American Society of Anesthesiologists

Anesthesia for Select Urologic Procedures

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Learning Objectives:

As a result of completing this activity, the participant will be able to

- Describe how new surgical techniques for transurethral resection of the prostate (TURP) have impacted anesthetic management and patient outcome
- Explain current perioperative challenges in urological robotic and renal calculi procedures
- Interpret the anesthesiologist's role in renal transplantation in distinct perioperative phases (donor management, allograft preservation, and recipient management) that determine transplant outcome

Author Disclosure Information:

Dr. O'Hara has disclosed that he has no financial interests in or significant relationship with any commercial companies pertaining to this educational activity.

NEW SURGICAL TECHNIQUES FOR TRANSURETHRAL RESECTION OF THE PROSTATE

In male patients presenting with symptomatic benign prostatic hypertrophy (BPH), the surgeon's goal is to resect as much prostatic tissue as possible while preserving the prostatic capsule. Complications occur when the rich plexus of prostatic veins is opened during surgical resection. This creates a conduit for bleeding and bladder irrigating fluid absorption when under pressure. Bipolar electrode resection and prostate lasers are replacing monopolar TURP as alternative surgical techniques for BPH resection.

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Monopolar TURP

The conventional gold standard for TURP was the monopolar electrode resectoscope (Figure 1). With the monopolar electrode, layers of prostatic tissue are resected with a cutting current that is transmitted through a single-limb electrode and exits the patient by way of a grounding pad. A nonelectrolyte bladder-irrigating solution is required to avoid dispersion of the electrical current and tissue damage at the site of prostatic resection. TURP syndrome is a potentially serious complication that can occur when a nonelectrolyte, hypoosmolar bladder-irrigating solution is used. The severity of the complication depends on the amount of the intravascular bladder-irrigating solution that is absorbed by prostatic veins opened during resection.

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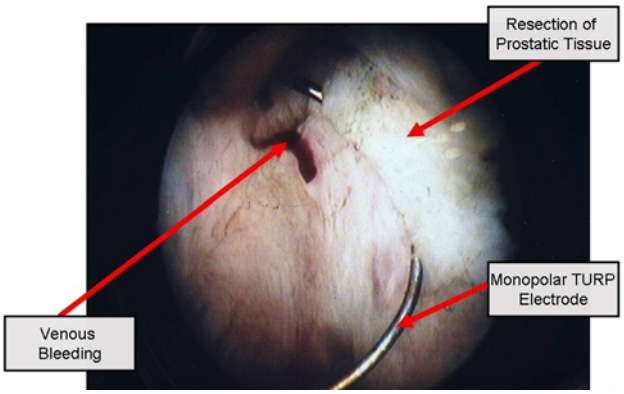

Figure 1. Monopolar electrode demonstrating prostate tissue resection as viewed through resectoscope. Note venous bleeding suspended in bladder irrigating fluid from partially resected vein.

Complications of TURP

Complications caused by TURP include dilutional hyponatremia, glycine toxicity, ammonia toxicity, bacteremia, anemia, hypothermia, bladder perforation, bleeding, and coagulopathy (see Supplemental Digital Content 1, http://links.lww.com/ASA/A70). Factors related to the volume of irrigating fluid absorption include the duration of resection and the height of the irrigating solution bag above the patient. The ideal irrigation fluid for monopolar TURP would be isotonic, nonhemolytic, nontoxic, nonelectrolytic, nonmetabolized, visually nondistorting, rapidly excreted, and inexpensive. However, there is no ideal bladder-irrigating fluid for monopolar TURP surgery and 1.5% glycine is the standard solution used. In a review of the pathophysiology and management of TURP syndrome in monopolar TURP, it was reported that TURP syndrome may present clinically as early as 15 minutes after resection starts or up to 24 hours postoperatively, with intravascular rates reaching 200 mL/minute of the bladder-irrigating fluid.[1]

Bipolar TURP

Bipolar TURP electrode technology incorporates a continuous loop electrode to resect prostatic tissue of BPH. This surgical tool is designed to contain the inflow and outflow of current by the resectoscope for prostatic tissue resection. By being completely self-contained within the bipolar unit, the current is prevented from passing through the patient. The advantage of this system is that an electrolyte-containing solution such as normal saline can be used for bladder irrigation. Although intravascular absorption of normal saline can occur through resected prostatic veins opened during prostatic resection, hypoosmolality and hyponatremia associated with TURP syndrome are prevented. The risk of volume overload as a consequence of the bladder-irrigating solution can still occur with the bipolar TURP technique.

