Chapter 21: Anesthesia for Genitourinary Procedures

Swapna Chaudhuri

INTRODUCTION

FOCUS POINTS

1. Pediatric patients undergo a wide variety of genitourinary procedures, which can range from isolated outpatient surgeries to complex reconstructions.
2. Most urological procedures are elective in nature, and majority of these patients are healthy or with stable chronic medical conditions.
3. Latex-free precautions during perioperative management are highly recommended in patients with chronic urological conditions due to concerns of hypersensitivity after repeated latex exposure.
4. Regional anesthesia and analgesia are excellent alternative/complementary techniques for genitourinary procedures with minimal risk when performed in asleep patients.
5. Perioperative medications should be reviewed in advance and administration or discontinuation discussed [chronic steroids or other immunosuppressants, antihypertensive medications such as angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin II receptor blockers (ARBs)].
6. Renally excreted medications should be adjusted perioperatively to decrease the risk of further renal impairment.
7. End-stage renal disease (ESRD) patients on dialysis should be particularly reviewed for fluid status and symptoms between dialysis sessions.

The genitourinary system has been described to have the highest percentage of congenital anomalies. A study of antenatal ultrasounds reported a frequency of 21% for urinary tract abnormalities;[1] this is supported by a review that estimated the screening sensitivity of urogenital anomalies to be almost 88%.[2] In the newborn period, ultrasonography is the preferable diagnostic tool for initial evaluation of abdominal masses; almost 55% of these have been shown to be of renal origin.[3] It is important to remember that nephrogenesis continues to progress until 36 weeks of postconceptual age. At birth, there is a significant decrease in renal vascular resistance with an associated increase in glomerular filtration rate.

Children undergoing urological procedures may be prone to emotional disturbances because of repeated interventions. In addition, patients with obstructive uropathy and chronic renal insufficiency are susceptible to frequent urinary tract infections (UTIs). Therefore, special attention to their psychological well-being and to the risk of septicemia is warranted in the perioperative period.[4]

This chapter highlights key surgical conditions involving the genitourinary system, and provides a brief overview of the anesthetic management for this diverse population of surgical patients.

KEY SURGICAL CONDITIONS

External Genitalia and Urethra

Circumcision

Circumcision, which involves surgical removal of foreskin of the penis, is a common outpatient operation in healthy male children. Besides religious and sociocultural reasons, medical indications include phimosis, balanitis, and urine outlet obstruction.

Neonatal circumcision has a low complication rate and is usually performed in the nursery under local anesthesia. In infants and children, circumcision is performed under general anesthesia, using face mask, laryngeal mask airway (LMA), or endotracheal tube.[5] While a caudal block may be performed for postoperative analgesia, a multimodal regimen using acetaminophen (10 to 15 mg/kg IV) and topical anesthesia (lidocaine-prilocaine) or a dorsal penile block is equally effective.

Two major complications of circumcision include infection and bleeding.

Hypospadius and Chordee

Hypospadius refers to malposition of the urethral meatus on the undersurface of the penis; 15% to 20% have an associated downward curvature of the penis (chordee), while 8% have an undescended testis.[4] Depending on the severity of the hypospadius, the operation may require a staged repair.

The procedure is usually performed at 6 to 18 months of age. Based on patient age, premedication may be needed (usually after age 6 months) to overcome separation anxiety. General anesthesia is usually initiated with an inhalation induction for outpatients without an existing IV, and maintenance accomplished with a balanced volatile agent–narcotic technique.

Regional anesthesia choice usually depends on preference of the surgeon as well as location of the hypospadius. For a distally located malposition, penile nerve block, together with nonsteroidal analgesics, can be quite effective. For more severe abnormalities and longer procedures, a caudal epidural block (0.2% ropivacaine or 0.25% bupivacaine, 0.8 to 1 mL/kg), with/without an indwelling catheter intraoperatively for supplementation, can reduce analgesic requirements, without delaying micturition.

