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European Association of Urology

Guidelines

EAU Guidelines on Iatrogenic Trauma

Duncan J. Summerton[a,*], *Noam D. Kitrey*[b], *Nicolaas Lumen*[c], *Efraim Serafetinidis*[d], *Nenad Djakovic*[e]

[a] *Department of Urology, University Hospitals of Leicester, Leicester, UK;* [b] *Department of Urology, Chaim Sheba Medical Centre, Tel-Hashomer, Israel;* [c] *Department of Urology, Ghent University Hospital, Ghent, Belgium;* [d] *Department of Urology, Asklipieion General Hospital, Athens, Greece;* [e] *Department of Urology, Mühldorf General Hospital, Mühldorf am Inn, Germany*

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Abstract

Context: The European Association of Urology (EAU) Trauma Guidelines Panel presents an updated iatrogenic trauma section of their guidelines. Iatrogenic injuries are known complications of surgery to the urinary tract. Timely and adequate intervention is key to their management.
Objective: To assess the optimal evaluation and management of iatrogenic injuries and present an update of the iatrogenic section of the EAU Trauma Guidelines.
Evidence acquisition: A systematic search of the literature was conducted, consulting Medline and the Cochrane Register of Systematic reviews. No time limitations were applied, although the focus was on more recent publications.
Evidence synthesis: The expert panel developed statements and recommendations. Statements were rated according to their level of evidence, and recommendations received a grade following a rating system modified from the Oxford Centre for Evidence-based Medicine. Currently, only limited high-powered studies are available addressing iatrogenic injuries. Because the reporting of complications or sequelae of interventions is now increasingly becoming a standard requirement, this situation will likely change in the future.
Conclusions: This section of the trauma guidelines presents an updated overview of the treatment of iatrogenic trauma that will be incorporated in the trauma guidelines available at the EAU Web site (http://www. uroweb.org/guidelines/online-guidelines/).

* Corresponding author. University Hospitals of Leicester NHS Trust, Department of Urology, Gwendolen Road, Leicester LE5 4PW, UK. Tel. +44 116 258 82 60.
E-mail address: duncan.summerton@uhl-tr.nhs.uk (D.J. Summerton).

1. Introduction

Iatrogenic injury to the urogenital tract, although rare, is an important area for any urologist. Appropriate investigation and treatment of suspected trauma, whether in the acute or delayed setting, is critical to reduce the potential impact of subsequent complications.

Newer energy applications, surgical techniques, and equipment have created a wider range of causes of iatrogenic trauma, but treatment of these injuries has remained essentially unchanged. However, in the past 15 yr, the management of even severe renal injuries has become more conservative, which has also been suggested for intraperitoneal bladder perforation.

The EAU Trauma Panel reviewed the current English-language literature via a Medline search. Although older references were included, more emphasis was placed on newer publications. We present an overview of the most common situations likely to be encountered in clinical practice.

This review does not provide complete information on the complex management of long-term sequelae. These are often the same as for noniatrogenic causes, and detailed management plans may be found in the full EAU guidelines

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Table 1 – Incidence and aetiology of the most common iatrogenic renal traumas during various procedures

Procedure	Haemorrhage	AVF	Pseudoaneurysm	Renal pelvis injury	Aortocaliceal fistula	Foreign body
Nephrostomy	+	+	+	+		
Biopsy	+ (0.5–1.5%)		+ (0.9%)			
PCNL	+	+		+		
Laparoscopic surgery (oncology)	+					
Open surgery (oncology)	+		+ (0.43%)			+
Transplantation	+	+	+		+	
Endopyelotomy	+			+		+
Endovascular procedure	+ (1.6%)					

AVF = arteriovenous fistula; PCNL = percutaneous nephrolithotomy.

on trauma [1]. With the exception of inadvertent injuries caused by circumcision, this paper deals only with iatrogenic trauma in the adult and not the paediatric population.

This paper concentrates on the immediate diagnosis and initial management of iatrogenic urologic trauma (IUT). A new system of nomenclature is introduced to distinguish between different organs while retaining a degree of standardisation.

2. Iatrogenic renal trauma

2.1. Introduction

Iatrogenic renal trauma (IRT) is rare but can lead to significant morbidity.

2.2. Incidence and aetiology

Table 1 lists the most common causes of IRT [2]. Large haematomas after biopsy (0.5–1.5%) are caused by laceration or arterial damage [3]. Renal artery and intraparenchymal pseudoaneurysms (0.9%) may be caused by percutaneous biopsy, nephrostomy, and partial nephrectomy (0.43%) [4]. In percutaneous nephrolithotomy (PCNL), haemorrhage is the most dangerous IRT. Vascular injuries may occur at any stage of the procedure, especially when punctures are too medial or directly of the renal pelvis. Other injuries include arteriovenous fistula (AVF) or tears in the pelvicaliceal system, causing extravasation and absorption of irrigation fluid.

IRT in renal transplantation is more common and includes AVF, intrarenal pseudoaneurysm, arterial dissection, and arteriocaliceal fistula. Pseudoaneurysm is a rare complication of allograft biopsy. Although the overall complication rate with biopsies in transplanted kidneys is 9% (including haematoma, AVF, macroscopic haematuria, and infection), vascular complications requiring intervention account for 0.2–2.0% [5]. Predisposing factors include hypertension, renal medullary disease, central biopsies, and numerous needle passes [6]. AVF and pseudoaneurysm can occur in 1–18% of allograft biopsies and may coexist in up to 30% of cases [7]. Extrarenal pseudoaneurysm after transplantation procedures generally occurs at the anastomosis, in association with local or haematogenous infection. Arterial dissection related to transplantation is rare and presents in the early postoperative period [8].

IRT associated with endopyelotomy is classified as major (vascular injury) or minor (urinoma) [9]. Patients undergoing cryoablation for small masses via the percutaneous or the laparoscopic approach may have minor IRT including asymptomatic perinephric haematoma and self-limited urine leakage [10]. Vascular injury is a rare complication (1.6%) of endovascular intervention, in contrast to patients with surgical injuries; the renal vessels are vulnerable mainly during oncologic procedures. Renal foreign bodies, such as retained sponges or wires during open or endourologic procedures, are uncommon.

2.3. Diagnosis: clinical signs and imaging

Haematuria is common after nephrostomy, but massive retroperitoneal haemorrhage is rare. If a nephrostomy catheter appears to transfix the renal pelvis, significant arterial injury is possible. The misplaced catheter should be withdrawn over a guidewire; embolisation may arrest the haemorrhage. Computed tomography (CT) can also successfully guide repositioning of the catheter into the collecting system [11]. Haemorrhage can be prevented by avoiding puncture in patients receiving anticoagulation treatment or in those with coagulopathy by carefully targeting the calices and avoiding medial puncture. Injuries to the renal pelvis are less likely to occur if the dilator is not advanced further than the calix; sheaths are handled with care, especially during advancement around the pelviureteric junction; and kinking of the guidewires is avoided [12]. After percutaneous biopsy, AVF may present with severe hypertension. Pseudoaneurysm should be suspected if the patient presents with flank pain and decreasing haematocrit, even in the absence of haematuria.