Issa[2] reviewed 16 studies over a 10-year period to compare the safety properties of monopolar and bipolar TURP; he found a statistically significant decrease in overall complication rate, transfusion rate, and TURP syndrome with bipolar TURP. A randomized outcome study by Chen *et al.*,[3] in which monopolar and bipolar TURP were compared, found that bipolar TURP was associated with significantly less fluid absorption, less change in serum sodium and in hemoglobin, and comparable urologic efficacy in prostate symptom scores and maximum urinary flows. Two meta-analytic studies comparing monopolar and bipolar TURP reported favorable outcomes in the bipolar TURP groups.[4,5]

Laser TURP

Laser TURP techniques produce a thin coagulation treatment zone (1 to 7 mm) during prostatic tissue resection.[6] This prevents excessive bleeding and intravascular absorption of bladder-irrigating fluid. In contrast to monopolar and bipolar TURP techniques, which open prostatic veins, the thin coagulation treatment zone seals them. As a result, bleeding and absorption of bladder irrigating fluid are minimized. Laser TURP is accordingly advocated for use in anticoagulated patients. Laser TURP can require several hours, depending on the size of the prostatic gland that is to be resected (see Supplemental Digital Content 2, http://links.lww.com/ASA/A71). Initially, sterile water was used as the bladder-irrigating fluid with laser TURP, without significant hyponatremia occurring.[7]Glycine as the bladder irrigating fluid is also acceptable. Significant absorption of the bladder-irrigating fluid during laser TURP does not normally occur. Currently, normal saline is generally recommended as the bladder irrigating solution during laser TURP. Of interest is our clinical experience which suggests that deactivation of an automatic implantable cardioversion device is not routinely needed during laser TURP.

Hanson *et al.*,[8] in their review of the anesthetic implications of newer laser TURP techniques, found that there was minimal absorption of bladder-irrigating fluid; that the techniques could be performed on anticoagulated patients; and that the techniques carried a lower risk of TURP syndrome. These findings placed less emphasis on regional as the "preferred anesthetic technique." Geavlete *et al.*[9] reported in a prospective randomized trial that in contrast to monopolar TURP, laser TURP had significantly decreased operative times, a shorter catherization period, shorter hospital stay, and fewer complications. A meta-analysis comparing laser versus monopolar TURP reported less clot retention and lower incidence of TURP syndrome, comparable postoperative bleeding, and a higher reoperation rate in the first year postoperatively.[5,9]

Overall mortality from TURP has steadily decreased: by 2.5% (in 1962), 1.3% (in 1974), 0.23% (in 1989), and 0.10% (in 2003).[10]

UROLOGIC ROBOTIC PROCEDURES

In many urologic procedures, the traditional laparoscopic approach is being replaced with robotic procedures in which a large, stationary multiarmed robot console is positioned around and above the patient for surgical mechanical laparoscopic assistance. To perform this procedure, the surgeon operates while sitting at a control unit that is

separated from the patient in the operating room. By manipulating joy sticks within the console, the surgeon directs laparoscopic movements in the surgical field. As with other laparoscopic surgeries, the usual physiologic changes of pneumoperitoneum and hemodynamic responses occur. However, unique features of urologic procedures using robotic laparoscopy include lithotomy position, often maximal Trendelenburg position, and a stationary robotic apparatus that secures intraperitoneal trocars to allow for kidney, bladder, and prostate procedures.

Robotic Laparoscopy Concerns

A prolonged lithotomy position places the patient at risk for lower extremity nerve injury. Patients in a prolonged maximal Trendelenburg position may also have increased risk of intraocular complications. Ocular complications have been reported after robotic prostatectomy in healthy patients.[11] Awad *et al.*[12] reported that intraocular pressure of patients in the steep Trendelenburg position increased statistically over baseline. Predictors included length of surgery, peak airway pressure, and an elevated end-tidal carbon dioxide level. However, the clinical significance of these findings has not been addressed. Chemosis is commonly observed postoperatively and is usually self-limiting. In severe cases, reassuring the patient and using moisturizing eye drops can help to prevent severe discomfort and corneal drying. Posterior ischemic optic neuropathy has been reported after robotic prostatectomy.[11] Kalmar *et al.*[13] reported that the effects of prolonged steep Trendelenburg and carbon dioxide pneumoperitoneum on hemodynamic, pulmonary, and regional cerebral oxygenation remained within safe limits. In laparoscopic radical prostatectomy, the incidence of gas embolism detected by transesophageal echocardiography was 17.7% but occurred without significant signs of cardiopulmonary instability.[14] Prolonged maximum Trendelenburg can result in marked laryngeal edema and postoperative respiratory distress.[15] Patients at risk for increased intracranial pressure should be identified. Ventriculoperitoneal shunt patients should be evaluated to ensure a functioning shunt before they are placed in an extreme Trendelenburg position. Although devices are commonly used to prevent patient movement on the operating table once maximum Trendelenburg is reached, careful evaluation of upper extremity positioning is nevertheless warranted to avoid brachial plexus neuropathy.

