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Anesthesia for urological procedures

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ABSTRACT

Urological procedures are performed on patients of varying ages, including pediatric and elderly individuals. Given the high prevalence of renal dysfunction in patients undergoing urological surgery, a comprehensive preoperative assessment is of particular importance, with a particular focus on renal function. There are a number of potential risks associated with patient positioning and position-related management during surgical procedures. It is crucial to consider the potential for complications, such as nerve damage and respiratory changes, when determining the optimal position for each patient, taking into account safety concerns. It is essential to determine the optimal anesthesia technique for urological surgical procedures, to identify potential complications, and to establish invasive monitoring protocols for high-risk cases. A comprehensive approach is essential for ensuring patient safety and attaining optimal surgical outcomes in urological procedures.

Keywords: Urology, anesthesia, management, patient safety

INTRODUCTION

Although the majority of patients who undergo genitourinary surgery procedures are elderly, these surgical procedures are performed on patients of all age groups. With appropriate perioperative anesthesia management; this process can be successfully managed despite its unique challenges, including physiological changes and comorbid conditions in the geriatric population and physiological and congenital problems of the pediatric population.[1,2]

Renal dysfunction is more common in patients undergoing urologic surgery than in other surgical groups. In the preoperative evaluation, the volume status of the patients, cardiac and pulmonary findings that may develop accordingly, complete blood count, renal function tests (urea, creatinine, glomerular filtration rate, creatinine clearance) and electrolyte values should be meticulously examined. In patients receiving renal replacement therapy, dialysis is generally recommended before surgery and acidemia should be monitored by blood gas analysis. Since the elimination of most of the drugs to be used during anesthesia is renal, it should be taken into consideration that dosage adjustment will be required to prevent accumulation of the drug itself or its metabolite in renal failure.[2,3]

PATIENT POSITIONS

The patient can be placed in different positions on the operating table according to the type of surgical procedure. While increasing the comfort of the surgical team by giving the appropriate position, the comfort of the patient (especially awake patients under regional anesthesia) should not be ignored. With the given position, minimum changes in respiratory and hemodynamic parameters should be ensured and possible nerve damage should be prevented.[4]

Supine Position

It is the most commonly used position. It is the standard for induction of anesthesia even if the patient will be operated on in another position. The head and neck should be supported with a suitable pillow. The arms should be spread at maximum 90 degrees to protect from brachial plexus nerve injury. In radical surgeries such as cystectomy, retropubic prostatectomy, pelvic lymph node dissection, patients are hyperextended in the supine position to facilitate access to the pelvis.[4,5]

Lithotomy Position

It is the most used position after the supine position in gynecological and urological procedures. Two staff are required to ensure that both legs can move simultaneously while

positioning. Incorrect positioning and inadequate padding can lead to nerve damage. Most commonly, loss of dorsiflexion of the foot occurs as a result of inadequate support of the lateral thigh and damage to the common peroneal nerve. Inadequate medial thigh support may result in saphenous nerve damage and loss of sensation on the medial aspect of the leg, while excessive thigh flexion may result in obturator/femoral/sciatic nerve damage. It should be remembered that compartment syndrome can develop with prolonged lithotomy. In addition to nerve damage, lithotomy also has adverse respiratory and hemodynamic effects. Functional residual capacity decreases with positioning, so atelectasis and hypoxia may develop. Elevating the legs shifts the vascular volume towards the centre, increasing blood pressure and cardiac output. When the operation is completed and the patient is returned to the supine position, care should be taken to avoid hypotension, as the blood will return to the lower limb in the opposite direction.[5,6]

Prone Position

In this position, the patient lies face down on the table. During positioning, attention should be paid to malposition of the endotracheal tube and, after turning the patient prone, auscultation should be used to confirm that both lungs are participating in respiration. Special pillows should be used to prevent pressure on the eyes and nose. In order for the chest to expand properly, the chest wall needs to be supported on both sides, particularly by reducing pressure on the woman's breasts. Similarly, the abdominal wall should be supported on both sides to prevent an increase in intra-abdominal pressure, and care should be taken to avoid pressure on the genitals, especially in men. Bone contact areas should be supported with soft padding.[4,5]

Lateral Decubitus Position

In this position, the patient lies on the right or left side. As endotracheal tube malposition may occur after positioning, the same precautions should be taken as in the prone position. The head and neck should be adequately supported to ensure axial alignment. Brachial plexus damage should be prevented by supporting the underlying axilla. The lower leg should be semiflexed, the thigh extended and supported by a soft material such as a pillow, and the bone contact areas also supported by soft pads. Ventilation/perfusion mismatch develops with position, functional residual capacity in the underlying lung decreases and atelectasis develops. The patient is placed in the lateral decubitus position and hyperextension is applied to facilitate access to the renal pelvis.[4,7]

