Critical care and the urologic patient

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Urologic laparoscopy

Advances in urologic laparoscopy now enable complex ablative or reconstructive operations to be done. These include laparoscopic adrenalectomy, nephrectomy, prostatectomy, or bladder augmentation [1]. Although laparoscopic surgery is costly, time-consuming, and skill-demanding, the demonstrated benefit of shorter hospital stay, decrease analgesic requirement, and reduction in complications have made it an attractive alternative to conventional approaches [2,3].

Mortality and complication rates

In 2,407 urologic laparoscopic procedures from four centers, the overall complication rate was 4.4% with a mortality rate of 0.08% [4]. When the procedures were classified into easy, difficult, and very difficult, the complication rates were 1.0%, 3.9%, and 9.2%, respectively. The complication rate was fourfold higher for the first 100 procedures (13.3% versus 3.6%) compared to subsequent procedures. Major complications included major vascular (1.7%) and visceral lesions (1.1%). Admission to the intensive care unit (ICU) is often required for and requested for difficult procedures and the presence of major complications or comorbidities, especially during the learning curve period. In a series of 567 laparoscopic radical prostatectomies, the incidence of ICU stay after major complication was only 1.7% in an experienced center [5].

Routine postoperative ICU care

Elective ICU admission after urologic laparocopy is primarily confined to patients with significant comorbidities who require close monitoring and treatment of underlying illess(es). Attention should be paid to analgesia, hemodynamic and fluid status, and prevention of atelectasis. Oliguria may be due to urinary leakage, obstruction, or prerenal factors. Fluid challenge, measuring drainage fluid creatinine levels, flushing the urinary catheter or stent as appropriate, and imaging studies will aid in the differentiation. Urinary leakage is treated conservatively by percutaneous drainage. With current surgical techniques, ileus is unusual, and most patients may commence on liquid diet within 24 hours.

As with many surgical procedures, postoperative bleeding is a serious complication, which may manifest by tachycardia, hypotension, anemia, and increasing bloody drainage. Increasing abdominal girth with respiratory compromise is a late sign. Emergency laparotomy is mandatory, with or without angioembolization.

Bladder reconstruction surgery

Radical cystectomy for bladder carcinoma is a standard therapy with various types of urinary diversion available. Mortality after radical cystectomy has decreased eightfold from 14% in 1970s [6] to 2–3% in the 1990s [7,8]. Comparable results have been reported in patients greater than 75 years of age [7,9].

Urinary diversions

Ureterosigmoidostomy was the earliest type of urinary diversion, and severe metabolic complications were common [10]. It has been replaced by the ileal conduit since the 1950s. Orthotopic bladder replacement, although technically difficult, is increasingly done to provide a better quality of life and undisturbed body image [11]. A segment of the bowel is used to create an orthotopic neobladder that can be anastomosed to the urethra, allowing natural micturition. Two hundred patients [11] who underwent reconstruction by means of an ileal neobladder had an operative mortality of 2.4% and an early complication rate directly related to the neobladder of 6.5%.

Complications

The overall complication rate varies between 17% to 32% [12] with urinary leakage, sepsis, intestinal obstruction, and thromboembolic events being the most common. Mild metabolic acidosis was reported in up to 15% of patients [10]. Predictive factors for electrolyte and acid-base problems include a preoperative glomerular filtration rate< 30 mL/min [13], use of ureterosigmoidostomy [13], and ileal reservoirs constructed from 60- versus 40-cm length [10]. The mainstay of treatment of hyperchloremic acidosis is repletion of fluid and long-term oral sodium bicarboncate. Long-term metabolic disturbances include malabsorption, diarrhoea, renal stones, and osteomalacia [10].

Deep vein thrombosis prophylaxis

A study that enrolled 1,464 patients with risk factors of age greater than 40 years, obesity, malignancy, recent surgery, and history of pulmonary embolish (PE) or deep vein thrombosis (DVT), found that when patients with no risk factors were compared with those with four risk factors, the incidence of DVT increased from 11% to 100%, while the incidence of PE increased from 1% to 47% [14]. Prophylactic treatment in patient undergoing radical pelvic surgery can reduce the risk of DVT from 30% to 10% and that of fatal PE from 5% to 0.4% [15].

