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Anesthesia for Urological Surgery

Zeki Tuncel Tekgül, Burcu Özalp Horsanali and
Mustafa Ozan Horsanali

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Abstract

Because of the variable techniques and patients' positions used in urological surgery, anesthesia for urologic surgery requires advanced knowledge and special transactions. In this matter, it is important to follow current approaches for anesthesiologists. Different surgical procedures and complications due to different positions or anesthesia were evaluated separately to be more concise. We have researched recent literature and created this chapter about new technologies in urological surgery and development in anesthesia for urological surgery.

Keywords: urological anesthesia, anesthesia management, anesthesia complications, urological surgery complications

1. Introduction

Anesthesia for urological surgery includes unique distinctive differences, as in all other surgical departments. Therefore, anesthesia for urological surgery requires featured training and experience.

To reduce the risk of complications in urological surgery, like all other kinds of surgery, regional anesthesia techniques came to prominence with the help of technological developments. For many urological ventures, only neuraxial blockade application could be enough. This also results in decreased complication risks. In surgeries that must be done with general anesthesia, epidural anesthesia can be used for the maintenance of anesthesia or in the post-operative period. In this way, the rate of intraoperative complications can be reduced and patients' comfort can be increased by providing postoperative pain control and also duration of hospital stay can be reduced [1].

During the urological surgery, different complications can develop depending on surgical techniques used. For example, most of urological ventures require lots of irrigation fluids. In this venture, use of unheated irrigation fluid can lead to complications such as hypothermia, delayed recovery from anesthesia and tremor [2].

In addition to neuraxial blockade, the use of peripheral blockade has gained importance in urological surgery. For example, obturator blockade application for lateral wall localized bladder cancer could reduce intraoperative complications and increased cancer-free survival [3, 4].

2. Anesthesia for kidney and upper urinary tract surgery

2.1. Oncological surgery of kidney and upper urinary tract

2.1.1. Radical and partial nephrectomy

Renal cell carcinoma (RCC) is the ninth common cancer in the USA. According to the SEER database analysis, it is estimated that there will be 62,700 new cases and 14,240 people will die because of this disease. The incidence of kidney and renal pelvis cancer was 15.6 per 100,000 in the USA between 2009 and 2013 [5]. All around the world, radical or partial nephrectomy is accepted curative treatment for kidney tumors. Partial nephrectomy can be performed depending on the tumor size and localization of tumor. During the partial nephrectomy, localized solid mass must be removed entirely with clear surgical margins [6]. The European Association of Urology (EAU) Renal Cell Cancer Guidelines Panel recommends partial nephrectomy for the tumors less than 4 cm [7].

The flank incision provides advantages in terms of access to the kidney directly, but in case of vena cava involvement, it can be insufficient anatomically. If the tumor size is huge and abdomen exploration or contralateral retroperitoneal exploration is needed, subcostal incision may supply advantages to the surgeon. Various factors including surgeon's experience, tumor size and localization, patient's body habits and localization of affected kidney can affect the incision type [8].

2.1.2. Radical nephroureterectomy

Upper urothelial cell carcinoma is a rare tumor among genitourinary system tumors that constitute approximately 5% [9]. Radical nephroureterectomy with bladder cuff resections is a standard curative treatment for patients with non-metastatic upper urothelial cell carcinoma, although advanced developments of minimal invasive surgery and surgical techniques for radical surgery are present [10].