Trendelenburg Position

This is the head-down position when the patient is supine. The endotracheal tube may slide deeper during positioning and after positioning it should be confirmed that both lungs are participating in breathing. As a result of gravity, the intra-abdominal organs are directed cephalad, which increases the intrathoracic pressure. Because the patient's head is below the level of the heart, intracranial pressure increases over time and head and neck oedema may occur. Venous drainage of the eye may be impaired and optic nerve damage may occur with increased intracranial pressure. Particular attention should be paid to the possibility of developing oedema of the face, eyes, tongue, larynx and brain due to the extreme degree of trendelenburg position in robotic surgery.[4,7,8]

ENDOUROLOGICAL INTERVENTIONS

Cystoscopy

It is the most common urological procedure. The lithotomy position is used for the procedure. In children, general anesthesia is used. In adults, the procedure can be performed under general anesthesia, regional anesthesia or local anesthesia, with or without sedation.

If general anesthesia is preferred, LMA is usually sufficient due to the short duration of the procedure. If regional anesthesia is preferred, spinal or epidural anesthesia including the T10 dermatome is sufficient. Due to the shortness of the urethra, topical anesthesia is more commonly used in women.[3,9,10]

Transurethral Resection of Bladder Tumor (TUR-BT)

The incidence of bladder cancer is three times higher in men than in women. It is the fourth most common type of cancer in men and the ninth most common type of cancer in women. In the TUR-BT procedure, tumor tissue that has formed in the bladder is removed by continuously washing the bladder and applying electric current to a special ring through the cystoscope.[3]

The procedure can be performed under general anesthesia or regional neuraxial anesthesia. A sensory block involving the T10 dermatome is sufficient for neuraxial anesthesia.[1,10] If the tumor is located on the lateral wall of the bladder, the obturator nerve will be stimulated with each use of the electrocautery in patients under spinal/epidural anesthesia due to the anatomical proximity of the obturator nerve, and adduction movement will occur in the leg. To prevent this movement, an obturator nerve block should also be performed when spinal/epidural anesthesia is to be used in patients with bladder sidewall tumors.[11,12]

Transurethral Resection of the Prostate (TUR-P)

It is the most commonly used surgical procedure for the treatment of benign prostatic hyperplasia. Just like in the TUR-BT procedure, continuous washing is done and an electric current is given to the ring passed through the cystoscope and the prostate tissue is resected.

General anesthesia or neuraxial anesthesia may be preferred. Neuraxial anesthesia requires a sensory block at the T10 level.[3,9]

Some complications may occur due to the characteristics of the prostate tissue and the irrigation fluid used. Bleeding, TURP syndrome, bladder perforation, hypothermia and disseminated intravascular coagulation (DIC) are some of these complications. Perforation of the prostate capsule occurs in 2% of patients and if it does, surgery should be terminated as soon as possible. Although bleeding is common during a prostate resection, it can be easily controlled. However, continuous irrigation causes blood to mix with the irrigation fluids and the amount of blood is not easy to calculate. DIC can occur as a result of thromboplastin released from the prostate tissue during the intraoperative process. Hypothermia occurs when large volumes of irrigation solution are used and not warmed sufficiently. If the patient shivers because they are cold, this can dislodge the clot and cause the bleeding to start again.[13,14]

TURP syndrome is a multifactorial condition that affects the central nervous system (CNS), cardiovascular system, respiratory system and metabolic homeostasis as a result of

excessive irrigation solution absorption (at least 2 liters). Early clinical symptoms include a burning sensation in the face and neck, anxiety and lethargy. Headache and irritability are other CNS findings. Eventually there can be blurred vision, confusion, seizures and finally coma. CNS findings are due to acute hyponatremia resulting from the absorption of any type of irrigation solution and hyperglycinemia/hyperammonemia when glycine is used as an irrigation solution. The rate and amount of irrigation solution absorbed depends on factors such as the hydrostatic pressure of the solution, bladder distension, the size of the venous sinuses opened by the resection and the length of the resection period. As regional anesthesia is superior to general anesthesia, the operation must be terminated quickly if the patient develops clinical symptoms and TUR syndrome is suspected. Renal function tests, electrolytes, glucose and arterial blood gas sampling should be obtained. Treatment of TUR syndrome should be based on the severity of symptoms. If symptoms are mild, the serum sodium level is greater than 120 mEq/L. In this case, loop diuretics together with fluid restriction are sufficient to correct serum sodium. If the serum sodium level is less than 120 mEq/L, a 3% hypertonic sodium chloride infusion should be administered at a rate of not more than 0.5 mEq/L per hour.[15,16]

One of the major complications of TUR-P is sepsis. Sepsis is significantly associated with a higher prostate volume and also with a longer duration of the TUR-P, the group of antibiotics used for prophylaxis and a longer duration of catheterisation. On the other hand, the data about antibiotic prophylaxis in TUR-P are controversial and outdated.[1] It may be advisable to send urine cultures from patients undergoing TURP in the preoperative period and to use antibiotics in case of bacterial growth.[17]

Ureteroscopy (URS) / Retrograd Intrarenal Surgery (RIRS)

The URS procedure uses a rigid ureteroscope to fragment small and medium-sized ureteral stones, and the RIRS procedure uses a flexible ureteroscope to fragment small and medium-sized kidney stones. Smaller stones are passed in the urine, and larger stones are removed with a basket. A double-J stent is usually placed after the procedure.