Mechanical means of DVT prophylaxis like intermittent pneumatic compression stockings and graduated compression stockings are attractive as they avoid the use of anticoagulants after a major operation. Intermittent pneumatic compression stockings is effective in decreasing the incidence of DVT in urologic patients [16,17]. However, the efficacy of graduated compression stockings was inferior to heparin/dihydroergotamin or intermittent pneumatic compression stockings [16]. Hence, graduated compression stockings are not recommended as the sole means of prophylaxis after pelvic or urologic surgery.

In 68 patients who received open prostatectomy, the DVT rate decreased from 39.4% to 9.7% and PE from 11% to 0% with the use of minidose heparin [18]. The morbidity from lymphocele formation and bleeding resulted in the comment that heparin should not be used routinely [18]. Low molecular weight heparin, theoretically associated with less bleeding, has gradually replaced the use of heparin. Despite the effectiveness of warfarin as DVT prophylaxis, its use was not recommended due to high bleeding rates [19]. However, low-dose warfarin keeping the postoperative prothrombin time 1.5 times baseline has been shown to be safe and effective for major urological operations [20].

The estimated incidence of late DVT, PE, and fatal PE are 20%, 2%, and 0.4%, respectively, after pelvic surgery [15]. A recent prospective, randomized trial has demonstrated the safety and efficacy of a 4-week course of enoxaparin 40 mg daily as thromboprophylaxis after abdominal and pelvic cancer surgery [21].

Routine ICU admission after radical cystectomy: past and present

After Hendry [22] reported that routine ICU care in the early postoperative period and epidural analgesia might have contributed to a better outcome, it is common practice to electively admit all patients to ICU after radical cystectomy [7,8,23]. Our practice, however, is to admit only selected patients. In one study, only 9% of high-risk patients with a median age of 77.5 and American Society of Anesthesiology class 3 (severe systemic disease) or 4 (disease that is a constant threat to life) who underwent radical cystectomy required admission to ICU for invasive monitoring, while 71% were directly transferred to the general urology ward after a 4-hour stay in the postanesthetic care unit. [24]. Factors that predicted active treatment requirement in the ICU were: American Society of Anesthesiology class, intraoperative complications and APACHE II score. Patient's age, operative time, intraoperative blood loss, and time to extubation had no impact at all [23].

Transurethral resection of prostate

Although transurethral resection of prostate is the current “gold standard” of surgical therapy for benign prostatic hypertrophy [25], laser therapy, transurethral microwave thermotherapy of prostate, transurethral electroevaporization of prostate, intraurethral stent, and transurethral needle ablation have been attempted. Laser therapy can achieve better hemostasis [26], while high-energy transurethral microwave thermotherapy can be performed on a outpatient basis with minimal need for anesthesia [27]. All these developments are expected to further reduce the requirement for ICU care.

Mortality and complications after transurethral resection of prostate

The 30-day mortality after transurethral resection of prostate currently ranges from 0.2–0.8% [28], but the morbidity has remained constant at 18% to 13% [28,29]. A resection time greater than 90 minutes and prostate gland size greater than 40–45 grams have been consistently shown in two study periods to be associated with increased morbidity [28,29]. Urinary tract infection remains the commonest postoperative complication (2.3–4%), and sepsis has been the leading cause of mortality [28]. Other complications include myocardial arrhythmia (1.1–1.3%) [28,29], myocardial infarction (0.2%) [29], transurethral resection syndrome (0.8–2.0%), bleeding requiring blood transfusion (2.5–0.2%), and bladder perforation (1.1%).

Urosepsis

Urologic instrumentation results in urethral abrasion and provides an avenue for bacterial entry [30]. Risk factors that predict an increased likelihood of infection are: preoperative infected urine, indwelling catheter [31], size of prostate > 45 grams, operative time > 90 minutes, and acute urinary retention [32]. The requirement for antibiotic prophylaxis to prevent urosepsis are well supported [33,34]. Prophylaxis with a second generation cephalosporin and/or an aminoglycoside is acceptable. A meta-analysis of prophylactic antibiotic therapy showed no difference among treatment durations of single dose, less than 72 hours or until catheter is removed, or more than 72 hours or after catheter removal [33].