2.1.2.1. Preoperative considerations

Known risk factors for RCC include tobacco smoking and be over the age of 60. The peak incidence of RCC is at the age of 60 years and male-female ratio is 2:1. Hence, these patients with RCC generally have comorbidities such as coronary-after-disease and chronic obstructive

pulmonary disease. Only small percent of patients (approximately 10%) have classic diagnostic triad of symptoms including flank pain, hematuria and palpable abdominal mass. Paraneoplastic symptoms and impaired laboratory test including increased erythrocyte sedimentation rate, eosinophilia and increased hormone levels of prolactin, renin and glucocorticoids [11]. The patient's health status is also optimized by management of anemia, glycemic control and treatment for hypertension, as well as dietary, weight and smoking-cessation advice before surgery. A consultant-led, multidisciplinary decision can be made as to which procedure and approach are required for each patient [12]. Because these patients usually have comorbid disease such as advanced age, hypertension, diabetes, chronic obstructive pulmonary disease and congestive heart failure and they have had a long and major surgery, it should be appropriate to prepare intensive care bed for these patients to stay in intensive care unit for the critical postoperative period. Intensive care unit can be appropriate to follow up and interfere with postoperative problems that must be treated quickly such as hypothermia, electrolyte imbalance, hemorrhage, infections, pulmonary disorders and requirement of dialysis.

2.1.2.2. Intraoperative considerations

In thoraco-abdominal approach, since the pleural space is entered, using the noble-lumen endotracheal tube may facilitate the surgery by deflating the ipsilateral lung. Postoperative ventilation may be needed because of prolonged retraction of the lung that is causing contusion. During the diaphragm dissection, the phrenic nerve may also be injured by both thoraco-abdominal incision and flank incision. During operation, excessive blood loss may occur at any stage of operation, which is the reason for the high vascularity of the tumor. Bleeding can be caused by the surreal gland. At last, adjacent abdominal organs including colon, duodenum and liver may be injured. If the renal mass is on the left side, bleeding due to splenic injury may occur with an incidence as high as 10% [13]. When extensive bleeding is observed, wide-channel venous cannulation and central venous cannulation should be obtained for monitoring both the central venous pressure and supply rapid blood transfusion. Prolonged retraction of vena cava may result of transient hypotension. Hence, direct arterial pressure monitoring may facilitate the control of blood pressure, especially in patients with cardiac comorbidity. Moreover, these applications may be helpful for the patients who need mechanic ventilation postoperatively. If the patient has caval obstruction due to naval thrombus, additional management may be needed. Embolization of the tumor fragment may occur during the central venous catheter application, if the thrombus in vena cava extends into the right atrium. When atrial thrombus is observed, a pulmonary artery catheter is contraindicated. For this reason, many authors suggested that the use of intraoperative transesophageal echocardiography in order to detect tumor extension in the inferior vena cava [14–16].

2.1.2.3. Choice of anesthesia

The anesthetic management of patients undergoing radical nephrectomy should include general endotracheal anesthesia. Alternately, combined regional/general endotracheal anesthesia advised to be employed. If the general and epidural anesthesia are combined, epidural catheter must be placed and test dose should be administered before the induction of general anes-

thetia. To perform the induction of general anesthesia after evaluating the effect of the test dose will be reduced the risk of unintended intrathecal and intravascular injection. Although test dose is administered, it would be safer to administer the epidural dose partially and intermittently. When neuraxial blockade performed, sensorial block level must be Th4. It has been shown that intraoperative epidural infusion of local anesthetic suppresses the stress hormone response and reduces opioid requirement when compared to straight general anesthesia in open nephrectomy [13]. Also, it is advised to reduce pulmonary complications and be more effective to control postoperative pain.

2.1.2.4. Complications

Patients with renal failure may be sensitive to benzodiazepines. Cisatracurium may be considered for muscle relaxation as it is metabolized via ester hydrolysis and Hofmann elimination. Other pharmacologic considerations for the patient with renal failure include adjusted dosing of antibiotics and avoidance of nonsteroidal anti-inflammatory agents. Patients with chronic kidney failure have decreased platelet function and von Willebrand factor and reduced red blood cell volume. So the anesthesiologist must transfuse appropriate blood product [17].