During PCNL, acute bleeding may be caused by injury to the anterior or posterior segmental arteries, or late postoperative bleeding may be caused by interlobar and lower-pole arterial lesions, AVF, and post-traumatic aneurysm [13]. Duplex ultrasound and CT angiography can be used to diagnose vascular injuries. Irrigation fluid input and output should be monitored closely to ensure early recognition of “fluid” extravasation. Intraoperative evaluation of serum electrolytes, acid-base status, oxygenation, and monitoring of airway pressure are good indicators of this complication because metabolic acidosis, hyponatraemia, hypokalaemia, peritonitis, and ileus may occur.

In arterial dissection related to transplantation, symptoms include anuria and prolonged dependence on dialysis. Doppler ultrasound can demonstrate compromised arterial flow. Dissection can lead to thrombosis of the renal artery and/or vein.

After angioplasty and stent-graft placement in the renal artery, during which wire or catheters may enter the parenchyma and penetrate through the capsule, possible radiologic findings include AVF, pseudoaneurysm, arterial dissection, and contrast extravasation. Common symptoms of pseudoaneurysm are flank pain and gross haematuria within 2 or 3 wk after surgery [14]. Transplant AVF and pseudoaneurysm may be asymptomatic or cause gross haematuria and/or hypovolaemia due to shunting and "steal" phenomenon, renal insufficiency, hypertension, and high-output cardiac failure. Patients with extrarenal pseudoaneurysm may present with infection/bleeding, swelling, pain, and intermittent claudication. Doppler ultrasound findings for AVF include high-velocity low-resistance spectral waveforms with focal areas of disorganised colour flow outside the normal vascular borders, and possibly a dilated vein [15]. Pseudoaneurysm appears on ultrasound as an anechoic cyst, with intracystic flow on colour Doppler.

Potential complications of retained sponges include abscess formation, fistulisation to the skin or intestinal tract, and sepsis. Retained sponges may cause pseudotumours or appear as solid masses. Magnetic resonance imaging clearly shows the characteristic features [16]. Absorbable haemostatic agents may also produce a foreign body giant cell reaction, but the imaging characteristics are not specific. Retained stents, wires, or fractured Acucise cutting wires may also present as foreign bodies and can serve as a nidus for stone formation [17].

2.4. Management

Small subcapsular haematoma after nephrostomy resolves spontaneously, whereas AVF is best managed by embolisation. AVF and pseudoaneurysm after biopsy are also managed by embolisation [18].

During PCNL, bleeding can be venous or arterial. In major venous trauma with haemorrhage, patients with concomitant renal insufficiency can be treated without open exploration or angiographic embolisation using a Council-tip balloon catheter [19]. In case of profuse bleeding at the end of PCNL, conservative management is usually effective (placing the patient in a supine position, clamping the nephrostomy catheter, and forcing diuresis). Superselective embolisation is required in <1% of cases and has proved effective in >90% [20]. Short-term deleterious effects are more pronounced in patients with a solitary kidney, but long-term follow-up shows functional and morphologic improvements [21]. Termination of PCNL if the renal pelvis is torn or ruptured is a safe choice. Management requires close monitoring, placement of an abdominal or retroperitoneal drain, and supportive measures [22].

Most surgical venous injuries have partial lacerations that can be managed with techniques such as venorrhaphy, patch angioplasty with autologous vein, or an expanded polytetrafluoroethylene graft [23]. If conservative measures fail in pseudoaneurysm and clinical symptoms or a relevant decrease in haemoglobin occurs, transarterial embolisation should be considered [24]. The success rate is similar for initial and repeat interventions; therefore, repeat intervention is justified when the clinical course allows [25].

Traditionally, patients with postoperative haemorrhage following intra-abdominal laparoscopic surgery of the kidney required laparotomy. Pseudoaneurysm and AVF are uncommon after minimally invasive partial nephrectomy but can lead to significant morbidity. Temporary haemostasis occurs with coagulation and/or tamponade, but later degradation of the clot, connection with the extravascular space, and possible fistulisation with the collecting system may develop. Patients typically present with gross haematuria, although they may also experience flank pain, dizziness, and fever. Embolisation is the reference standard for both diagnosis and treatment in the acute setting, although CT can be used if the symptoms are not severe and/or the diagnosis is ambiguous. Reports have described a good preservation of renal function after embolisation [26].

Endoluminal management after renal transplantation consists of stabilising the intimal flap with stent placement. Embolisation is the treatment of choice for a symptomatic transplant AVF or enlarging pseudoaneurysm [8]. Superselective embolisation with a coaxial catheter and metallic coils helps limit the loss of normal functioning graft tissue [27]. A success rate of 71–100% has been reported, with alleviation of symptoms in 57–88% of cases. Major infarcts involving >30–50% of the allograft and leading to allograft loss have been reported in up to 28.6% of cases in which combined coil embolisation and polyvinyl alcohol or Gelfoam were used. If symptoms persist, a second angiogram with possible repeat embolisation is warranted [28]. Failure of embolisation is associated with a high nephrectomy rate. The long-term outcome depends on the course of the transplant and the amount of contrast medium used during the procedure. Surgery for AVF consists of partial or total nephrectomy or arterial ligation, which results in the loss of part or the entire transplant.

Surgery has to date been the main approach for the treatment of renovascular injuries. In patients with retroperitoneal haematoma, AVF, and haemorrhagic shock, intervention is associated with a lower level of risk than surgery [29]. Renal arteriography followed by selective embolisation can confirm the injury. In injuries during angioplasty and stent-graft placement, transcatheter embolisation is the first choice [30]. The treatment for acute iatrogenic rupture of the main renal artery is balloon tamponade. If this fails, the immediate availability of a stent graft is vital [31]. The true nature of lesions caused by foreign bodies is revealed after exploration. Table 2 lists the statements and recommendations regarding IRT.

Table 2 – Statements and recommendations regarding iatrogenic renal trauma

Statements	LE
• IRT is procedure dependent (1.8–15%).	3
• Significant injury requiring intervention is rare.	3
• Most common injuries are vascular.	3
• Renal allografts are more susceptible.	3
• Injuries occurring during surgery are rectified immediately.	3
• Symptoms suggestive of significant injury require investigation.	3
Recommendations	**GR**
• Patients with minor injuries should be treated conservatively.	B
• Severe or persistent injuries require intervention with embolisation.	B
• In stable patients, repeat embolisation should be considered for failure.	C

IRT = iatrogenic renal trauma; LE = level of evidence; GR = grade of recommendation.