Treatment of established postoperative urosepsis should be started while awaiting culture results. The most frequent infecting organisms are *Escherichia coli*, *Proteus*spp. and *Klebsiella*spp. [32], and empiric therapy with a beta-lactam and aminoglycoside combination such as ceftriaxone plus gentamicin is acceptable. In the case of hypersensitivity to beta-lactam or probable *Pseudomonas aeruginosa* infection, a fluoroquinolone can substitute for the beta-lactam [35]. Admission to ICU for other supportive measures should be considered, including the need for invasive monitoring, fluid resuscitation, and cardiopulmonary support. In the event of acute renal failure, our standard practice is to prescribe continuous veno-venous hemofiltration with regional citrate anticoagulation to avoid the risk of bleeding from heparin administration.

Transurethral resection syndrome

Pathophysiology

The pathophysiology of the transurethral resection syndrome is unclear, but acute water intoxication, toxic effects of glycine and ammonia (a biotransformation product of glycine) have all been implicated [36,37].

Plasma tonicity in the transurethral resection symptom can range from isotonic to hypotonic despite the universal finding of dilutional hyponatremia [36,37]. Before glycine enters the cell through a slow carrier-mediated process and is metabolized, its extracellular osmotic effect results in isotonic dilutional hyponatremia and a large osmotic gap. Once it enters the cell and is metabolized to nonosmotic products, its effect is equivalent to the infusion of an equal volume of free water with resultant hypoosmolarity and cellular edema. In the presence of normal cardiac and renal function, the kidneys respond by excreting the excess water load. In clinical practice, the effect of glycine infusion on sodium concentration, osmolality and water distribution is unpredictable [36].

Signs and symptoms

Neurologic and cardiovascular abnormalties are the two major clinical manifestations of the transurethral resection syndrome. Dilutional hyponatremia with cerebral edema results in agitation, mental confusion, seizures, and coma. Acute volume overload may manifest as hypertension and bradycardia. As the sodium level decreases below 120 mEq/L, it may exert a negative inotropic effect and cause hypotension. ECG changes include ST segment elevation, widening of QRS and T-inversion. Glycine has a direct neuroinhibitory effect, causing transient blindness [36]. Patients with encephalopathy and delayed awakening have an association with high ammonia levels.

Treatment

The diagnosis of hypotonic or isotonic hyponatremia is crucial. Hypotonic hyponatremia secondary to acute fluid overload will respond to fluid restriction and loop diuretics, and hypertonic saline may be reserved for severe symptomatic hyponatremia [36,37]. However, treatment options are less well defined in isotonic hyponatremia. It tends to be a self-limiting process as glycine is metabolized and excess free water is excreted [37]. Hypertonic saline in this setting may be harmful by causing central pontine myelinosis or pulmonary edema [36]. Severely decompensated patients may require cardiopulmonary support. A 3-hour session of hemodialysis was reported to completely correct hemodynamic, neurologic, and biochemical disturbances. The success of hemodialysis was attributed to the removal of glycine [36].

Renovascular disease: renal artery stenosis

Renal artery stenosis (RAS) accounts for 1–5% of unscreened hypertensive patients [38], although underdiagnosis is likely. It is associated with two important functional consequences, namely renohypertension and ischemic nephropathy.

Natural history of renal artery stenosis

Atherosclerotic RAS accounts for up to 90% of RAS. The prevalence increases with advanced age, diabetic mellitus, coronary artery disease, and peripheral atherosclerotic disease [39]. This disease is progressive, and a decline in renal function is a common sequelae [38,39]. The survival of patients in end-stage renal failure due to atherosclerotic RAS is poor, with a 27-month median survival and 12% 5-year survival [39].

Fibromuscular dysplasia accounts for 10% of the cases, more common in young women aged 20–50 years [38]. Involvement of the distal two-thirds of the renal artery produces the typical “string of bead” appearance on angiography. Progressive renal arterial obstruction is observed in 33% of patients, but it seldom progresses to total occlusion [40] and rarely causes excretory dysfunction [40].

Surgical treatment of renal artery stenosis

Aortorenal bypass and renal endarterectomy were commonly used in the past. Comparable results with extra-anatomical bypass like splenorenal or hepatorenal bypass is increasingly used to avoid operating on diseased aorta [41]. The reported surgical mortality varies from 2.1% to 6.1% [39]. Bilateral renal bypass [42], the need for aortic reconstruction [43], and severe renal insufficiency [44] have been associated with increased peri-operative mortality. Other complications [40] include early graft failure secondary to thrombosis (1.4–10%), myocardial infarction (2.0–9.0%), stroke (0–3.3%), hemorrhage requiring surgical exploration (2.0–3.0%), and cholesterol embolization (1.0–4.3%).