2.2. Nononcological surgery of kidney and upper urinary tract

Nononcological urological surgery of kidney and upper urinary tract includes such procedures like simple nephrectomy, pyeloplasty, nephrolithotomy or pyelolithotomy, percutaneous nephrolithotomy (PNL), extracorporeal shockwave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS), percutaneous nephrostomy, ureterorenoscopy and ureteral stent replacement. Open stone surgery (nephrolithotomy or pyelolithotomy) is now dramatically reducing and the endoscopic and extracorporeal methods are increasing, overcoat ESWL in those hospitals which has an own lithotripter. Open surgery is actually indicated for the complex renal stone and the complicated ureteral stone [18]. Classically, PNL is done on the patient first in the supine position for replacement of the ureteral catheter and then in a prone position for accessing the caliceal system. Other procedures such as simple nephrectomy, pyeloplasty, nephrolithotomy and pyelolithotomy are performed on the patients in the lateral decubitus position.

2.2.1. Preoperative considerations

The anesthesiologist should evaluate not only patients' history and physical examination but also existing urinary tract infection. If it exists, antibiotherapy must be given perioperatively. All anticoagulation medications including aspirin and nonsteroidal anti-inflammatory drugs (NSAIDs) are typically held for 5 days prior to surgery. Blood type and screening are recommended for the patients who are at high risk of intraoperative bleeding.

2.2.2. Intraoperative considerations

Antegrade or retrograde ureteropyelography (RPG) is often used to demonstrate the anatomical structure of urinary system or localized the level of urinary system obstruction. Due to the radiographic-iodinated contrast media used in such PNL procedure, patients have

predisposed factors for iodinated contrast media-related adverse reactions such as a previous adverse reaction to iodinated contrast media, a history of asthma and atopy, dehydration, acute or chronic renal diseases and advanced age, where iodinated contrast media-induced adverse reactions may be observed [19]. The prone position alone for PNL is associated with a variety of position-related complications. To avoid cervical spine injury during positioning, the head should be held in a neutral position through the turn and positioning. Neck extension or head rotation could also impede carotid and/or vertebral artery blood flow and venous return. The etiology of peripheral nerve injury is usually multifactorial, requiring both a direct pressure and a stretch component. The large volume of irrigation fluid used during PCNL can decrease body temperature. Hence, monitoring core temperature is routine [2, 20, 21].

2.2.3. Choice of anesthesia

Commonly, general anesthesia with an endotracheal intubation is preferred for simple nephrectomy, pyeloplasty, nephrolithotomy, pyelolithotomy and PNL, although sedation and neuraxial anesthesia for PNL have also been successful [22]. If neuraxial blockade is performed, the sensorial block level must be Th4.

Recently, anesthetic management of routine ESWL treatments on adults covers effective sedative and analgesic practice. Different applications could be used successfully such as meperidine and promethazine, midazolam with alfentanil, fentanyl and ketamine. Substantial research on the use of alfentanil by various routes reported that this drug is very effective [23–25].

2.2.4. Complications

The major complications during nononcological urological surgery of kidney and upper urinary system tract include bleeding, bowel and collecting system injury, traumatic arteriovenous fistula or false aneurysm, sepsis, atelectasis, pneumothorax, pleural effusion and hemothorax [26, 27]. As excessive amount of irrigation solution is used intraoperatively in surgical procedures like PCNL, hypothermia is frequently observed. Tekgöl and colleagues reported that effects of irrigation solutions, administered at either 21 or 37°C in percutaneous nephrolithotomy (PCNL), on hypothermia and related postoperative complications such as late emergence and late recovery from anesthesia, shivering, lactic acidosis and excess bleeding [2].

3. Anesthesia for bladder and prostate

3.1. Oncological surgery of bladder and prostate

This part covers transurethral resection of bladder tumor (TUR BT), radical cystectomy and radical prostatectomy operations as urological surgery. Bladder cancer is the fourth most common cancer in the United States. Initial diagnosis and treatment of non-muscle invasive bladder cancer is TUR BT. Radical cystectomy is the treatment of choice for invasive urinary

bladders tumors. Prostate cancer is a major cause of morbidity and mortality and it is estimated that there will be 240,890 new diagnoses of prostate cancer in 2011 and that prostate cancer will be responsible for approximately 33,720 deaths in 2011 [28].