Posterior Urethral Valves

Posterior urethral valves (PUVs) are a common etiology for congenital urethral obstruction that can produce a spectrum of urological and renal sequelae.[6] Antenatal diagnosis, proteinuria, and hydronephrosis have all been postulated as predictors of poor long-term renal function; nadir creatinine, the lowest creatinine during the first year after diagnosis, has been demonstrated as an independent prognostic indicator for poor renal outcomes.[6]

These patients are usually scheduled for elective surgery. Because they often present with various degrees of renal insufficiency, serum electrolytes and other renal function tests should be examined preoperatively. General anesthetic technique is usually required; close monitoring of urine output and of intravenous fluid administration is highly recommended.

Cystoscopy

Cystoscopy is performed for various diagnostic and therapeutic procedures, including assessment of urological anomalies, recurrent UTIs, correction of urethral strictures, as well as treatment of urolithiasis. Prophylactic antibiotics are usually needed (gentamicin 5 mg/kg or amoxicillin/clavulanic acid 30 mg/kg).

Anesthetic management involves preoperative medication for separation anxiety if needed, and general anesthesia with face mask or LMA. Postoperative care often includes dexmedetomidine (0.5 mcg/kg) and acetaminophen (IV or oral: 10 to 15 mg/kg) for pain management, and ondansetron (0.1 mg/kg) for prophylaxis against postoperative nausea and vomiting (PONV). Patients should be monitored for hemorrhage and hyponatremia (which could be caused by absorption of irrigation fluid).

Feminizing Genitoplasty

Feminizing genital surgery is performed to treat disorders of sexual development (DSD), and involves three surgical procedures—clitoroplasty, labioplasty, and vaginoplasty. The commonest cause for DSD is congenital adrenal hyperplasia (CAD), believed to result from exposure of a 46 XX female fetus to androgens before the 12th week of gestation.[7] CAD is an autosomal recessive disorder primarily caused by deficiency of 21-hydroxylase

enzyme in the steroidogenic pathway; CAD patients have both glucocorticoid and mineralocorticoid deficiencies.

The first two reconstructive surgeries may be undertaken in infancy, while vaginoplasty is recommended around puberty. During general anesthetic management, key issues to address are metabolic disturbances and adequate steroid supplementation. Postoperative analgesia can be provided effectively via a caudal epidural catheter.

Scrotum and Testes

Cryptorchidism and Orchiopexy

Approximately 33% of premature male infants are born with one undescended testis; if left untreated, cryptorchidism is associated with a tenfold greater risk of malignancy. Besides the higher incidence of prematurity, cryptorchidism is often associated with congenital conditions such as Noonan syndrome, Prader-Willi syndrome, and cloacal exstrophy.[4]

Orchiopexy involves mobilization of the testis from the inguinal canal, or less commonly, from the abdominal cavity. Surgical placement of the testis often requires a two-stage repair; both stages of the Fowler-Stephens approach (clipping and transecting the testicular vessels) may be performed with laparoscopic surgery.

Preoperative evaluation for residual complications of prematurity and oral premedication to manage separation anxiety are recommended. Anesthetic management involves general endotracheal anesthesia with muscle relaxation, especially if performed by laparoscopy. Traction and manipulation of the spermatic cord and testicle may cause bradycardia and laryngospasm; relieving traction, deepening of anesthesia, administering anticholinergic medications (atropine, glycopyrrolate), and intraoperative blocks can alleviate these side effects.

Regional anesthesia by blocking the iliohypogastric and ilioinguinal nerves with local anesthetics (ropivacaine or bupivacaine), together with parenteral and oral analgesics, is a great measure for postoperative pain relief.[5]

Testicular Torsion

Acute onset of scrotal pain in the absence of trauma requires prompt investigation for testicular torsion. This is one of the few pediatric urological emergencies where surgery should be performed within 6 hours of onset of pain to save the testis.[8] General anesthesia with rapid sequence induction and endotracheal intubation is the usual technique in this situation. Surgical therapy usually relieves the pain; therefore, aggressive postoperative pain management is not normally required.