While general anesthesia or neuraxial regional anesthesia at the T6 sensory level may be preferred for URS, general anesthesia is generally preferred for RIRS.[3,10]

PERCUTANEOUS NEPHROLITHOTOMY (PNL)

PNL is performed on kidney stones larger than 2 cm through a 1 cm incision on the patient's back. The stone, the location of which has been determined using fluoroscopy, is reached with a nephroscope through an incision in the back. The broken stone pieces are removed from the body. At the end of the operation, a nephrostomy catheter is placed in the patient.[9]

General anesthesia is preferred. Attention should be paid to the complications of the prone position as patients are operated on in this position. Nowadays, peripheral nerve/plane blocks such as quadratus lumborum block (QLB) and erector spina plane block (ESP) can be applied for postoperative analgesia.[18,19]

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL)

ESWL is the process of focusing repeated high-energy sound waves on the stone to break up upper ureteral stones. The fragmented stones are passed in the urine.

General anesthesia has advantages such as control of the patient's movements and breathing. In this way, focused high-energy waves can be prevented from damaging tissues such as the lungs and intestines.

High energy shock waves may trigger arrhythmias in patients with a history of arrhythmias or in patients with a pacemaker or ICD. In addition, shock waves can damage the internal components of these devices.[20]

RADICAL SURGERY

Radical Retropubic Prostatectomy (RRP)

RRP is a surgical procedure used to treat prostate cancer by removing prostate tissue and anastomosing the neck of the bladder directly to the urethra. To prevent postoperative erectile dysfunction, nerve-sparing surgery has become more common.

A combination of general anesthesia and neuraxial techniques is often preferred for postoperative pain management. Excessive hyperextension in the supine or even Trendelenburg position is very difficult for the awake patient to tolerate.[21] Bleeding is the most important complication that can occur during the intraoperative and postoperative period. However, deep vein thrombosis (DVT), pulmonary thromboembolism (PTE) and air embolism from the prostate tissue above the level of the head are other complications that may be seen. Invasive arterial monitoring and insertion of at least two large peripheral vascular lines or, if necessary, a central venous catheter are recommended for anesthesia management.[9,22,23]

Radical Cystectomy

The surgical procedure entails the complete removal of all anterior pelvic organs in the treatment of advanced bladder tumors. Following cystectomy, the ureters are connected to a segment of bowel, forming a urinary diversion.

In most cases, general anesthesia and neuraxial regional anesthesia techniques are combined.[24] The surgical procedure is typically prolonged and associated with significant blood loss. It is necessary that invasive arterial monitoring is conducted, and that a central venous catheter or at least two peripheral vascular access points with large lumens are established. The administration of hypotensive anesthesia has been demonstrated to result in a reduction in the incidence of bleeding. It is of significant importance to provide appropriate intravenous hydration in order to ensure adequate urine flow following the anastomosis of the ureters. The prolonged contact of urine with the intestinal mucosa, which occurs as a consequence of slow urine flow, has been identified as a potential cause of metabolic disorders. In the event of an ileal ureteral anastomosis, there is a potential for hyperchloremic metabolic acidosis to occur. With a jejunal ureteral anastomosis, the

possibility of hyponatremia, hypochloremia, hyperkalemia, and metabolic acidosis arises. As with RRP, other potential complications include DVT and PTE.[23,25]

Radical Nephrectomy

Radical nephrectomy is a surgical procedure performed for renal cell carcinoma, the most common type of kidney tumor, which is resistant to chemotherapy and radiation therapy. It is not uncommon for paraneoplastic syndromes, such as hypertension, hypercalcemia and erythrocytosis, to be observed in these patients. In a minority of patients, comprising 5 to 10% of cases, tumor tissue extends as a thrombus into the renal vein and inferior vena cava. In a range of between comprising 5 to 10% of cases, tumor tissue is observed to extend as a thrombus into the renal vein and inferior vena cava.[26]