3.1.1. Preoperative considerations

Average blood loss associated with radical cystectomy has been reported from 560 to 3000 mL [29, 30] and blood loss associated with radical retropubic prostatectomy is commonly reported between 550 and 800 mL, although higher estimates are infrequently reported [31, 32]. Blood transfusion for patients with high risk of bleeding has been recommended before elective procedures.

In patients who underwent surgery, the major and most common causes of the nonsurgical death are deep vein thrombosis (DVT) and related pulmonary thromboembolism. Especially, patients who underwent radical surgery such as prostatectomy and cystectomy have major risk factors for development of DVT due to malignancy, surgery, immobility and advanced age. For good postoperative care of patients and to prevent the development of DVT, DVT prophylaxis is needed before the surgery in patients with high risk for DVT. The risk of development DVT in patients undergoing open radical prostatectomy without DVT prophylaxis is estimated to be 32% [33].

3.1.2. Intraoperative considerations

Because of the possible excessive blood loss, wide-channel venous cannula is required. After positioning the patient, arterial cannula should be placed for monitoring the patient. If there is a risk for excessive blood loss, central venous catheter should be utilized for purpose of transfusion. However, central venous pressure monitoring could not demonstrate cardiac performance related to fluid infusion [34].

3.1.3. Choice of anesthesia

General endotracheal anesthesia is indicated; consideration should be given to a combined general/neuraxial technique for postoperative analgesia [35]. The sensorial block level must be Th10 for TUR BT and Th6 for radical cystectomy or prostatectomy. Especially, obturator nerve blockade should be added to neuraxial block to prevent the adductor jerk due to electrical stimulation of cautery applied in lateral wall localized tumors of the bladder. Obturator nerve block is performed following verification of the level of spinal anesthesia with the patient in lithotomy position. A 21 gauge 100 mm stimuable needle is inserted perpendicularly 2 cm inferior and 2 cm lateral point from the pubic tubercle. According to the "traditional approach", the needle was inserted from the skin through the inferior rami of the pubic bone, redirected anterolaterally and contacting with the obturator nerve after advancing to a depth of 2–4 cm. After the contraction of adductor muscle group was observed, 10 mL 0.25% levobupivacaine was administered with current at 0.3–0.5 mA [3, 4].

3.1.4. Complications

The anesthesiologist should always consider that patients underwent radical cystectomy and urinary diversion could produce bacteremia. If ileal conduit operation performed, ionic

alterations may cause metabolic disturbances. This disorder usually emerges in the form of hyperchloremic metabolic acidosis. When urine contact with intestinal segment, ammonium, ammonia, hydrogen and chloride are reabsorbed from intestinal segment. Alkalizing agents or drugs such as chlorpromazine or nicotinic acid that blockade the chloride transport can be used successfully for the treatment of this disorder [35].

Hemorrhage is the most common observed complication of radical surgery in urological field. For radical prostatectomy operations during the pelvic lymph node dissection hypogastric veins can be injured and results in extensive blood loss. Similarly, the deep dorsal vein complex can be injured during the transection of this vein complex and extensive blood loss may also occur. Additionally, deep vein thrombosis and pulmonary thromboembolism are other radical prostatectomy-related major complications [30].

3.2. Nononcological surgery of bladder and prostate

Nononcological urological surgery procedures of bladder and prostate include such as transurethral resection of prostate, suprapubic transvesical prostatectomy and cystoscopy. Most patients with bladder obstruction caused by benign prostatic hyperplasia are successfully treated by transurethral resection of the prostate (TURP) or, if prostate size is over than 70 cc, suprapubic transvesical prostatectomy could be performed [36]. Diagnostic examination of the lower urinary tract is often performed using a cystoscope and initial diagnosis and treatment of bladder cancer is conducted by transurethral resection of bladder.