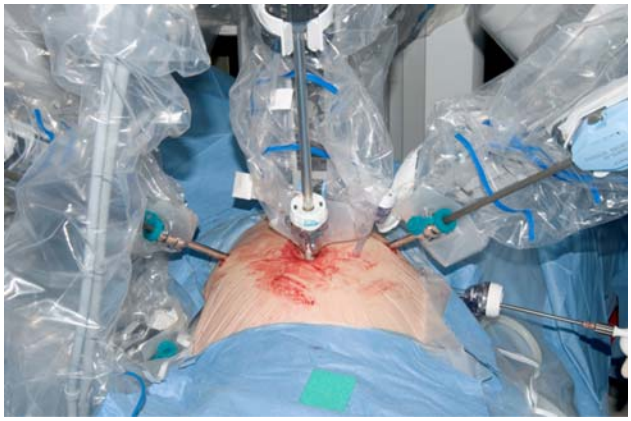

Figure 2. Robotic prostatectomy.

Once the laparoscopic robot is positioned, the multiple intraperitoneal trocar insertion sites (Figure 2) become fixed. Appropriate muscle relaxation to prevent patient movement and potential tissue injury is critical while the fixed trocars are in place. To prepare for an airway emergency, a plan for multiple trocar disengagement in a laterally positioned patient or in response to cardiac arrest should be rehearsed. Intraperitoneal carbon dioxide insufflation can lead to carbon dioxide subcutaneous emphysema. Even in moderate to severe cases, rapid resolution is expected once carbon dioxide insufflation is discontinued. Only in rare cases does the patient have to remain intubated postoperatively.

THE ANESTHESIOLOGIST'S ROLE IN RENAL TRANSPLANTATION

In the United States approximately 85,000 end-stage renal disease patients are listed for a renal transplant. The mean wait time for a deceased donor transplant is approximately 3.5 years. The latest reported trend, as of 2009, revealed that more deceased-donor (7,188) than living-donor (5,968) renal transplants are performed in the United States.[16] Renal transplantation remains the preferred treatment for patients with end-stage renal disease, and it is more cost-effective than long-term dialysis.[17] However, there remains a persistent shortage of organs for transplantation. Meier-Kriesche and Kaplan[18] concluded that the best outcome in renal transplantation occurs when the recipient receives a living donor kidney before the need to be placed on dialysis. It has also been shown that female recipients outperform male recipients because of the effects of estrogen and allograph size.[19]

The outcome in renal transplantation depends upon three perioperative factors: donor—deceased or living; allograft ischemia time—warm or cold; and recipient management.

Anesthesiologists are directly involved in managing the kidney donor patient during allograft harvesting.

Anesthesiologists are directly involved in managing the kidney donor patient during allograft harvesting. In accordance with the standard criteria governing deceased donors, the anesthesiologist manages physiologic functions to maintain end-organ perfusion for all harvested organs. In living-donor kidney transplantation, the anesthesiologist is responsible for perioperative care of the donor, who is undergoing a surgical procedure to benefit someone else. Anesthetic care in donation after cardiac death begins after the primary medical team declares the donor dead, after allograft harvesting has been completed, and when the recipient presents for transplantation. Paired donation renal transplants

involve matching two incompatible living pairs to conduct transplantation involving two living kidney donors. The anesthesia team plays a critical role in coordinating the initiation of these procedures, especially if each renal transplant is to be performed at separate hospitals.

The surgical team is responsible for monitoring warm ischemia time of the allograft during harvesting and again at reimplantation. The preservation team is responsible for cold preservation of the allograft.

The anesthesiologist cares for the recipient during allograft reimplantation. The important therapeutic efforts by anesthesiologists to preserve renal function during allograft harvesting and during reperfusion of the transplanted kidney are influenced by anesthetic techniques. Factors affecting the outcome for renal preservation include anesthetic choices, fluid management, and renal preservation therapies.