3. Ureteric iatrogenic trauma

Iatrogenic ureteric trauma (IUeT) is the most common cause of ureteric injury. It occurs in open, laparoscopic or endoscopic procedures and is often not recognised intraoperatively. It may result in severe sequelae.

Gynaecologic surgical procedures are the most common cause of IUeT [32–35] (Table 1) and usually involve damage to the lower third of the ureter. Colorectal (especially abdominoperineal resection and sigmoid colectomy) and urologic operations (especially endoscopic) also cause IUeT. In ureteroscopic procedures, most injuries are minor but may sometimes be serious (eg, complete ureteric avulsion). The incidence of urologic IUeT has diminished in the past 20 yr [32,36] with improvements in technique, instruments, and experience. Table 3 describes the incidence of ureteral injury in various procedures.

IUeT can result from various mechanisms: ligation or kinking with a suture, crushing from a clamp, partial, or complete transaction, thermal injury, or ischaemia from devascularisation [32,34,37]. Occult ureteric injury occurs more often than reported, and not all injuries are diagnosed intraoperatively. In gynaecologic surgery, IUeT is almost five times higher if routine intraoperative cystoscopy is used [38,39]. Risk factors for IUeT include conditions that alter normal anatomy such as advanced malignancy, prior surgery or irradiation, diverticulitis, endometriosis, anatomic abnormalities, and major haemorrhage [32,34,39]. Nevertheless, most IUeT has no identifiable risk factors [32,37,40].

Table 3 – Incidence of ureteral injury in various procedures

Procedure	%
Gynaecologic [30,35,37]	
Vaginal hysterectomy	0.02–0.5
Abdominal hysterectomy	0.03–2.0
Laparoscopy-assisted vaginal hysterectomy	0.2–6.0
Urogynaecologic	1.7–3.0
Colorectal [34,38,39]	0.3–10
Ureteroscopy [36,40]	
Mucosal abrasion	0.3–4.1
Ureteral perforation	0.2–2.0
Intussusception/avulsion	0–0.3

3.1. *Diagnosis*

Diagnosis can be difficult and is delayed in most cases (65–80%) [32,35,41]. IUeT may be noticed during the primary procedure or later, when it is typically discovered by flank pain, urinary incontinence, vaginal or drain urinary leakage, haematuria, fever, azotemia, or urinoma. When the diagnosis is missed, the complication rate increases [32,35,37]. Early recognition facilitates immediate repair and provides the best outcome. Delayed diagnosis predisposes the patient to pain, infection, and renal damage [39].

Clinical diagnosis is generally supported by imaging studies. Extravasation of contrast medium in CT or intravenous pyelography is the hallmark sign of IUeT, but often hydronephrosis, ascites, urinoma, or only mild ureteric dilation is noticed. Retrograde or antegrade urography is the gold standard for the confirmation of IUeT [32].

3.2. *Prevention*

Prevention of IUeT is based on visual identification of the ureters and cautious intraoperative dissection [32,33,37]. Prophylactic preoperative ureteric stent insertion assists visualisation and palpation, and it is commonly used in complicated cases. However, it does not decrease the rate of injury [32]. Apart from its evident disadvantages (potential complications and cost), a stent may alter the location of the ureter and diminish flexibility [33,42]. Stenting is probably useful as secondary prevention by facilitating detection of IUeT [33]. Routine prophylactic stenting is usually not cost effective [33], and it is estimated to become cost effective in hysterectomy when the rate of IUeT exceeds 3.2% [39]; therefore, it is advocated only in selected patients with risk factors [42].

Another form of secondary prevention is intraoperative cystoscopy after intravenous indigo carmine, which offers confirmation of ureteric patency [35]. Routine cystoscopy has minimal risks and markedly increases the rate of IUeT detection [38]. However, its universal use incurs significant costs. It was estimated for benign gynaecologic operations to be cost saving above a threshold IUeT rate of 1.5–2% [35].

3.3. *Treatment*

Management of IUeT depends on many factors including the nature and location of the injury. Immediate diagnosis of a ligation injury can be managed by de-ligation and stent placement. Partial injuries can be repaired immediately with a stent or urinary diversion by a nephrostomy tube. Stenting may be advantageous because it provides canalisation and may decrease the risk of stricture [32].

Table 4 – Statements and recommendations regarding iatrogenic ureteric trauma

Statements	LE
• Ureteric iatrogenic trauma occurs in 0.02–6% of gynaecologic, colorectal, and urologic operations.	3
• Injury is predominantly to the distal third of the ureter.	3
• Preoperative prophylactic stents do not prevent ureteric injury but may assist in its detection.	2
• Endourologic treatment of small ureteric fistulae and strictures is safe and effective.	3
• Major ureteric injury requires ureteric reconstruction following temporary urinary diversion.	3
Recommendations	**GR**
• Visual identification of the ureters and meticulous dissection in their vicinity are mandatory to prevent ureteric trauma during abdominal and pelvic surgery.	A
• Prophylactic ureteric stent insertion and intraoperative cystoscopy should only be used in selected cases based on risk factors and surgeons' experience.	B

LE = level of evidence; GR = grade of recommendation.

Injuries diagnosed later are usually treated initially by a nephrostomy tube with or without stents. Retrograde stenting is frequently unsuccessful in this setting. Endourologic treatment of small ureteric fistulae and strictures is safe and effective in selected cases [43], but deferred surgical repair is often necessary based on location and the degree of injury. The most common methods of ureteric reconstruction include ureteroureterostomy and ureteroneocystostomy, although there are many alternatives (for details refer to the EAU Trauma Guidelines). Table 4 lists the statements and recommendations for IUeT.

4. Bladder trauma

4.1. Introduction

The bladder is the urologic organ most often subject to iatrogenic injury [44]. Iatrogenic bladder trauma (IBT) is defined as full-thickness laceration. Table 5 shows the incidence of bladder perforation during various procedures.

4.2. Incidence and aetiology

External IBT mostly occurs during obstetric and gynaecologic procedures, followed by general surgical and urologic interventions [44]. Table 6 shows the risk factors for bladder injury.

Internal IBT mainly occurs during transurethral resection of the bladder (TURB) for the treatment of tumours. Large perforations requiring intervention are rare (0.16–0.57%) [45]. Extraperitoneal perforations are more frequent than intraperitoneal ones.

Iatrogenic foreign body inside the bladder can be caused by failure of the resectoscope, ureteric stents, bladder catheters, forgotten pieces of surgical gauze, sutures, or staples used in pelvic procedures [46,47], unrecognised perforation, erosion of mesh for urinary incontinence, or pelvic organ prolapse [46].