3.2.1. Preoperative considerations

This procedure is often performed on older patients with impaired renal function, cardiovascular and respiratory problems. Thus, it is important to limit the block level to minimize hemodynamic changes during the spinal anesthesia in such patients [37, 38].

3.2.2. Intraoperative considerations

During the resection of prostate, surgeon must take maximum care not to damage prostatic capsule. In 2% of the patients who underwent resection of the prostate, capsule perforation may occur. In these patients, symptoms such as restlessness, nausea, vomiting and abdominal pain can be observed. If perforation occurred, the operation must be terminated immediately [39]. Bleeding may occur during the TURP but can be controlled easily. Since the irrigation fluids and blood mix during the TURP, it is difficult to determine the amount of bleeding. According to the researches, estimated bleeding during the TURP operation is 2–4 mL/min of resection time or 20–50 mL/g of resected prostatic tissue [40]. The need for transfusion due to hemorrhage during TURP is in 2.5% of patients undergoing TURP [41].

The clinical presentation of TURP syndrome is multifactorial, initiated by excessive absorption of irrigating solution that affects central nerve system (CNS), cardiovascular, respiratory and metabolic homeostasis. Initial signs of TURP syndrome cover burning sensations in the face and neck along with lethargy and apprehension. Additionally, headache and irritability may be observed due to affected CNS. Finally, visual disturbances, confusion, seizures and eventually coma may be observed. These CNS disturbances have been attributed to hyponatremia, which occurs with the absorption of any type of irrigating solution and

hyperglycinemia and/or hyperammonemia if glycine is used [42, 43]. The amount and rate of fluid absorption depend on several factors such as hydrostatic pressure of the irrigation fluids, bladder distention, the size of opened venous sinuses and the length of resection time [44]. If there is a suspicion of TURP syndrome, operation must be terminated immediately and blood samples including electrolytes, creatinine, glucose and arterial blood gases must be sent for analyses and electrocardiogram should be obtained [45]. Treatment of hyponatremia and excessive fluid loading should be adjusted according to the severity of the patient's symptoms. When patient's symptoms are mild (serum sodium level is greater than 120 mEq/L), only fluid restriction combined with loop diuretics can be enough to bring increased serum sodium levels to normal levels. If the serum sodium levels are less than 120 mEq/L, intravenous hypertonic saline administration is recommended for the patients with severe symptoms. The 3% sodium chloride solution 100 mL/h should be infused and the patient's serum sodium levels should be corrected at a rate not greater than 0.5 mEq/L/h [46, 47].

3.2.3. Choice of anesthesia

Sedation and routine patient monitoring is enough for minor procedures. But other procedures such as suprapubic transvesical prostatectomy and TURP or necessitate full distension of the bladder, a neuraxial anesthesia should be used. The block level must be Th10.

3.2.4. Complications

Bleeding, transurethral resection syndrome (TUR), bladder perforation, hypothermia, intraoperative and early postoperative occurrence of disseminated intravascular coagulation are most common observed complications of TURP. Providing stable anesthesia is essential for these patients to minimize hemodynamic changes. Under the general anesthesia, it could be difficult to realize complications such as TUR syndrome and bladder perforation, so regional anesthesia is recommended for TURP operations [48, 49]. Side effects of TUR BT is bladder perforation that has a reported incidence of 0.9–5% and presents with the signs and symptoms of inability to distend the bladder, low return of irrigation solution, abdominal distension and tachycardia [50]. Rarely, intraperitoneal fluid extravasation related to bladder perforation during the TUR BT can be identified as 'TUR BT syndrome'. Similar clinic symptoms can be observed like TUR P syndrome, but in TUR BT syndrome, intravascular fluid deficit that causes renal impairment is not observed. The mechanism of the possible causes of intravascular hypovolemia is that sodium equilibrates with the intraperitoneal fluid [51]. If the tumoral mass localized near the obturator nerve in bladder wall, bladder perforation may occur during the resection. The obturator nerve usually passes through the pelvis close to the lateral bladder wall, bladder neck and prostatic urethra. During the resection of bladder cancer, obturator nerve may stimulated by electrocautery that causes bladder perforation by the forceful thigh contraction of adductor muscles. Recently, combined neuraxial and obturator nerve blockage is recommended to prevent this complication. This combined technique is recommended to reduce the complications of general anesthesia in these patients which often covers older patients with lots of comorbidities.