Donor Management

Deceased donor management centers on the maintenance of adequate intravascular volume and blood pressure in the operating room before organ harvesting (see Supplemental Digital Content 3, http://links.lww.com/ASA/A72). Retrospective data from renal transplant registries show that the administration of vasopressors (dopamine, dobutamine, isoproterenol) results in a lower incidence of acute rejection and improved graft survival after transplantation.[20] Although these data do not directly confirm a benefit in renal preservation, they do nevertheless suggest that these therapies provide adequate cardiac output for maintaining renal perfusion. Schnuelle *et al.*[21] reported that deceased donors receiving a continuous infusion of norepinephrine (≤ 0.4 μg/kg/minute), and who were randomized to a treatment group with an infusion of 4 μg/kg/minute of dopamine until cross-clamping at harvest, reduced the need for dialysis after renal allograft transplantation. Mannitol, dopamine, and diuretics are reported to prevent tubular obstruction by maintaining adequate urine output in the event of acute tubular necrosis. However, clinical evidence shows that the only diuretic conferring a renal preservation benefit is mannitol.[22]

Primary anesthetic goals center upon maintaining adequate renal perfusion, which is accomplished by inducing a moderate hypervolemic state and administering mannitol before allograft ischemia as a renal preservation therapy.

The management of living donor kidney transplantation usually involves preparation of a general anesthetic for laparoscopic kidney harvesting. Primary anesthetic goals center upon maintaining adequate renal perfusion, which is accomplished by inducing a moderate hypervolemic state and administering mannitol before allograft ischemia as a renal preservation therapy.

Donation after cardiac death accounts for the greatest percent increase in the supply of organs for transplantation. Anesthesiologists should understand that the primary care team, not the anesthesiology team, is primarily responsible for managing the donor in the critical care setting and in the operating room when donation occurs after cardiac death. The anesthesiology care team is generally involved only if they are the primary team caring for the donor in the critical care setting, or if they are asked to transport the donor to the operating room. Otherwise, the anesthesiology care team is not involved in the operating room. This constraint differs significantly from the criteria that govern a deceased donor.

Recipient Management

Anesthetic management of the recipient entails optimizing therapy for a patient with comorbidities, coordinating dialysis, and understanding the pharmacokinetic and pharmacodynamic effects of drugs administered to patients with end-stage renal disease. In deceased donor transplantation, prolonged cold ischemia time becomes urgent for the allograft; however, urgency should not preclude efficient steps being taken to optimally prepare a recipient for renal transplant surgery. Although regional anesthesia has been designated for renal transplantation, general anesthesia remains the predominant choice.[23] Placements of intra-arterial catheters are common and central venous catheters routine for intraoperative management.

Renal Preservation Management

Favorable outcomes in postrenal transplantation depend upon optimizing cardiac output while reestablishing renal allograft perfusion. These steps are more important than any of the multiple renal preservation therapies previously studied in renal transplantation.

Balanced crystalloid solutions remain the initial volume replacement therapy in renal transplantation. Potassium-containing solutions should be used cautiously, and saline-based fluids have been associated with acid-base disturbances because of the high chloride load.[21,24] Both short-term benefits (delayed graft function) and long-term advantages (graft survival after one year) have been reported in renal transplantation when volume expansion was done using human albumin.[22] However, it is debatable whether albumin administration was directly beneficial in renal preservation or indirectly beneficial by providing adequate intravascular volume. In renal transplantation, synthetic colloid administration should be used with the understanding that it has the potential to cause renal dysfunction.[22]

Pharmacologic therapies such as diuretics, dopamine agonists, and calcium channel blockers have been evaluated for renal preservation in allograft function. Mannitol (up to 50 g intravenously) administered to the recipient before allograft reperfusion reduced the delay time to graft function,

but failed to produce a long-term allograft benefit.[25–27] Administration of loop diuretics or dopamine intraoperatively failed to demonstrate an improvement in allograft outcomes.[22] Perioperative administration of calcium channel blockers to enhance renal arteriole dilatation demonstrated a decreased incidence of delayed graft function, but no long-term allograft benefit.[28,29] The majority of studies undertaken on renal preservation therapy in renal transplantation have been limited to deceased donors and often involved cases in which other therapies were administered.

Another anesthetic consideration for deceased donor management is hyperglycemia control. In an animal study, severe renal injury resulted when hyperglycemia was induced before a renal ischemia-reperfusion event.[30] Renal ischemia-reperfusion injury benefit was demonstrated when volatile anesthetics (isoflurane > sevoflurane, halothane, and desflurane) were administered before the ischemic event.[31] Accordingly, these anesthetics should be considered as potential renal preservation therapy when donors are deceased.

SUMMARY

Newer surgical techniques such as bipolar and laser TURP have been developed to minimize the incidence of TURP syndrome. These newer techniques are replacing monopolar TURP. Robotic laparoscopic urologic procedures present additional anesthetic management concerns related to the need for a prolonged maximal Trendelenburg position and mechanically fixed intraperitoneal trocars. The anesthesiologist plays a critical role in the management of donor and recipient in renal transplantation. Renal transplant outcomes depend upon the selection of renal preservation strategies, the most important of which is to maintain adequate cardiac output during allograft reperfusion.

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