Urinary Bladder and Ureters

Bladder and Cloacal Exstrophy

Bladder exstrophy, a rare congenital anomaly with 2:1 male preponderance and a familial association, involves protrusion of the urinary bladder through a defect in the anterior abdominal wall. It is part of a spectrum of exstrophy–epispadius complex that may include cloacal exstrophy, spinal defects, and pelvic diastasis.[5]

A staged surgical repair is planned soon after birth, which involves closure of the bladder, abdominal wall, and possibly pelvic osteotomies. Epispadius repair is undertaken at 6 to 12 months of age, while bladder neck reconstruction is usually performed at 4 to 5 years, once bladder training has occurred.

Preoperative assessment should include evaluation of any cardiac anomalies, renal insufficiency, and electrolyte imbalance. General anesthesia for the initial repair is similar to that for most prolonged newborn surgeries; invasive hemodynamic monitoring, close attention to fluid and blood resuscitation and temperature maintenance, and postoperative intensive care constitute the usual management plan.[4] Caudal or epidural analgesia with a secured/tunneled catheter, using 0.2% ropivacaine, 0.1% lidocaine, or 0.125% bupivacaine with/without epinephrine, is usually initiated intraoperatively and continued up to 48 to 72 hours.[9] Local anesthetic toxicity should be kept in mind, especially with use of bupivacaine or if continued beyond 2 to 3 days.[10] Chloroprocaine is an attractive alternative in neonates and infants, especially in patients with liver impairment, or

when higher infusion rates may be needed for large surgical incisions covering several dermatomes.[11]

Vesicoureteral Reflux

Vesicoureteral reflux (VUR) is a congenital defect, believed to be due to failure of ureteral development with abnormal insertion of the ureter into the bladder, resulting in retrograde flow into the ureters and kidneys during micturition. Secondary VUR usually results from urinary blockage following recurrent UTIs. Risk factors include female gender, age below 2 years, Caucasian race, and familial predilection. A voiding cystourethrogram can assist with assessment of the severity of reflux. Surgical intervention is usually required because if left untreated, VUR can lead to hydronephrosis, pyelonephritis, and progressive renal failure.

Ureteral reimplantation is a 3- to 4-hour open procedure under general endotracheal anesthesia with volatile anesthetics and muscle relaxants, paying close attention to normothermia and adequate urine flow. Effective postoperative analgesia can be achieved with caudal epidural block, or with transversus abdominis plane blocks (0.5 mL/kg 0.25% bupivacaine with 1:200,000 epinephrine). Postoperative bladder spasms can be treated with ketorolac and bethanechol.[12]

Laparoscopic techniques have been fairly successful but are associated with much longer surgical times.[13] Recently, endoscopic management of VUR under general anesthesia, with injection of tissue bulking substances at the vesicoureteral junction, has also been reported.[14]

While open ureteral reimplantation remains the gold standard for surgical correction of VUR, robotic-assisted laparoscopic ureteral reimplantation (RALUR) is increasingly being utilized. The latter provides the advantages of finer dissection and precise placement of intracorporeal sutures within a confined space, as well as lower postoperative analgesic requirements and decreased hospital stay.[15] However, RALUR is associated with longer operative times and increased costs; published outcomes are mixed and currently restricted to a few surgical facilities.[16]

Urolithiasis

Pediatric urolithiasis is much less common compared to adults; any metabolic (hypercalciuria, hyperoxaluria, cystinuria, etc.) patient should be investigated and treated preoperatively. Stones can be managed by extracorporeal shock-wave lithotripsy (ESWL), ureteroscopy, laser lithotripsy, percutaneous nephrolithotomy (PCNL) or via open approach. Deep sedation may be adequate for ESWL in older children; however, most cases will require general anesthesia with LMA or endotracheal tube, depending on the surgical procedure (muscle relaxation for ureteral stones). Postoperative management should include acetaminophen, ketorolac (IV 0.5 mg/kg), opioids, and prophylactic ondansetron for PONV.