4. Anesthesia for urethra and genital surgery

4.1. Oncological surgery of genital legion

In this section, the title of oncologic surgery of the genital region covers the operations of radical orchiectomy and retroperitoneal lymph node dissection. Initial treatment of testicular cancer is radical orchiectomy with inguinal incision. Retroperitoneal lymph node dissection (RPLND) for the treatment of testicular cancer is a relatively rare and complex operation after chemotherapy.

4.1.1. Preoperative consideration

The preoperative medical evaluation of cancer patients should include an assessment of nutritional status, functional status and symptom control (particularly regarding cancer-related pain) in addition to an assessment of general medical issues. The natural history of the cancer and effects of any prior chemotherapy or radiation therapy should also be considered [52].

Pulmonary insufficiency may occur in patients who underwent retroperitoneal lymph node dissection and have adjuvant bleomycin preoperatively. Oxygen toxicity and fluid overload may also develop, too. Physicians must be careful in terms of developing acute respiratory distress syndrome postoperatively for these patients.

4.1.2. Intraoperative consideration

Routine monitorization of the patient is enough. If bradycardia occurs, surgeon must be warned to reduce the stretch of the spermatic cord and if it does not improve, 1 mg atropin should be given.

4.1.3. Choice of anesthesia

Neuraxial anesthesia has been considered as the anesthetic technique of choice for radical orchiectomy. Sensorial block level must be Th10, but minimized to psychiatric trauma, sedation must be added to neuraxial blockade. For the RPLND procedure general anesthesia must be chosen. If neuraxial blockade is chosen (if general anesthesia is contraindicated), high-level sensorial block (Th4) with sedation must be performed.

4.1.4. Complications

Sometimes in this procedure, vagal reflex and bradycardia can occur during the operation due to stretch of the spermatic cord and patient can feel pain.

4.2. Nononcological surgery of urethra and genital legion

This section covers urological procedures such as cystoscopy, urethrotomy interna, scrotal orchiectomy, hydrocelectomy, varicocelectomy and penile prosthesis implantation.

4.2.1. Preoperative consideration

These procedures generally do not require any particular anesthetic technique, depending upon the procedure, the medical condition of the patient and patient's and/or surgeon's preference, one technique may be more appropriate.

4.2.2. Intraoperative consideration

Routine monitorization is advised. During the varicocelelectomy, bradycardia can occur due to stretch of the spermatic cord.

4.2.3. Choice of anesthesia

Many of these procedures are ambulatory, performed in cystoscopy suites with a rapid turnover of patients and the anesthetic choice must also consider these concerns. Evaluation of the lower urinary system tract is often performed by the urologist with a flexible cystoscope. This procedure generally performed by the urologist with local topical anesthesia applied to the inside of the urethra as it does not require full bladder distention. If patient could not tolerate pain, the procedure must be performed under monitored anesthesia care with sedation [53]. Neuraxial anesthesia has been long considered the anesthetic technique of choice for these urological procedures. The sensorial block level must be Th10.

4.2.4. Complications

During the varicocelelectomy, bradycardia can occur due to stretch of the spermatic cord.

5. Anesthesia for urological laparoscopic surgery

Laparoscopic procedures in urology cover both oncological surgery like nephrectomy, prostatectomy, cystectomy and nononcological surgery like pyeloplasty. Laparoscopic surgery has found wide applications in urological surgery with the developing technology. After laparoscopic surgery, some complications due to pneumoperitoneum began to occur more frequent.