Table 5 – Incidence of bladder perforation during various procedures

Procedure	%
External	
Obstetrics	
Caesarean delivery	0.0016–0.94
Gynaecology	
Laparoscopic sterilisation	0.02
Diagnostic laparoscopy	0.01
Laparoscopic hysterectomy (benign)	0.5–2.0
Vaginal hysterectomy (benign)	0.44–6.3
Abdominal hysterectomy (benign)	0.73–2.5
General surgery	
Inguinal canal surgery	0.08–0.3
Tunnelling of synthetic bypass grafts	Case reports
Urology	
Retropubic male sling	8.0–50
Laparoscopic sacrocolpopexy	1.9
Burch colposuspension	1.0–1.2
Synthetic midurethral slings (all)	6.0–6.6
Transobturator route	0–2.4
Retropubic route	3.2–8.5
Pubovaginal sling	2.8
Transvaginal mesh surgery	1.5–3.5
Anterior colporrhaphy	0.5
Internal	
TURB	1.3–58
TURP	0.01
Cystography	Case reports
Intravesical instillation with chemotherapeutic agent	Case reports

TURB = transurethral resection of the bladder; TURP = transurethral resection of the prostate.

Table 6 – Risk factors for the bladder associated with various procedures

Procedure	Risk factors
Caesarean delivery	Previous caesarean delivery
	Previous pelvic surgery
	Presence of labour
	Station of presenting foetal part $\geq +1$
	Foetal weight >4 kg
Hysterectomy	Malignancy
	Endometriosis
	Prior pelvic surgery
	Concomitant anti-incontinence or pelvic organ prolapse surgery
General surgery	Malignancy
	Diverticulitis
	Inflammatory bowel disease
Midurethral sling operations	Retropubic route
	Previous caesarean delivery
	Previous colposuspension
	BMI <30 kg/m^2
	Rectocele
	Procedures under local anaesthesia
	Inexperienced surgeon
TURB	Tumour size
	Elderly patients
	Pretreated bladder (previous TURB, intravesical instillation, radiotherapy)
	Tumour location at the dome or in diverticulum

BMI = body mass index; TURB = transurethral resection of the bladder.

4.3. Diagnosis

4.3.1. Bladder perforation

4.3.1.1. Perioperative: external iatrogenic bladder trauma. Direct inspection is the most reliable method of assessing bladder integrity. Suggestive signs are extravasation of urine, visible laceration, clear fluid in the surgical field, appearance of the bladder catheter, and blood and/or gas in the urine bag during laparoscopy. Intravesical instillation of methylene blue may be helpful. If bladder perforation is present, the integrity of the ureteric orifices should be checked [48].

Cystoscopy is recommended after suburethral sling operations via the retropubic route [49]. Routine cystoscopy after insertion via the obturator route is controversial because bladder injuries are rare but not impossible [49]. Cystoscopy after transvaginal mesh procedures is preferable but not mandatory [50]. Vakili et al. reported that 64.7% of bladder injuries during hysterectomy were not detected before cystoscopy, and they advised cystoscopy after hysterectomy and every major gynaecologic procedure [40].

4.3.1.2. Perioperative: internal iatrogenic bladder trauma. Fatty tissue, a dark space between detrusor muscle fibres, or the visualisation of bowel suggests perforation [51]. Signs of major perforation are the inability to distend the bladder, a low return of irrigation fluid, and abdominal distension [52].

4.3.1.3. Postoperative: unrecognised bladder injury. Clinical signs and symptoms include haematuria, lower abdominal pain, abdominal distension, ileus, peritonitis, sepsis, urine leakage from the wound, decreased urinary output, and increased serum creatinine [48,52]. Imaging findings include the following:

- On ultrasound, intraperitoneal fluid or an extraperitoneal collection suggests intraperitoneal or extraperitoneal perforation, respectively. Ultrasound alone is insufficient [48].
- Cystoscopy may directly visualise perforation and permit checking of the integrity of the ureteral orifices [53]. An inability to distend the bladder suggests a large perforation.
- Cystography is the standard examination for diagnosis [48].
- CT is useful for differential diagnosis of other causes of abdominal pain [48]. If necessary, the bladder can be filled with contrast medium (CT cystography) [48,53].

4.3.2. Intravesical foreign body

Symptoms of an intravesical foreign body include dysuria, recurrent urinary tract infection, frequency, urgency, haematuria, and perineal/pelvic pain [47]. Bladder calculi usually develop once the foreign body has been present >3 mo [47]. Cystoscopy is the preferred examination method [47].

4.4. Treatment

4.4.1. Bladder injury

Perforations recognised intraoperatively are closed using two-layer vesicorrhaphy with absorbable sutures. Postoperative bladder drainage is required for 7–14 d. Cystography to exclude contrast extravasation before catheter removal is advised [48].

For bladder injuries not recognised during surgery or for internal injuries, a distinction must be made between intraperitoneal and extraperitoneal injuries.

For intraperitoneal injuries, the standard of care is surgical exploration with repair [48,53]. In selected cases (in the absence of peritonitis or ileus), conservative management with continuous bladder drainage (7 d) and antibiotic prophylaxis may be offered [48,53]. In addition to this conservative treatment, placement of an intraperitoneal drain has been advocated, especially when the lesion is larger [54]. If surgical exploration is performed after transurethral resection of the bladder (TURB), meticulous bowel inspection is required to rule out concomitant injury [45].

Table 7 – Statements and recommendations regarding bladder injury

Statements	LE
• The bladder is the urologic organ most commonly injured during surgery, with obstetric and gynaecologic procedures as the main causes.	2
• Intraoperatively, visual inspection is the most reliable method of assessing bladder integrity.	3
• Meshes represent most of the foreign bodies found in the female bladder.	2
Recommendations	**GR**
• Cystoscopy is recommended after suburethral sling operations via the retropubic route and major gynaecologic operations.	B
• Cystoscopy is optional after any other type of sling procedure or transvaginal mesh procedure.	C
• Cystography is the standard examination for diagnosing postoperative bladder injury.	B
• For diagnosing iatrogenic foreign bodies, cystoscopy is the examination method of choice.	C
• External bladder perforations that are recognised intraoperatively should be closed with two-layer vesicorrhaphy.	A*
• Extraperitoneal bladder perforations that are not recognised during surgery or are caused by endourologic procedures should be treated conservatively.	B
• For intraperitoneal bladder perforations that are not recognised at the time of surgery, the standard of care is surgical repair.	B
• Conservative management is an option for small uncomplicated intraperitoneal bladder perforations.	C

LE = level of evidence; GR = grade of recommendation.
* Upgraded based on panel consensus.

