Asian Journal of Urology (2018) xx, 1–6

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journal homepage: www.elsevier.com/locate/ajur

Review

Adult iatrogenic ureteral injury and stricture—incidence and treatment strategies

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Received 16 September 2016; received in revised form 22 May 2017; accepted 23 June 2017

KEYWORDS
Iatrogenic;
Outcomes;
Reconstructive surgical procedures;
Surgical technique;
Surgical management;
Trauma;
Ureter;
Ureteral strictures

Abstract Iatrogenic ureteral injuries and strictures are a relatively common complication of pelvic surgery and radiation treatment. Left untreated they are associated with severe short- and long-term complications such as urinoma, septic state, renal failure, and loss of a renal unit. Treatment depends on timing of diagnosis, as well as extent of injury, and ranges from simple endoscopic management to complex surgical reconstruction under usage of pedicled grafts. While recent advances in ureteral tissue engineering are promising the topic is still underreported. Historically a domain of open surgery, laparoscopic and robotic-assisted approaches have proven their feasibility in small case series, and are increasingly being utilized as means of reconstructive surgery. This review aims to give an outline of incidence and treatment of ureteral injuries and strictures in light of the latest advances.

1. Introduction

Iatrogenic injuries and radiation treatment cause 75% of all ureteral strictures [1], which represent a rare but challenging field of reconstructive urology [2]. If left untreated they can result in serious short- and long-term complications such as urinoma and abscess formation, septic state, development of fistula, chronic renal failure, and even lost of a renal unit [3].

The management of ureteric injuries and strictures shows a broad range of therapeutic options from endoscopic management to complex reconstruction or even renal autotransplantation, and depends on the location, i.e. proximal, mid, or distal ureter and the length and severity

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Peer review under responsibility of Second Military Medical University.

https://doi.org/10.1016/j.ajur.2018.02.003

Please cite this article in press as: Gild P, et al., Adult iatrogenic ureteral injury and stricture—incidence and treatment strategies, Asian Journal of Urology (2018), https://doi.org/10.1016/j.ajur.2018.02.003

of the injury [4,5]. While the distal third of the ureter is a frequent site of injury (91%), the middle and proximal third are rarely affected (7%, and 2%, respectively) [4,6].

Due to its retroperitoneal location, mobility, and diameter as well as peritoneal coverage the ureter is shielded from external and blunt trauma. At the same time the ureter shows great proximity to anatomic structures that are common sites of gynecologic and general surgery, such as gonadal and uterine vessels, the cervix, iliac arteries, inferior mesenteric, and sigmoid vessels as well as colon and rectum [7]. Further it has a delicate subadventitial blood supply that is segmentally provided by the renal, gonadal, common iliac artery, and the aorta. Taken together its unique anatomy and proximity to other pelvic and abdominal organs render it prone to iatrogenic trauma. Common mechanisms of injury include either direct trauma (transection, suture ligation, crush injury, and coagulation), or indirect trauma that is afflicted by relative ischemia due to large caliber instruments, devascularization, and thermal injury [2,8–10].

This review aims to give an outline of incidence rates, diagnostics, and treatment for ureteric injuries and strictures.

2. Incidence

Gynecologic procedures account for the majority of ureteral injuries with 64–82%, while colorectal, vascular pelvic, and urologic surgery account for approximately 15%–26% and 11%–30%, respectively [7,10,11].

Incidences of ureteral trauma in gynecologic surgery have been reported to range between 0.3 - 2.5% [12–17] for hysterectomies and standard pelvic operations, and <5% of oncological procedures such as radical hysterectomy [4]. In an extensive review of 3344 articles the leading cause of ureteral injury in laparoscopically assisted surgery was vaginal hysterectomy (20%), followed by oophorectomy (11.4%), pelvic lymphadenectomy (10%), sterilization (7.1%), excision and resection of endometriosis (12.8%), and either adhesiolysis, lymphocele drainage, or electrocoagulation (4.3%) [18].

Of note, under the advent of minimally invasive surgery an increase of ureteral injuries in gynecological and general surgery has been seen in some [10,19,20] but not all conducted studies [21,22]. A prospective multicenter study that assessed laparoscopic hysterectomies over nearly 2 years found drastic differences in incidences of 13.9 and 0.4 cases per 1000 procedures in laparoscopic and open hysterectomy, respectively [13]. Another work, focusing on laparoscopic colectomy corroborated significant differences in incidences of 0.66% and0.15% in laparoscopic and open cases, respectively [20].

In regard to general surgery the commonest causes for ureteral injuries are low anterior and abdominal perineal resection, and incidences between 0.24% and 5.7% have been reported [11,19–21].

Urologic interventions including ureteroscopy, lymphadenectomy, and urinary diversion account for up to 13% or ureteral injury and strictures. Most commonly they are attributed to endoscopic procedures that involve stone treatment [1,7]. Mucosal abrasion occurs in 0.3%–4.1%, perforation occurs in 0.2%–6.0%, and ureteral avulsion amounts to 0.3%–1% of ureteroscopy. The formation of ureteral stricture as a consequence is seen in 0.5%–2.5% of cases [5,11,23–26].

Strictures associated with radiation treatment usually become apparent with a latency of several years and depend on the treatment modality and delivered dose of radiation. Previous studies reported incidence rates of 1.8%–2.7%, and 1.2% at 10 years of follow-up in prostate cancer and cervical cancer, patients, respectively [27].

3. Diagnosis& initial treatment

The treatment of ureteric injuries and strictures depends on their location, extend, and time of discovery. Ideally they are treated and repaired at the time they originate; otherwise therapeutic mainstay is to restore urinary drainage in order to prevent complications such as secondary retroperitoneal fibrosis, sepsis, and renal failure [1,3].

The majority of injuries (>65%) are diagnosed postoperatively [5,18]. A retrograde pyelogram is the diagnostic tool of choice, despite its high sensitivity it allows for placement of an indwelling stent that restores urinary drainage. If a retrograde pyelogram is not available, a computed tomography with intravenous urography (CT-IVU) should be performed and a percutaneous nephrostomy placed in combination with an attempt to place an indwelling stent in antegrade fashion. In short defects (≤2.5 cm) the placement of an indwelling stent, placed either retro- or antegradely makes for an adequate treatment and is removed after 2–6 weeks [6,28,29]. Injuries associated with ureteroscopy are only rarely treated with open surgery (0.22%) [25]. Smaller case series have even demonstrated satisfactory results after endoscopically realigning completely transected ureters. Studies were limited by short-term follow-up of 21.5 and 26.5 months and small cohort size but nevertheless success rates of 75% (6/8) and 78% (14/18) were reported, respectively [30,31].

Traditionally a waiting period of 6 weeks to 3 months had been suggested for secondary reconstructive surgery to take place. This was suggested in order for inflammation, fibrosis, adhesions, tissue edema and distorted anatomy to subside [6,32]. Selected other authors however have reported equal outcome for immediate reconstruction after diagnosis when compared to deferred repair [33,34]. Taken together these results do not allow for a final conclusion and timing of ureteral repair should be decided on an individual base and at the discretion of the surgeon.

4. Open reconstructive approaches

Endoscopic management holds its place in the treatment of minor injuries and management of strictures in patients unsuitable for surgery. However in regard of ureteral strictures the long-term success rates of endoscopic management (stenting, dilation, endoureterotomy) are limited [2] and surgical management should be undertaken.

Ureteral reconstruction, regardless of the surgical approach follows basic principles: Debridement of necrotic tissue, spatulation or ureteral ends, tension free and watertight mucosa-to-mucosa anastomosis with absorbable sutures, internal stenting and external drain [35].

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