Prune Belly Syndrome

Prune Belly syndrome is a male-dominated anomaly, consisting of a triad of anterior abdominal muscle deficiency with wrinkled overlying skin, urinary tract abnormalities, and undescended testes. This rare syndrome is often associated with orthopedic (congenital hip dislocation, scoliosis), gastrointestinal (malrotation, volvulus), and cardiac (tetralogy of Fallot, ventricular septal defect) abnormalities and with chromosomal defects (trisomy 18—primarily in girls—and trisomy 21).[17] Prognosis depends on the degree of renal impairment and pulmonary hypoplasia, with mortality approaching 50% by age 2 in severe cases.[18]

Children present to the surgical suite for correction of VUR, orchiopexy, or abdominal wall reconstruction. During management of general anesthesia in these cases, primary considerations should be directed to gastrointestinal, renal, and pulmonary issues. Postoperatively, vomiting and risk of aspiration after extubation are of concern, and respiratory tract infections are common. Continued postoperative ventilation may be the best approach for patients undergoing extensive abdominal procedures and when significant pulmonary disease is present.[5]

Kidneys and Renal Pelvis

Wilms Tumor

Also known as nephroblastoma, Wilms tumor is the commonest intra-abdominal tumor observed in children. It comprises about 5% of all cancers in children; approximately 500 to 600 new cases of Wilms tumor are diagnosed each year in the United States.[19] Most of these patients present with a painless abdominal mass between 3 and 4 years of age. About 10% of patients have a syndromic association, primarily Beckwith-Wiedemann

syndrome (macrosomia, overgrowth syndrome) and Soto syndrome (overgrowth, distinctive facial features, learning disability). Almost 50% present with hypertension at diagnosis. Acquired von Willebrand disease may be seen in about 10% of patients.[4] Tailored multimodal therapy consists of radical nephrectomy, chemotherapy, and radiation. With progress in management of Wilms tumor over the past few decades, overall cure rates have exceeded 85%. Prognosis is primarily dependent on clinical staging and histological characteristics of the tumor.[20]

Most children presenting for radical nephrectomy should be evaluated preoperatively for concomitant syndromes, serum electrolytes, complete blood counts, coagulation profile, and renal function studies. Children with more extensive disease may undergo chemotherapy prior to surgery; cardiac assessment with echocardiography is recommended in these cases. Anesthetic considerations primarily pertain to the lengthy transabdominal retroperitoneal procedure (thermoregulation, positioning, fluid balance) and increased intra-abdominal pressure (intermittent inferior vena cava compression, ventilatory issues) in small children. Injury to major organs with potential for hemorrhage is also a concern during these procedures.[20] There is no particular drug choice for general endotracheal anesthesia (sedative, muscle relaxant) unless renal compromise has been documented (adjustment of renally excreted medications should be considered). Two large-bore peripheral IVs should be placed above the diaphragm; arterial monitoring is recommended for patients with large tumors or extensive disease. Postoperative analgesia is achieved with opioids or regional epidural analgesia (either caudal or thoracolumbar with threaded catheter to the level of the incision), provided the risk of coagulopathy is ruled out.

Ureteropelvic Junction Obstruction

Ureteropelvic junction (UPJ) obstruction usually occurs due to intrinsic or extrinsic compression of the ureter, resulting in hydronephrosis. The goal of surgery is to relieve UPJ obstruction at the renal pelvis. This is usually achieved with an open dismembered pyeloplasty, via an extraperitoneal flank incision.[12] Pediatric laparoscopic and robotic pyeloplasty are increasingly being used as an alternative to the open approach.[21]

Anesthetic considerations include proper patient positioning, adequate fluid resuscitation, and postoperative pain. Blood loss is usually not an issue. General endotracheal anesthesia with standard monitoring is the norm. For robotic surgery, additional concerns with positioning, immobilization, ventilation difficulties, etc., should be addressed.[22] Local infiltration with bupivacaine, and postoperative opioids with nonsteroidal anti-inflammatory drugs (NSAIDs) and ketorolac are reasonable measures for postoperative analgesia.