For extraperitoneal injuries, conservative treatment with bladder drainage (5 d) and antibiotic prophylaxis is advised [48]. Large extraperitoneal perforations complicated by symptomatic extravesical collections require drainage, with or without closure of the perforation [52].

If perforation occurs during TURB, immediate intravesical instillation with chemotherapeutic agents should not be performed [55]. If bladder perforation is encountered during midurethral sling or transvaginal mesh procedures, sling reinsertion and urethral catheterisation (1–2 d) should be performed [56].

4.4.2. Intravesical foreign body

For perforated or eroded meshes, the intravesical portion must be removed by open cystotomy or endoscopically [50,57]. The choice depends on the surgeon's level of experience and the location of the mesh. For other types of foreign body, cystoscopic removal is performed or a cystotomy if that fails [47]. Table 7 lists the statements and recommendations regarding bladder injury.

5. Iatrogenic urethral trauma

5.1. Introduction

The most common type of urethral trauma seen in modern urologic practice is iatrogenic, due to catheterisation, instrumentation, or surgery [58,59]. New treatment methods and applied energy sources can also injure the urethra. In most cases, iatrogenic urethral lesions require surgery due to strictures, which vary in their location and degree and require different management strategies [60].

5.2. Causes of iatrogenic urethral trauma

5.2.1. Transurethral catheterisation

Iatrogenic urethral trauma (IUhT), most of which results from improper or prolonged catheterisation, accounts for 32% of strictures. Most of these affect the bulbar urethra [60].

In incorrectly placed transurethral catheters, the pressure needed to fill the balloon and the force associated with manual extraction are much greater than when the catheter is placed correctly. This leads to a greater probability of urethral lesions [61]. Improper urethral catheter insertion is a preventable source of urethral trauma in male patients [62]. The risk of this type of urethral injury occurring during a hospital stay has been estimated at 3.2 per 1000 cases [60].

Stricture formation due to indwelling catheters is a common problem [58] that primarily affects the anterior urethra. The bladder neck is rarely affected in such cases [63].

It is possible to prevent or reduce the frequency of a wide range of iatrogenic urethral injuries. Implementing training programmes may significantly decrease the incidence, increasing patient safety and reducing the negative long-term effects [58,64] (level of evidence [LE]: 2b).

Male patients undergoing cardiac surgery, such as bypass and other major operations associated with a need for catheterisation, are at risk for urethral trauma and stricture formation. Women undergoing abdominal surgery are also at risk during catheterisation. The size and type of catheter used have an important impact on urethral stricture formation. Current data indicate that silicone catheters and small-calibre Foley catheters are associated with less urethral morbidity [65].

5.2.2. Transurethral surgery

Transurethral procedures are a common cause of IUhT. Electrical dispersion generated by unipolar current and the diameter of the instruments used are factors that may influence the development of iatrogenic endoscopic urethral strictures [66] (LE: 1b).

Predisposing factors most strongly associated with stricture formation in patients undergoing transurethral resection of the prostate (TURP) are increasing prostate volume, prostate cancer, and surgeons' experience [67].

Meatal strictures occur as a result of disproportion between the size of the instrument and the diameter of the urethral meatus. Bulbar strictures occur due to insufficient insulation by the lubricant, causing monopolar current to leak. To prevent strictures, lubricant gel should be applied carefully in the urethra. The lubricant must be reapplied when the resection time is prolonged. Internal urethrotomy must be performed before TURP if there are preexisting meatal or urethral strictures [68].

There appears to be no relationship with the duration of procedures or the method used—holmium laser or traditional TURP—on the rate of stricture formation [69].

5.2.3. Surgical treatment for prostate cancer

Urethral stricture following prostate cancer treatment can occur anywhere from the bladder neck to the urethral meatus. The rate of bladder neck constriction after radical prostatectomy varies with the definition of the stricture used and individual practice [70,71] (LE: 2a). The Cancer of the Prostate Strategic Urologic Research Endeavour (CaPSURE) database shows an incidence of urethral stricture after various forms of prostate cancer therapy of 1.1–8.4%. The risk is greatest after radical prostatectomy if combined with external-beam radiation therapy. In a multivariate analysis, primary treatment type, age, and obesity were found to be significant predictors for stricture development [70] (LE: 2b).

Robot-assisted prostatectomy also affects urinary function and the risk of iatrogenic trauma. Iatrogenic complications involving the bladder neck account for 2.2%, corresponding to the stricture rate seen with conventional treatment for localised prostate cancer [72] (LE: 2b).

Anastomotic stricture is also a complication in conventional laparoscopic prostatectomy. Taking only prospective studies into account, there is no significant difference in anastomotic stricture rate between laparoscopic and robot-assisted radical prostatectomy [73] (LE: 3b).

5.2.4. Radiotherapy for prostate cancer

The development of urinary fistulae has been reported after brachytherapy and radical prostatectomy, with incidences of 0.3–3.0% and 0–0.6%, respectively. Most fistulae involve

Table 8 – Most common causes of urethral trauma

Procedure	Percentage
Catheterisation	32% of iatrogenic urethral strictures (52% bulbar urethra)
Urethral instrumentation for therapy and/or diagnosis	
Treatment for prostatic disease	1.1–8.4% urethral stricture rate
Transurethral surgery (eg, TURB/TURP)	2.2–9.8% urethral stricture rate
Radical prostatectomy	0.5–32% bladder neck constriction; no difference between LRP and RALP (relative risk: 1.42; 95% confidence interval for relative risk, 0.40–5.06; $p = 0.59$)
Radiotherapy (percutaneous or brachytherapy)	6% urethral stricture rate, 0.3–3.0% urinary fistula rate Greatest risk for urethral stricture is found for the combination of radical prostatectomy and EBRT
Cryotherapy	
High-intensity focussed ultrasound	
Treatment for bladder disease:	
TURB	
Cystectomy	3.1% subneovesical obstruction, 1.2% neovesicourethral anastomotic strictures, 0.9% urethral strictures
Injury during major abdominal and pelvic operations	

TURB = transurethral resection of the bladder; TURP = transurethral resection of the bladder; LRP = radical prostatectomy; RALP = robot-assisted laparoscopic prostatectomy; EBRT = external-beam radiation therapy.

the rectum [74,75] (LE: 3). Brachytherapy is a recognised cause of strictures in patients with localised prostate cancer, as the CaPSURE study has shown [76]. Previous TURP increases the risk of stricture formation [77,78].

5.2.5. *Major abdominal surgery and cystectomy*

Iatrogenic injuries to the urethra are not a rare complication of abdominal and pelvic procedures. Bladder and urethral catheterisation must therefore be carried out preoperatively to prevent these complications [79] (LE: 2). Radical cystectomy and subsequent urinary diversion may also cause urethral trauma [80]. Table 8 lists the most common causes of urethral trauma.

