasodilation. It requires close monitoring of CO_2 levels, adjusting ventilation and insufflation pressure, using appropriate CO_2 absorbers and filters, and limiting the procedure duration. If not promptly addressed, hypercarbia may lead to CO_2 narcosis, resulting in impaired cognitive function, altered mental state, and potentially life-threatening complications.

It also increases stress response due to increase catecholamine. Activation of renin-angiotensin system, decrease renal, splanchnic blood flow and cerebral blood flow. Edema of face, eyes and airway. Nerve injuries and neuropraxias (e.g. brachial plexus). Emphysema due to Carbon dioxide insufflation.

The ideal temperature range of the operating theater, allowing optimal performance and functionality of the robotic system, is between 68°F (20°C) and 72°F (22°C). Temperatures beyond this range can affect robotic precision. Temperature regulation is crucial during robotic surgery to ensure patient safety, preventing hypothermia (body temp < 36°C), maintaining optimal surgical conditions for precise dissection and suturing, reducing the risk of infection, blood loss, and postoperative recovery by using forced air warming blankets, electric warming mattresses, warming pads, heat wraps, warm IV fluids, blood warmers, insufflation gas warmers, or warming gowns.[8] These warming devices help maintain normothermia, reducing the risk of hypothermia-related complications such as cardiac arrhythmias, coagulopathy, infection, postoperative shivering, and prolonged recovery.

Robotic surgery requires specialized training and experience, leading to longer procedure times initially, and is often used for complex cases. It requires more time to complete the setup of the robotic system, and docking the robot can add to the overall surgical time. Longer anesthesia and preparation times, rare technical issues with the robotic system, team coordination, and the surgical precision of the robot contribute to longer surgical times.

There are several pitfalls to be considered regarding robotic-assisted surgery. First, the equipment is extremely bulky and thus considerable space is required. Second, the large size of robot itself may result in collisions with its own arms, assistants or patients. Third, it is difficult for anesthesiologist to quickly assess the patients during an operation. In addition, it is almost impossible to reposition the patient once the robot has been stationed. Nevertheless, application of robotic assisted surgery will continue to increase and be extended to other fields. Anesthesiologist should be up to date with this latest surgical trend to be ready to provide better anesthesia care for patients undergoing robotic assisted surgery.

Conflict of interests

The authors declare no conflict of interest.

Authors' contribution

All authors contributed in the intellectual input as well as in the manuscript preparation

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