Indications for surgical treatment of renal artery stenosis

For blood pressure (BP) control in patients with fibromuscular dysplasia, the role of surgery has been replaced by medical treatment or percutaneous angioplasty [40]. In patients with atherosclerotic RAS, the aim of surgery has shifted from BP control to the salvage of renal function. Other indications for surgery include uncontrolled hypertension or deterioration of ischemic nephropathy after failure of the percutaneous approach, branch renal artery, stenosis associated with aneurismal disease or dissection [45], or RAS originating from a large aortic aneurysm [46].

Management of postoperative complications

Problems pertaining to any vascular surgery are hemorrhage and graft thrombosis. Tachycardia, low filling pressure, raised intraabdominal pressure, and hypotension unresponsive to fluid challenge signify significant intraabdominal hemorrhage and require reexploration. Hypotension or hypovolemia should be avoided to prevent aggravation of graft thrombosis. Careful titration of fluid status is needed in the presence of severe cardiac or renal dysfunction. Hypertension is common in the immediate postoperative period. Causes like inadequate pain control, hypothermia, and acute fluid overload should be excluded. A nitroprusside infusion is infrequently required to control the blood pressure. Unexplained hypertension should prompt urgent evaluation for graft thrombosis. Other signs and symptoms include loin pain and renal failure. Digital substration angiography is valuable for assessing graft patency.

Percutaneous transluminal angioplasty in renal artery stenosis

The mortality rate of percutaneous transluminal angioplasty is lower than surgery, varying from 0.5% [47] to 1% [48]. The complication rate ranges from 2% to 18%, with restenosis being the major limitation of the procedure. Although stenting improves the patency rate, the patency rate does not correlate with better outcome in terms of BP control [49] or improved renal function [50]. Other complications include contrast nephropathy (13%), retroperitoneal hemorrage (1%) [48], renal artery occlusion requiring surgery, and pseudoaneurysm at the site of vascular access [51]. Many of these complications require supportive care in the ICU.

In three recent randomized trials, percutaneous transluminal angioplasty with or without stenting had no short term benefit in BP control compared with medical treament [49,52,53]. The effect of percutaneous transluminal angioplasty on preservation of renal function is still not established, but a poor response was noted once the baseline creatinine level was elevated [48,51]. Hence, the role of invasive therapy in the treatment of atherosclerotic RAS currently remains unclear.

Urologic trauma

Urologic injury requiring ICU care is commonly due to bleeding from renal vasculature or as a component of multiple or pelvic trauma. Specific signs of urologic trauma include gross hematuria, blood at the urethral meatus, perineal hematoma, and a “free-floating” prostate on rectal examination. A suspicion of urethral involvement is a contraindication to urethral catheterization, until such injury has been excluded by retrograde urethrography. After primary survey and resuscitation, a CT abdomen with contrast can outline urogenital injury, and other sources of bleeding. Renal involvement on CT requires angiography to establish and define the renovascular injury. Embolization is then done when significant bleeding or an arteriovenous fistula is demonstrated. Renal artery thrombosis requires immediate surgery to minimize warm ischemic time.

Renal contusions, perirenal hematomas, and most renal fractures may be managed conservatively. An intravenous pyelogram is obtained after other life-threatening torso or pelvic injuries have been handled. Urinary extravasation with urinoma formation may present with signs and symptoms of an intraabdominal collection. This can be drained percutaneously to determine if it is infected. Continued extravasation of urine from the drain generally requires surgical repair. Upper ureteral injuries can be managed by primary repair or urinary diversion with percutaneous nephrostomy. Distal ureteral injuries may be managed by ureteral reimplantation into the bladder. Intraperitoneal bladder ruptures and penetrating bladder injuries require surgical repair. Membranous urethral injury is treated with suprapubic cystotomy.

Summary

Changing concepts of disease management, expanding indications for invasive therapy to elderly patients, together with technologic advances have changed the management of various urologic diseases. Although minimally invasive surgery may have reduced the need for ICU care, we are faced with new and unique treatment problems.