5.3. *Symptoms of iatrogenic urethral injury*

Symptoms of urethral lesions caused by improper catheterisation or instrumentation are penile and/or perineal pain (100%) and urethral bleeding (86%) [63] (LE: 2b). Failure to diagnose accurately and treat urethral injuries may lead to significant long-term sequelae, in most cases presenting as strictures [81,82].

5.4. *Diagnosis*

Uroflowmetry, urethrography, and/or urethroscopy are the key investigations in diagnosis, and the algorithm is the same for acute and delayed symptoms. In the acute phase, the symptoms are bleeding and difficulty during catheterisation. Delayed symptoms include worsening of flow and other symptoms of obstruction.

5.5. *Treatment*

The value of temporary stenting in minor urethral injuries is unproven. Temporary stenting with an indwelling catheter is the conventional treatment option for an acute false passage [83]. In difficult cases, it may be assisted by cystoscopy and guidewire placement [84] (LE: 3). Suprapubic catheterisation is an alternative.

Endoscopic management, either with incision or resection, can successfully treat iatrogenic prostatic urethral strictures. Indwelling catheter placement or an open procedure, associated with increased morbidity, are alternatives [85] (LE: 2b).

Urethral lesions following radiotherapy are often more difficult to treat and may require complex reconstructive surgery [74,75]. Table 9 lists the statements and recommendations regarding the iatrogenic causes of IUhT.

6. Iatrogenic genital trauma

6.1. *Introduction*

Iatrogenic injury to the external genital organs can vary from trivial to devastating. Its prevalence is not known, and it can occur during any genital procedure (eg, operations for penile congenital anomalies, penile prosthesis insertion, penile enlargement procedures, and circumcision). Iatrogenic injury to the epididymis, vas deferens, or spermatic

Table 9 – Statements and recommendations regarding iatrogenic urethral trauma

Statements	LE
• Iatrogenic causes are the most common type of urethral injury in Europe and therefore the most common cause of urethral stricture formation.	2a
• Implementing training programmes on urinary catheter insertion significantly improves the rate of catheter-related complications.	2b
• New technologies represent an additional source of urethral injury.	3
Recommendations	**GR**
• Proper training should be provided to reduce the risk of traumatic catheterisation.	A
• Urethral instrumentation should only be carried out when there are valid clinical indications.	A
• When catheterisation is necessary, its duration should be kept to a minimum.	B

LE level of evidence; GR = grade of recommendation.

vessels may occur during scrotal, inguinal, or even pelvic and abdominal procedures, and it may not be noticed until the patient presents for fertility evaluation. This section is limited to complications of circumcision.

6.2. Iatrogenic injury in circumcision

Circumcision is the most common operation performed worldwide. Up to 30% of males throughout the world are circumcised. Many ethnic groups practice ritual circumcision, and it is also very common in the United States. It is motivated by a combination of religious, traditional, aesthetic, and cultural ideas. Most circumcision worldwide is carried out by ritual circumcisers without analgesia or sterile conditions. There is continuing debate in the medical literature regarding nontherapeutic circumcision. Circumcision is done with a freehand technique or with special devices (eg, Mogen and Gomco clamps, Plastibell). Good visualisation of the glans penis is crucial in all cases.

6.2.1. Incidence and aetiology

The incidence of complications after circumcision varies considerably (0.2–31%) depending on the study type, technique, geographic area, age, indications, and era. Complications occur less frequently among neonates and infants than in older boys and adults [86]. If circumcision is performed by an experienced professional, it is a safe procedure with a low complication rate. Many authors argue that circumcision performed by traditional circumcisers is more prone to complications, especially serious ones [87,88], whereas others have found no increased rate of complications with skilful circumcisers [89]. However, an alarmingly high prevalence of complications was reported when the procedure is undertaken by inexperienced operators [86,90].

6.2.2. Early complications

Postoperative bleeding is the most common early complication. The rate ranges from 0.1% to 5% [91,92]. It can usually be controlled by local pressure, topical haemostatic agents, electrocautery, or an absorbable suture. It rarely requires blood transfusion or reoperation. Infection is also common (0.2–4%) [89,92]. It is usually managed by wound care and local or systemic antibiotics. Rarely, it may lead to necrotising fasciitis and sepsis. Other complications include urinary retention due to tight circular bandaging, glans necrosis, and minimal partial to complete amputation of the penis, requiring microsurgical reimplantation or phallic reconstruction.

6.2.3. Late complications

Meatitis is the most common late complication and occurs in 8–31% of circumcised young boys [89]. It probably results from frequent irritation of the naked glans penis by a urine-soaked diaper, and it can lead to symptomatic meatal stenosis and subsequent meatotomy. Other complications include removal of excessive or inadequate foreskin, skin bridges between the glans penis and the penile shaft, inclusion cysts, penile torsion or curvature, urethrocutaneous fistula, phimosis, and penile adhesions with a hidden or "buried" penis. The effects of these complications vary from minor cosmetic problems to severe functional problems. Table 10 lists the statements and recommendations regarding circumcision.

Table 10 – Statements and recommendations regarding circumcision

Statements	
• Circumcision is very common. • Complication rates vary considerably. • The vast majority of complications due to circumcision are minor and easily treated.	
Recommendations	**GR**
• Circumcision, at all ages, should be performed by an experienced professional using proper analgesia and in sterile conditions.	A
• Challenging complications require complex reconstructive surgery and should be referred to a specialised centre.	A
LE level of evidence; GR = grade of recommendation.	

7. Conclusions

Iatrogenic trauma to the urogenital tract should always be suspected, especially in the context of complicated cases or when the patient fails to progress or recover sufficiently quickly.

The unifying message is that education both within and outside urologic training and practice is vitally important to minimise the risk of these injuries.

Iatrogenic injuries will still occur, and they must be suspected and identified as early as possible, investigated thoroughly, and treated appropriately in the immediate and delayed scenario. A logical, practical, and safe approach to the management of these complications should be the aim of every practising urologist.

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Study concept and design: Summerton, Kitrey, Lumen, Serafetinidis, Djakovic.
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Analysis and interpretation of data: Summerton, Kitrey, Lumen, Serafetinidis, Djakovic.
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References

[1] Lynch TH, Martínez-Piñeiro L, Plas E, et al., members of the European Association of Urology (EAU) Guidelines Office. EAU guidelines on urological trauma. Arnhem, Netherlands: European Association of Urology.

[2] Heye S, Vanbeckevoort D, Blockmans D, Nevelsteen A, Maleux G. Iatrogenic main renal artery injury: treatment by endovascular stent-graft placement. Cardiovasc Intervent Radiol 2005;28:93–4.

