Acta Clin Croat (Suppl. 3) 2022; 61:76-80
doi: 10.20471/acc.2022.61.s3.11

Professional Paper

ANESTHESIA FOR ROBOT-ASSISTED RADICAL PROSTATECTOMY - A CHALLENGE FOR ANAESTHESIOLOGIST

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SUMMARY: Mininimally invasive surgery has become one of the most popular ones over the last few decades due to many benefits. The advantages are minimal surgical incision, reduced blood loss, reduced postoperative pain, faster postoperative recovery, shorter hospital stay, lower morbidity and better outcomes compared to open surgery. The most common robotic procedures in urology are radical prostatectomies. In UHC Zagreb, since November 2019 until now, there have been more than 180 robotic assisted radical prostatectomies (RALP) using Senhance robotic system performed. As a procedure with many possible complications, it represents a challenge for anaesthesiologist. Some of the problems the anaesthesiologists have to face are related to limited patient access, possible difficulties connected with positioning, pneumoperitoneum, subcutaneous emphysema, possible airway oedema. Pneumoperitoneum has impact on almost every system: cardiovascular, renal, respiratory, gastrointestinal and other. Detailed understanding of physiological changes of RALP, with intraoperative impact on nearly every body system is ultimate. Careful preoperative evaluation and intraoperative conduction minimize the risk of complications, and help patients to reach full recovery in a very short time. Excellent outcomes are the result of individualized approach to the patient and good communication between team members.

Key words: *radical prostatectomy, robotic surgery, anaesthesia, perioperative management*

Introduction

Many advantages have made it possible for minimally invasive surgery to become one of the most „popular surgeries". Some of the benefits are reduced postoperative pain and blood loss, minimal surgical incision, faster postoperative recovery, shorter hospital stay, lower morbidity (1,2).

During a robotic surgery procedure, a surgeon performs the procedure from afar supported by 3D vision and movement control of wristed laparoscopic surgical instruments (3,4). According to its pronounced benefits, robotic-assisted surgery techniques are increasingly used for numerous urologic procedures like prostatectomy, nephrectomy, adrenalectomy and other. Robotic surgery is one of the most popular surgical

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technique methods in enclosed spaces, like pelvis (5). Postoperative outcomes have been studied for major urologic procedures, especially prostatectomies and nephrectomies. The most common robotic procedures in urology are radical prostatectomies.

Robotic -assisted radical prostatectomy (RALP) presents a challenge for anaesthesiologist due to potentially serious complications as a result of Trendelenburg position, pneumoperitoneum and difficult access to the patient during the procedure. Advances in surgery like robotic surgery aim to improve patient outcomes and satisfaction along with the decrease in mortality and morbidity.

At the University Hospital Centre (UHC) Zagreb, robotic-assisted urologic procedures started to be performed in November 2019, and until today we have performed more than 180 RALP using Senhance robotic system (6,7). Anaesthesiologists have to attend zo proper screening and patient selection, patient positioning at the operating table, restricted access to the patient in the operating room and subcutaneous emphysema.

PREOPERATIVE EVALUATION

At our institution, preoperative evaluation of the patient for robotic prostatectomy is the same as for the open or any other procedure. After standard evaluation, where typical comorbidities are considered, high-risk patients are identified. Over the last years, the average age of men undergoing prostatectomy has decreased because of the earlier detection of a prostate tumour.

After detailed anamnesis and physical examination, and after checking the electrocardiogram, anaesthesiologist determine cardiac risk. Patients with significant cardiac disease require further evaluation and consultation with a cardiologist.

American Heart Association/American College of Cardiology (AHA/ACC) guidelines recommend cancelling or delaying the operation for the patients with the following conditions: recent myocardial infarction, decompensated heart failure, significant arrhythmias and severe valvular disease. Patients with cardiovascular stents have predisposition for stent thrombosis even when being administered anticoagulants and antiplatelet drugs. Special attention should be paid to the discontinuation of these drugs before operation (8).

Patients with severe chronic obstructive pulmonary disease are at increased risk because of the higher peak airway pressures during intraoperative mechanical ventilation. For patients with lung bullae which could potentially rupture and complicate the procedure, RALP is a relative contraindication.

Obese patients with body mass index BMI >30 kg/m^2 are carefully evaluated because of higher incidence of coronary artery disease, pulmonary dysfunction, diabetes and potentially unexpected difficult airway. Positioning on the operating table in these patients may also be difficult in order to avoid neurological injury. In experienced RALP institutions, the outcomes with obese patients are similar to the outcomes of non-obese patients (6,9)

The optimization of cardiovascular, respiratory, metabolic, and other systems in preoperative evaluation should be carefully managed.