It is common practice to utilise both general anesthesia and neuraxial regional anesthesia techniques in conjunction with one another. Given the likelihood of hemorrhage, it is recommended that invasive arterial monitoring be conducted. It is advised that at least two wide-lumen peripheral vascular access or central venous catheters be inserted. The tumor has extended to the right atrium via the inferior vena cava, which renders central venous catheterisation an inherently risky procedure due to the potential for tumor rupture and pulmonary embolisation. Patients are operated on in the lateral decubitus position, which entails hyperextension. It is of the utmost importance to exercise caution with regard to the potential complications associated with this particular position, which have been previously discussed.[23,26]

Retroperitoneal Lymph Node Dissection

This surgical procedure is performed for the purposes of staging and treatment of nonseminomatous germ cell tumors. A midline incision is employed to facilitate the removal of lymphatic tissue situated between the bifurcation of the iliac vessels and the renal vessels. As a consequence of sympathectomy, the ability to ejaculate is irreversibly lost, resulting in complete infertility in patients who have undergone the procedure.[27]

Due to the significant postoperative pain typically experienced by patients, general anesthesia is often combined with neuraxial regional anesthesia techniques. Patients who receive chemotherapy with bleomycin in the preoperative period are at risk of developing postoperative oxygen toxicity, volume overload and ARDS. It is not uncommon for atelectasis to occur in patients who have undergone surgery and who have not received adequate postoperative analgesia.[28]

Radical Orchiectomy

It constitutes the primary treatment for testicular tumors. The procedure may be conducted with the patient under either general or regional anesthesia. It is imperative that the anesthetist exercise caution to avoid reflex bradycardia, which may result from the traction of the spermatic cord.[9]

UROLOGICAL LAPAROSCOPIC / ROBOTIC SURGERY

The advancement of technology has led to a significant expansion in the range of urological laparoscopic procedures, which now encompass nephrectomy, prostatectomy, cystectomy and pyeloplasty.

General anesthesia is the preferred method for patients undergoing laparoscopic surgery. However, if general anesthesia is contraindicated, T4 high-level neuraxial block methods may be employed as an alternative. The Trendelenburg position with pneumoperitoneum also has an adverse effect on respiratory dynamics, particularly in patients with a high body-mass index and during prolonged surgical procedures. The decompression of the stomach with a nasogastric tube and the emptying of the bladder with a Foley catheter are standard procedures in laparoscopic surgery. In the event that invasive arterial monitoring is required, it may be applied.[23]

It has been demonstrated that an excessive Trendelenburg position during robotic surgery may result in the development of oedema in various regions of the body, including the face, eyelids, tongue, larynx and brain. This is attributed to the congestion of the venous system. Severe edema of the airways may render extubation of the patient challenging. Furthermore, once the position has been established, it becomes challenging to gain access to the patient in robotic surgery. It is of the utmost importance that the vascular access and arterial cannula are positioned and fixed meticulously.[22]

SCROTAL SURGERY

The most common indications for scrotal surgery are hydrocele and varicocele. General anesthesia or neuraxial regional anesthesia techniques may be preferred. It is important to exercise caution in the event of reflex bradycardia, which may occur as a result of traction on the spermatic cord.[9]

PEDIATRIC SURGERY

The most common indications for pediatric urological surgery are circumcision, orchidopexy, hypospadias, epispadias and ureteropelvic stenosis.

The administration of general anesthesia is typically the preferred option. Postoperative pain can be managed with the use of caudal, penile, or local anesthetic applications. The LMA is frequently the preferred choice for short-term surgical procedures.[29,30]

PAIN CONTROL

The mitigation and therapy of pain is one of the most important primary medical tasks. Some of the urogenital operative procedures only cause little pain (e.g. vesical interventions or operations of the male genitalia). In these cases, oral analgesia using an NSAID and/or weak opioid is usually sufficient. Other more invasive operations, e.g. nephrectomy and cystectomy, result in severe pain and disturbance of gastrointestinal function, requiring intravenous opioid or perispinal therapy. The latter includes intrathecal (spinal) and epidural infusion of local anaesthetics with or without opioids. Nowadays, peripheral nerve/plane blocks such as quadratus lumborum block (QLB) and erector spina plane block (ESP) can be applied for postoperative analgesia. Multimodal analgesia not only enhances patient satisfaction but also improves the surgical outcome.[31]

CONCLUSION

Effective anesthesia management is critical to the success of urological surgical procedures, ensuring both patient safety

and optimal outcomes. This requires a thorough understanding of the unique physiological considerations across various patient populations and procedure-specific requirements. Comprehensive preoperative evaluations, meticulous attention to patient positioning, and tailored anesthetic techniques are fundamental to minimizing complications and enhancing recovery. As technology advances and surgical methods evolve, the role of anesthesia must adapt to address new challenges, particularly in robotic and minimally invasive surgeries. Ultimately, a multidisciplinary approach that integrates anesthesiology, surgical expertise, and postoperative care is essential for improving patient experiences and outcomes in urological surgery.

ETHICAL DECLARATIONS

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The authors have no conflicts of interest to declare.

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All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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