[3] Chatziioannou A, Brountzos E, Primetis E, et al. Effects of superselective embolization for renal vascular injuries on renal parenchyma and function. Eur J Vasc Endovasc Surg 2004;28:201–6.

[4] Phadke RV, Sawlani V, Rastogi H, et al. Iatrogenic renal vascular injuries and their radiological management. Clin Radiol 1997;52: 119–23.

[5] Albani JM, Novick AC. Renal artery pseudoaneurysm after partial nephrectomy: three case reports and a literature review. Urology 2003;62:227–31.

[6] Furness PN, Philpott CM, Chorbadjian MT, et al. Protocol biopsy of the stable renal transplant: a multicenter study of methods and complication rates. Transplantation 2003;76:969–73.

[7] Barley FL, Kessel D, Nicholson T, Robertson I. Selective embolization of large symptomatic iatrogenic renal transplant arteriovenous fistula. Cardiovasc Intervent Radiol 2006;29:1084–7.

[8] Maleux G, Messiaen T, Stockx L, Vanrenterghem Y, Wilms G. Transcatheter embolization of biopsy-related vascular injuries in renal allografts. Long-term technical, clinical and biochemical results. Acta Radiol 2003;44:13–7.

[9] Takahashi M, Humke U, Girndt M, Kramann B, Uder M. Early posttransplantation renal allograft perfusion failure due to dissection: diagnosis and interventional treatment. AJR Am J Roentgenol 2003;180:759–63.

[10] Bellman GC. Complications of endopyelotomy. J Endourol 1996;10: 177–81.

[11] Hinshaw JL, Shadid AM, Nakada SY, Hedican SP, Winter III TC, Lee Jr FT. Comparison of percutaneous and laparoscopic cryoablation for the treatment of solid renal masses. AJR Am J Roentgenol 2008;191: 1159–68.

[12] Cohenpour M, Strauss S, Gottlieb P, et al. Pseudoaneurysm of the renal artery following partial nephrectomy: imaging findings and coil embolization. Clin Radiol 2007;62:1104–9.

[13] Loffroy R, Guiu B, Lambert A, et al. Management of post-biopsy renal allograft arteriovenous fistulas with selective arterial embolization: immediate and long-term outcomes. Clin Radiol 2008;63:657–65.

[14] Jones CD, McGahan JP. Computed tomographic evaluation and guided correction of malpositioned nephrostomy catheters. Abdom Imaging 1999;24:422–5.

[15] Lewis S, Patel U. Major complications after percutaneous nephrostomy—lessons from a department audit. Clin Radiol 2004;59:171–9.

[16] Ben Meir D, Lask D, Koren R, Livne PM. Intrarenal foreign body presenting as a solid tumor. Urology 2003;61:1035.

[17] Nakada SY, Johnson M. Ureteropelvic junction obstruction. Retrograde endopyelotomy. Urol Clin North Am 2000;27:677–84.

[18] Breyer BN, McAninch JW, Elliott SP, Master VA. Minimally invasive endovascular techniques to treat acute renal hemorrhage. J Urol 2008;179:2248–52, discussion 2253.

[19] Wang MQ, Xie CM, Wang ZP, Guan J, Gu XF, Liu FY. Treatment of acquired arteriovenous fistulas with interventional minimally invasive techniques [in Chinese]. Zhonghua Wai Ke Za Zhi 2004;42: 687–91.

[20] Morris CS, Bonnevie GJ, Najarian KE. Nonsurgical treatment of acute iatrogenic renal artery injuries occurring after renal artery angioplasty and stenting. AJR Am J Roentgenol 2001;177:1353–7.

[21] Oderich GS, Panneton JM, Hofer J, et al. Iatrogenic operative injuries of abdominal and pelvic veins: a potentially lethal complication. J Vasc Surg 2004;39:931–6.

[22] Taneja M, Tan KT. Renal vascular injuries following nephron-sparing surgery and their endovascular management. Singapore Med J 2008;49:63–6.

[23] Huber J, Pahernik S, Hallscheidt P, et al. Selective transarterial embolization for posttraumatic renal hemorrhage: a second try is worthwhile. J Urol 2011;185:1751–5.

[24] Perini S, Gordon RL, LaBerge JM, et al. Transcatheter embolization of biopsy-related vascular injury in the transplant kidney: immediate and long-term outcome. J Vasc Interv Radiol 1998;9:1011–9.

[25] Nakatani T, Uchida J, Han YS, et al. Renal allograft arteriovenous fistula and large pseudoaneurysm. Clin Transplant 2003;17:9–12.

[26] Dorffner R, Thurnher S, Prokesch R, et al. Embolization of iatrogenic vascular injuries of renal transplants: immediate and follow-up results. Cardiovasc Intervent Radiol 1998;21:129–34.

[27] Ozdemir S, Cekirge S, Kara A, Bakkaloğlu A. A rare complication of renal biopsy in a child with membranoproliferative glomerulonephritis. Int Urol Nephrol 1998;30:689–92.

[28] Silberzweig JE, et al. Percutaneous renal biopsy complicated by renal capsular artery pseudoaneurysm. Am J Kidney Dis 1998;31: 533–5.

[29] Gupta M, Bellman GC, Smith AD. Massive hemorrhage from renal vein injury during percutaneous renal surgery: endourological management. J Urol 1997;157:795–7.

[30] El-Nahas AR, Shokeir AA, El-Assmy AM, et al. Post-percutaneous nephrolithotomy extensive hemorrhage: a study of risk factors. J Urol 2007;177:576–9.

[31] el-Nahas AR, Shokeir AA, Mohsen T, et al. Functional and morphological effects of postpercutaneous nephrolithotomy superselective renal angiographic embolization. Urology 2008;71:408–12.

[32] Brandes S, Coburn M, Armenakas N, McAninch J. Diagnosis and management of ureteric injury: an evidence-based analysis. BJU Int 2004;94:277–89.

[33] Chou MT, Wang CJ, Lien RC. Prophylactic ureteral catheterization in gynecologic surgery: a 12-year randomized trial in a community hospital. Int Urogynecol J Pelvic Floor Dysfunct 2009;20:689–93.

[34] Pfitzenmaier J, Gilfrich C, Haferkamp A, Hohenfellner M. Trauma of the ureter. In: Hohenfellner RAS, editor. Emergencies in urology. New York, NY: Springer; 2007. p. 233–45.

[35] Visco AG, Taber KH, Weidner AC, Barber MD, Myers ER. Cost-effectiveness of universal cystoscopy to identify ureteral injury at hysterectomy. Obstet Gynecol 2001;97:685–92.

[36] Johnson DB, Pearle MS. Complications of ureteroscopy. Urol Clin North Am 2004;31:157–71.