INTRAOPERATIVE MANAGEMENT

One of the main problems for anaesthesiologists in robotic surgery is limited patient access intraoperatively. There is a huge amount of equipment and setup in the operating room, so there should be enough space for staff and patient. The arms and body of the robot take up a lot of space that could interfere with „anaesthesiologist's space". If intraoperative removing of the robot should be necessary, it is important to know that this is a multistep process that cannot be done immediately. This is a crucial fact in case of cardiopulmonary resuscitation. Since robot's moving parts are close to patient position, endotracheal tube has to be secured firmly. Access to the airway can be limited, which should be kept in mind if something unexpected happens.

In UHC Zagreb, when a premedicated patient gets to the operating table, he/she is routinely monitored. After that, two large bore peripheral venous accesses are secured. After induction to anaesthesia, arterial line is placed on one forearm for invasive blood pressure monitoring and for intra and postoperative gas analysis and haemoglobin monitoring. Central venous access is usually not required. Urinary catheterization is required. After securing the airway and IV lines, the patient is under surgeon's and anaesthesiologist's supervision properly positioned on the operating table. During the procedure, deep neuromuscular blockade used to ensure complete patient immobility is essential, because any intraoperative movement can be catastrophic. Maintenance of anaesthesia includes volatile agents (sevoflurane) or total intravenous propofol anaesthesia and opioids.

After inducing pneumoperitoneum, the intraabdominal pressure rises and accordingly the patient's airway pressure. High peak inspiratory pressures may result in barotrauma. Special ventilation difficulties are expected in patients with chronic obstructive or restrictive pulmonary disease. Anaesthesiologist applies different modes of ventilation in order to maintain good respiratory mechanics and gas exchange.

Intraoperative fluid administration is restricted to reduce facial and airway oedema and urine production. Excessive urine secretion can affect surgical field visibility before urethral anastomosis. After suturing anastomosis, intravenous fluid can be given as required.

PATIENT POSITIONING

Patient positioning is a crucial part of any robotic surgery and can have impact on patient outcomes. During the robot-assisted prostatectomy, the patient is placed in Trendelenburg position that produces physiologic changes in hemodynamic, pulmonary, kidney and respiratory system in combination with pneumoperitoneum. Ideal patient positioning is crucial to prevent nerve injuries. The risk factors for neuropathies are diabetes, skinny patient, inadequate position on the operating table (10).

There are many nerves in the upper or lower extremities that can be injured during robotic prostatectomy. In Trendelenburg position, brachial plexus injury is possible. It results in weakness in shoulder adduction and elbow flexion. In 2010, Manny et al. reported in 9-month follow up, that the patients complained of lower extremity neuropathic symptoms. The authors explained that symptoms are related to possible injury of common peroneal, lateral femoral cutaneous or obturator nerve (11).

UHC Zagreb has not reported any nerve injury after robotic-assisted prostatectomy so far. Since we use Senhance robotic system, we perform extraperitoneal radical prostatectomy, and patients are usually placed in milder Trendelenburg position, 10 to 15 degrees (12). Other possible complications include unrecognized surgical injury, risk of hypothermia in case of prolonged procedure, and occult blood loss.

The impact of Trendelenburg positioning on respiratory system is a result of cephalad displacement of diaphragm which decreases lung compliance and functional residual capacity (13-15).

Arterial oxygenation is also decreased during Trendelenburg position (13,16).

PNEUMOPERITONEUM

Pneumoperitoneum has profound effects on the cardiac, renal, pulmonary and immune systems. The effects are related to intraabdominal pressure (IAP) and CO2 insufflation and absorption.

The increase in IAP results is related to releasing catecholamine and activation of renin-angiotensin system with vasopressin release. The result is an increased mean arterial pressure (MAP) and increased systemic (SVR) and pulmonal vascular resistance (PVR).

Bradycardia is common after vagal stimulation caused by insertion of Veress needle or peritoneal irritation during gas insufflation.

The impact of pneumoperitoneum on cardiovascular system depends on patient's preoperative volume status and cardiac risks, insufflation pressure and positioning on the operating table.

During insufflation, CO2 as a highly soluble gas is absorbed rapidly into circulation and according to some studies, reaches peak values in about 60 minutes after starting insufflation (17-20).

As mentioned above, anaesthesiologist have to increase minute ventilation to maintain normal or supranormal values of CO2. The hyperventilation in patients with respiratory disease (asthma, COPD) and obese patients may be difficult. After CO2 absorption, hypercapnia can increase SVR and PVR. Hypercapnia is directly associated with acidosis and can decrease cardiac contractility, produce arrhythmia and vasodilatation. Indirectly, the hypercapnia causes tachycardia and vasoconstriction as a result of sympathetic stimulation (17-20).