ANESTHETIC MANAGEMENT

Preoperative Evaluation

A comprehensive preoperative evaluation should include the patient's medical history and a physical examination (which can be difficult in an uncooperative child) with focus on comorbid conditions (cardiopulmonary, syndromic). Pertinent laboratory investigations should also be included based on clinical conditions and surgical procedure (electrolytes, creatinine levels, coagulation profile, hemoglobin, and platelet counts).

As with most pediatric cases, thorough preparation of the operating room (appropriate room temperature, warming blankets, padding appropriate for age and size, etc.) prior to entry of the patient is essential. In addition to spina bifida patients who are a known high-risk group for latex sensitization, other patients undergoing repeated urological interventions are also prone to latex sensitivity. Therefore, a latex-free environment should be utilized and discussed during time-out.[23]

Depending on the patient age, timely and adequate preoperative medication (midazolam, dexmedetomidine, ketamine through oral, intranasal, intramuscular, or intravenous route) will go a long way toward achieving a calm and comfortable patient, as well as allaying anxiety for the parents.

In-room setup for cases requires the usual attention to detail that is essential for these small-size patients. Laryngoscope blades with correct (slim) handle, cuffed endotracheal tubes, oral airways, laryngeal mask airways (LMAs), etc. need to be age- or patient size–appropriate. Having a video laryngoscope (C-MAC®, GlideScope®) readily available is optimal when dealing with premature and syndromic children. Fluid delivery systems (buretrol and intravenous tubing, fluid warmers) should be free of air bubbles and ready to go before the patient enters the operating room. Pediatric suction tip and tubings need to be readily available, and appropriate ventilator settings should be programmed. Relevant anesthetic medications (sedatives, muscle relaxants, opioids), as well as resuscitative drugs, should be drawn up in appropriate-sized syringes, paying particular attention to appropriate dilutions as necessary.

Patients for genitourinary procedures may have impaired renal function and may be on chronic disease medications. All medications should be reviewed carefully, and specific instructions should be given regarding perioperative administration. Fluid administration and nil per os (NPO) guidelines should also be reviewed. A discussion with the pediatric nephrologist may be prudent to outline goals and expectations for perioperative management. If the patient has end-stage renal disease (ESRD) and on dialysis, the surgical procedure or diagnostic evaluation requiring anesthesia should be planned in between dialysis sessions (or at least 4 hours after dialysis) to allow for adequate volume and electrolyte equilibrium.

Secondary effects include abnormalities in the cardiovascular system; therefore, an electrocardiogram and/or a transthoracic echocardiogram may be beneficial to evaluate perioperative risk.

Systemic hypertension can be associated with renal insufficiency and subclinical cardiovascular disease.[24] In chronic hypertensive patients, wide fluctuations in blood pressure are expected intraoperatively especially if they are on medications such as angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin II receptor blockers (ARBs). Patients with proteinuria or following renal transplantation may be on chronic steroid supplementation. As such, the daily oral dose should be continued and a stress dose of a glucocorticoid (1 mg/kg IV hydrocortisone) should be considered intraoperatively to prevent clinical manifestations of adrenal suppression such as refractory hypotension. Postoperative steroid administration should be discussed until resumption of usual medications orally.[4] Table 21-1 shows the relative equivalent doses and activities for IV steroids in comparison to oral prednisone.

Table 21-1

Comparative Potency and Relative Equivalent Doses of Steroids

Steroid/Activity	Glucocorticoid Potency	Mineralocorticoid Potency	Equivalent Glucocorticoid Dose (mg)
Hydrocortisone	1	1	20
Methylprednisolone	5	0.5	4
Dexamethasone	30	0	0.75
Prednisone (po)	4	0.8	5

Intraoperative Management

Anesthetic Technique

The type of anesthetic technique is dictated by the surgical procedure, level of patient cooperation, surgeon preference, and comfort level of the anesthesiologist. The overwhelming majority of cases are performed by general anesthesia—using face mask, LMA, endotracheal tube—as deemed appropriate. Regional anesthesia—using spinal, epidural, and peripheral nerve blocks—is usually performed in supplementation; it may be utilized as the sole anesthetic in isolated cases. Spinal anesthesia (0.5% preservative-free bupivacaine 1 mg/kg with/without epinephrine) has been described for infants undergoing urological procedures with an 89% success rate.[25] Caudal epidural blocks in sedated patients are a safe and effective means of providing postoperative analgesia for pediatric patients, including for neonates.[10]