5.1. Preoperative considerations

An anesthetic plan is developed based not only on the patient's physical status determined by the assessment but on how the patient will tolerate pneumoperitoneum and body position during the surgery. Some factors like obesity and Trendelenburg level may increase the intraabdominal pressure during the laparoscopic operations. These factors should be considered, when anesthetic management is planned. Difficult airway, cardiopulmonary status, allergies, medications and comorbid conditions are important issues for patients undergoing laparoscopic surgery. Especially, decision of laparoscopic surgery should be considered carefully in patients with advanced respiratory disorder because of the high risk of anesthesia.

5.2. Intraoperative considerations

Pneumoperitoneum and patient positioning impede normal respiratory mechanics. Placement of an endotracheal tube allows the ventilator to supply the work necessary to breathe. Gastric secretions are commonly seen in the oropharynx or on the face of patients at the end of surgery. The placement of an arterial line may be indicated if the patient's medical condition warrants closer blood pressure monitoring nasogastric tube decompression of the stomach and Foley catheter drainage of the bladder is the basic procedure for most urologic laparoscopic surgeries. Hypothermia is common beginning with the disruption of thermal regulation due to anesthesia.

5.3. Choice of anesthesia

Most common anesthetic plan is general anesthesia. General endotracheal anesthesia is chosen to counter the adverse conditions created by the pneumoperitoneum, patient positioning and surgical time. If general anesthesia is contraindicated, high level sensorial block (Th4) can be performed.

5.4. Complications

Anesthetic complications are addressed through that prism: anesthetic strategies to minimize hemodynamic changes due to pneumoperitoneum and patient position. Increasing the intrathoracic blood volume improved hemodynamic function in all body positions with pneumoperitoneum. Fluid management is the most important element for minimizing pneumoperitoneum side effects [54].

Most common observed complications of laparoscopic surgeries are swelling of the face, eyelids, conjunctivae and tongue along with a plethoric color of venous stasis in the head and neck. Although facial edema is common, but laryngeal edema may prevent the extubation of patient and can cause delay extubation in 5% of patients [55, 56].

6. Anesthesia for urologic emergency

Urologic emergencies requiring surgical intervention are relatively rare. This section reviews both the common and rare urologic emergencies such as renal trauma, bladder trauma, urethral trauma, scrotal trauma, testicular torsion and fournier gangrene.

Testicular torsion occurs due to rotation of spermatic cord around. This rotation blocks the blood flow of testis and impairs venous drainage. As a result of this pathology, edema, ischemia and necrosis develop. Testicular torsion is common in the two periods of life. While first peak is at age of 1–2 years, second peak is common in adolescence. Testicular torsion is rarely observed after the age of 40 [57].

6.1. Preoperative considerations

In patients with Fournier gangrene, there is usually rapid development of severe toxemia leading to sepsis and progressive organ dysfunction. The appropriate administration of intravenous fluid therapy to maintain an effective circulating volume and prevent inadequate tissue perfusion is a core element of the preoperative practice of the anesthesia [58].

6.2. Intraoperative considerations

Routine monitorization is advised for all patients with urological emergencies. The patient with the risk of hypovolemia and hypotension, central venous catheterization must be performed to monitor the central venous pressure and providing rapid fluid transfusion. Invasive arterial blood pressure must be done to follow blood pressure in patients with the risk of hypotension.

6.3. Choice of anesthesia

Most common anesthetic plan is general anesthesia in trauma patients, but neuraxial blockade can be chosen for testicular torsion. If affected area is localized in patients with Fournier gangrene or the patient is not septic, neuraxial blockade can be chosen, too. The sensory block level must be chosen according to the level of lesion. T10 sensory block level can be enough for testicular torsion.

7. Patient positioning for urological surgery

Nerve injuries comprise 22% of all anesthesia-related medico-legal claims in the United States [59]. In an extensive study that reviewed 380,680 cases over 10 years in single center reported that perioperative nerve injuries were observed in 112 cases. Urological procedures were 15% of all cases and 13% of cases have peripheral nerve injuries [60].