It is important to mention, that UHC Zagreb surgeons use extraperitoneal approach, resulting in

less pressure on the abdominal wall, smaller internal incision and less intestinal irritation compared to transperitoneal approach. Also, Trendelenburg position for extraperitoneal approach is 10–15°, which is less than the 30° of the transabdominal approach. It results in faster postoperative intestinal recovery. Subcutaneous emphysema is common during extraperitoneal insufflation, although it is noticed after transperitoneal insufflation (6,7). Our surgeons use insufflation pressure of 12mmHg, although they can lower pressure for the purpose of patient safety, as long as surgical conditions allow.

Pneumoperitoneum affects the renal function by parenchymal compression, reducing renal vein flow and increasing the level of vasopressin. It results in the re-

duction in renal perfusion and oliguria. When intraabdominal pressure is under 15 mmHg, the renal function normalizes very fast after desufflation.

Hypercapnia and Trendelenburg position increase cerebral blood flow (CBF) and intracranial pressure (ICP).

Intraocular pressure (IOP) also increases with the establishment of pneumoperitoneum and Trendelenburg position. Increased IOP may have impact on postoperative loss of vision after prolonged procedures, as reported by some studies (19-21).

Pneumoperitoneum can decrease splanchnic circulation and, in that way, reduces perfusion of gastrointestinal tract and total hepatic blood flow. Hypercapnia causes splanchnic vasodilatation, however there is no clinical significance (19,20).

POSTOPERATIVE MANAGEMENT

Airway oedema and respiratory distress is possible in 0.7% patients after longer lasting procedure in Trendelenburg position (22). The case reports have been published about airway oedema after prolonged Trendelenburg in RALP, but the authors of this text have not found the

studies in the literature dealing with greater number of patients. So far, RALP has been performed in more than 180 patients in UHC Zagreb. We had the cases of subcutaneous emphysema in scrotal and penile region in the first few RALP patients, although we do not know why it was the case, and now such cases are not occurring so frequently.

The postoperative pain after RALP can be incisional, shoulder and visceral pain. The exact mechanism of shoulder pain developing postoperatively after laparoscopic surgery is still unknown. The pain is probably related to residual CO2 after pneumoperitoneum, although some studies suggest warming the insufflation gas or lower insufflation pressures to reduce the incidence of shoulder pain. These measures probably have impact on reducing the irritation of peritoneum and thus reduce the shoulder pain. Our patients do not complain of shoulder pain after RALP, probably due to the benefits of extraperitoneal approach. The postoperative pain is managed by using anti-inflammatory drugs (NSAIDs) in combination with opioids. Reduced incidence of postoperative pain is one of the benefits of RALP. In our institution, the control of postoperative pain is easy and fast, because patients have really low VAS scores. Mostly, in the first three hours after RALP, they complain of „full bladder" and discomfort which is caused by urinary catheter balloon.

Conclusion

Robot-assisted radical prostatectomy presents a challenge for surgeons but also for anesthesiologists . The detailed understanding of physiological changes of RALP, with intraoperative impact on nearly every body system, is essential. Careful preoperative evaluation, intraoperative conduction, minimizes the risk of complications and helps patients to reach full recovery in a very short time. Excellent outcomes are the result of individualized approach to the patient and good communication between team members.

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Sažetak

ANESTEZIJA ZA ROBOT-ASISTIRANU RADIKALNU PROSTATEKTOMIJU - IZAZOV ZA ANESTEZIOLOGA

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Zbog brojnih prednosti, minimalno invazivna kirurgija postala je u posljednjih nekoliko godina jedna od najpopularnijih grana kirurgije. Prednosti su minimalan kirurški rez, manje krvarenja. bolja postoperativna analgezija, brži postoperacijski oporavak, kraća hospitalizacija, niža smrtnost i bolji ishod u usporedbi s otvorenim zahvatima. Najčešći robotski asistiran zahvat u urologiji je radikalna prostatektomija. U KBC Zagreb, od rujna 2019 do danas učinjeno je više od 180 robotski asitiranih radikalnih prostatektomija (RALP) uz Senhance sustav. RALP je zahvat s dosta potencijalnih komplikacija, te predstavlja izazov za anesteziologa. Neki od problema s kojima se anesteziolog susreće je ograničen pristup bolesniku na operacijskom stolu, položaj bolesnika na operacijskom stoplu, pneumoperitoneum, subkutani emfizem, mogući razvoj edema dišnog puta. Pneumoperitoneum može imati utjecaj na gotove sve organske sustave: Kardiovaskularni, plućni, bubrežni, gastrointestinalni i drugi. Važno je dobro razumjeti fiziološke promjene tijekom pneumoperitoneuma intraoperacijski. Pažljivom preoperacijskom obradom i intaroperacijskim vođenjem anestezije, smanjuje se mogući broj komplikacija te ubrzava oporavak pacijenta u kratkom periodu. Odličan ishod rezultat je individualiziranog pristupa pacijentu i dobre komunikacije između članova operacijskog tima.

Ključne riječi: *Radikalna prostatektomija, robotska kirurgija, anestezija, perioperativno postupanje*