Anesthetic Medications

Volatile inhalational agents are the mainstay of general anesthetic techniques, with sevoflurane with/without nitrous oxide being used for inhalation induction. Any intraoperative medications should be adjusted based on renal impairment if present with avoidance of nonsteroidal anti-inflammatory medications (unless explicitly discussed with surgical colleague). Fentanyl and other opioids (bolus/infusion/neuraxial) are administered in most patients. Dexmedetomidine is an excellent agent to alleviate anxiety (sedative agent) to prevent/treat emergence delirium in pediatric patients and to decrease perioperative opioid consumption. Antiemetics (ondansetron) and analgesics (acetaminophen) should also be strongly considered as adjuncts. Bupivacaine, lidocaine, and ropivacaine are primarily used for regional anesthesia and analgesia. Safe total amounts in mg/kg doses, when

used with or without epinephrine, should be calculated prior to administration. Increased toxicity of bupivacaine, especially when used for caudal epidural analgesia in neonates, is a concern.

Monitoring

Standard noninvasive monitoring is adequate for the vast majority of cases (circumcision, orchiopexy, ureteral reimplantation). Invasive hemodynamic monitoring (arterial and central venous) is recommended for prolonged complex procedures, and for those with potential for major fluid shifts and significant blood loss. Measures to maintain optimal temperature (forced-air mattress, heated blanket) should be in place. Urine output should be monitored as an index of fluid status and perfusion.

Positioning

Laparoscopic and robotic surgeries are increasingly being utilized for pediatric urological procedures including pyeloplasty, nephrectomy, and antireflux surgery. Surgical advantages of minimally invasive surgery consist of better visualization of surgical field, mechanical improvements, stabilization of instruments, and improved ergonomics for the operating surgeon.[22] Anesthetic concerns for these procedures are related to specific positioning such as steep Trendelenburg and to inadequate patient access intraoperatively. Positioning may affect ventilation, intra-abdominal pressure, and in return cardiac output and systemic perfusion.

Postoperative Care

Disposition after surgery to the outpatient recovery facility, post-anesthesia care unit (PACU), or intensive care unit (ICU) is dependent on (a) patient comorbidity, (b) type and outcome of surgery, and (c) intraoperative anesthetic course. Intraoperative management should include anticipation and prophylactic treatment for emergence delirium, PONV, and postoperative pain. Judicious administration of opioids and non-narcotic drugs (acetaminophen, ketorolac, etc.) should be complemented with intraoperative topical anesthetics and effective use of regional blocks whenever appropriate.

Ambulatory surgery patients should meet discharge criteria recommended for pediatric patients as age-appropriate. Premature children or patients with obstructive sleep apnea should be considered for an overnight stay.

For patients requiring inpatient stays, discharge from PACU should similarly meet age-appropriate criteria. Indwelling epidural or peripheral nerve catheters should be followed up religiously to ensure adequate pain relief, and to avert potential complications such as catheter migration, bleeding, or persistent neuropathy.

Patients requiring ICU postoperatively should be transferred to the respective unit with continued monitoring, oxygen supplementation (Ambu bag support when intubated), sedation, and analgesia. Resuscitative drugs and airway adjuncts should be carried with the patient during transport. Complete hand-off to the critical care team should be initiated outlining perioperative concerns and specific intraoperative management challenges, if any.

SUMMARY

Pediatric patients undergoing urological procedures are a diverse group of children. The acuity of the surgical intervention usually determines the perioperative anesthetic plan. Patient comorbidity is usually the greatest factor determining the rate of perioperative complications as well as the length of hospital stay. With growing experience and advanced training of pediatric urologists in laparoscopy and robotic surgery, it is incumbent upon pediatric anesthesiologists to gain familiarity and comfort in providing safe and effective perioperative care to pediatric patients undergoing minimally invasive genitourinary procedures.

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