Different ocular injuries can be observed. Although minor complications like corneal abrasion that can occur in any position are common, major complications like ischemic optic neuropathy occur in prone or Trendelenburg positions [61]. Compartment syndrome has been reported to occur in several positions after prolonged urologic surgery [62].

7.1. The supine position

The upper extremities should be properly secured to avoid pressure on the ulnar groove or hyperextension. One or both arms may be adducted or abducted while supine. Padding should be placed over the elbow and any sharp objects and the arms secured using the draw sheet tucked underneath the patient rather than the mattress.

Ulnar neuropathy is the most frequent site (28%) of anesthesia-related nerve injury according to the ASA Closed Claims Database [63]. The median nerve is susceptible to neuropathy due to excessive stretching as it courses through the antecubital fossa. Careful attention should be given to avoid hyperextension at the elbow [64].

7.2. The prone position

It is most commonly used for percutaneous nephrolithotomy, adrenalectomy and pediatric pyeloplasty via the dorsal lumbotomy approach. During positioning, attention should be paid to avoid inadvertent extubation of the trachea and to maintain the neck in neutral position, fixed relative to the thorax. All pressure points, including forehead, chin, elbows, knees, shins and toes, must be properly padded.

A decrease in cardiac index (CI) can occur when turning patients from the supine to the prone position ranging from 12.9 to 24% [20].

In contrast to the supine position, the prone position results in a minimal reduction in functional residual capacity relative to the upright position [65].

Other rare complications related to the prone position are ophthalmic injury, upper airway edema and venous air embolism.

7.3. The lithotomy position

The lithotomy position is most frequently used for transurethral cystoscopy procedures or for open urologic procedures where access to the perineum and anus is necessary. Elevating the legs into the lithotomy position translocates the blood volume of the lower extremities into the central compartment, increasing venous return. Similar to the supine position, placing the legs into lithotomy position will shift the abdominal viscera cephalad into the diaphragm, decreasing lung capacities and compliance.

Neuropathy of the common peroneal nerve is the most common lower extremity neuropathy seen in the lithotomy position, accounting for 78% of lower extremity nerve injuries [66]. The obturator nerve, which supplies motor innervation to thigh adductors, may be stretched when the patient's hips are flexed beyond 80–100° [67]. Posterior tibial nerve, lateral femoral cutaneous nerve and saphaneus nerve can be injured during lithotomy position.

7.4. The Trendelenburg position

The Trendelenburg position is obtained by tilting the patient in the supine position to head down. According to the Trendelenburg position, abdominal organs move toward the diaphragm and facilitate the exploration of lower abdomen and pelvis by surgeons. The arms should be abducted <90° in the neutral position preferably. Physicians should be careful about the sliding down of the arms from the board when patient is tilted [68].

The Trendelenburg position may cause visual loss by impairing the venous drainage of the head. If the patient's head below the level of the heart, increased intracranial and venous pressure can intensify the pressure on optic nerve [69].

Edema can be observed in head or neck, due to the increased intracranial and venous pressure caused by the prolonged Trendelenburg position. Swelling of the face, eyes, larynx and tongue may occur and is essential for indication of fluid resuscitation.

7.5. The lateral decubitus position

The lateral decubitus position generally is preferred to explore surreal gland, kidney or collecting system without entering the peritoneal space. This position is suitable for simple nephrectomy procedure, removing renal tones that required open surgery and ureter stones localized in the upper urinary system.

Cardiac output while in the lateral decubitus position should remain unchanged unless venous return is impeded. Ventilation is increased in the dependent lung and gas exchange remains unchanged [70].

Author details

Zeki Tuncel Tekgül^{1*}, Burcu Özalp Horsanali¹ and Mustafa Ozan Horsanali²

*Address all correspondence to: zekitek gul@yahoo.com

1 Department of Anesthesiology and Reanimation, Izmir Bozyaka Research and Training Hospital, Izmir, Turkey

2 Department of Urology, Izmir Atatürk Research and Training Hospital, Izmir, Turkey

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