[37] Delacroix Jr SE, Winters JC. Urinary tract injures: recognition and management. Clin Colon Rectal Surg 2010;23:104–12.

[38] Gilmour DT, Das S, Flowerdew G. Rates of urinary tract injury from gynecologic surgery and the role of intraoperative cystoscopy. Obstet Gynecol 2006;107:1366–72.

[39] Schimpf MO, Gottenger EE, Wagner JR. Universal ureteral stent placement at hysterectomy to identify ureteral injury: a decision analysis. BJOG 2008;115:1151–8.

[40] Vakili B, Chesson RR, Kyle BL, et al. The incidence of urinary tract injury during hysterectomy: a prospective analysis based on universal cystoscopy. Am J Obstet Gynecol 2005;192:1599–604.

[41] Parpala-Sparman T, Paananen I, Santala M, Ohtonen P, Hellström P. Increasing numbers of ureteric injuries after the introduction of laparoscopic surgery. Scand J Urol Nephrol 2008;42:422–7.

[42] Pokala N, Delaney CP, Kiran RP, Bast J, Angermeier K, Fazio VW. A randomized controlled trial comparing simultaneous intra-operative vs sequential prophylactic ureteric catheter insertion in re-operative and complicated colorectal surgery. Int J Colorectal Dis 2007;22:683–7.

[43] Koukouras D, Petsas T, Liatsikos E, et al. Percutaneous minimally invasive management of iatrogenic ureteral injuries. J Endourol 2010;24:1921–7.

[44] Armenakas NA, Pareek G, Fracchia JA. Iatrogenic bladder perforations: long-term followup of 65 patients. J Am Coll Surg 2004;198:78–82.

[45] Golan S, Baniel J, Lask D, Livne PM, Yossepowitch O. Transurethral resection of bladder tumour complicated by perforation requiring open surgical repair—clinical characteristics and oncological outcomes. BJU Int 2010;107:1065–8.

[46] Frenkl TL, Rackley RR, Vasavada SP, Goldman HB. Management of iatrogenic foreign bodies of the bladder and urethra following pelvic floor surgery. Neurourol Urodyn 2008;27:491–5.

[47] Rafique M. Intravesical foreign bodies: review and current management strategies. Urol J 2008;5:223–31.

[48] Gomez RG, Ceballos L, Coburn M, et al. Consensus statement on bladder injuries. BJU Int 2004;94:27–32.

[49] Ogah J, Cody DJ, Rogerson L. Minimally invasive synthetic suburethral sling operations for stress urinary incontinence in women: a short version Cochrane review. Neurourol Urodyn 2011;30:284–91.

[50] Bekker MD, Bevers RF, Elzevier HW. Transurethral and suprapubic mesh resection after Prolift bladder perforation: a case report. Int Urogynecol J Pelvic Floor Dysfunct 2010;21:130–3.

[51] Balbay MD, Cimentepe E, Unsal A, Bayrak O, Koç A, Akbulut Z. The actual incidence of bladder perforation following transurethral bladder surgery. J Urol 2005;174:2260–2, discussion 2262–3.

[52] Traxer O, Pasqui F, Gattegno B, Pearle MS. Technique and complications of transurethral surgery for bladder tumours. BJU Int 2004;94:492–6.

[53] Alperin M, Mantia-Smaldone G, Sagan ER. Conservative management of postoperatively diagnosed cystotomy. Urology 2009;73, 1163.e17–9.

[54] Manikandan R, Lynch N, Grills RJ. Percutaneous peritoneal drainage for intraperitoneal bladder perforations during transurethral resection of bladder tumors. J Endourol 2003;17:945–7.

[55] Babjuk M, Oosterlinck W, Sylvester R, et al. EAU guidelines on non-muscle-invasive urothelial carcinoma of the bladder, the 2011 update. Eur Urol 2011;59:997–1008.

[56] Stav K, Dwyer PL, Rosamilia A, Schierlitz L, Lim YN, Lee J. Risk factors for trocar injury to the bladder during mid urethral sling procedures. J Urol 2009;182:174–9.

[57] Foley C, Patki P, Boustead G. Unrecognized bladder perforation with mid-urethral slings. BJU Int 2010;106:1514–8.

[58] Kashefi C, Messer K, Barden R, Sexton C, Parsons JK. Incidence and prevention of iatrogenic urethral injuries. J Urol 2008;179:2254–7, discussion 2257–8.

[59] Mundy AR, Andrich DE. Urethral trauma. Part I: introduction, history, anatomy, pathology, assessment and emergency management. BJU Int 2011;108:310–27.

[60] Fenton AS, Morey AF, Aviles R, Garcia CR. Anterior urethral strictures: etiology and characteristics. Urology 2005;65:1055–8.

[61] Wu AK, Blaschko SD, Garcia M, McAninch JW, Aaronson DS. Safer urethral catheters: how study of catheter balloon pressure and force can guide design. BJU Int 2012;109:1110–4.

[62] Buddha S. Complication of urethral catheterisation. Lancet 2005; 365:909.

[63] Hammarsten J, Lindqvist K. Suprapubic catheter following transurethral resection of the prostate: a way to decrease the number of urethral strictures and improve the outcome of operations. J Urol 1992;147:648–51, discussion 651–2.

[64] Thomas AZ, Giri SK, Meagher D, Creagh T. Avoidable iatrogenic complications of urethral catheterization and inadequate intern training in a tertiary-care teaching hospital. BJU Int 2009;104: 1109–12.

[65] Katz G, Milgalter E, Landau Y, Borman JB. Prevention of urethral strictures following coronary artery bypass graft surgery. Urology 1992;39:433–5.

[66] Vicente J, Rosales A, Montlleó M, Caffaratti J. Value of electrical dispersion as a cause of urethral stenosis after endoscopic surgery. Eur Urol 1992;21:280–3.

[67] Hammarsten J, Lindqvist K, Sunzel H. Urethral strictures following transurethral resection of the prostate. The role of the catheter. Br J Urol 1989;63:397–400.

[68] Rassweiler J, Teber D, Kuntz R, Hofmann R. Complications of transurethral resection of the prostate (TURP)—incidence, management, and prevention. Eur Urol 2006;50:969–80, discussion 980.

[69] Eltabey MA, Sherif H, Hussein AA. Holmium laser enucleation versus transurethral resection of the prostate. Can J Urol 2010; 17:5447–52.

[70] Elliott SP, Meng MV, Elkin EP, et al., CaPSURE Investigators. Incidence of urethral stricture after primary treatment for prostate cancer: data From CaPSURE. J Urol 2007;178:529–34, discussion 534.

[71] Park R, Martin S, Goldberg JD, Lepor H. Anastomotic strictures following radical prostatectomy: insights into incidence, effectiveness of intervention, effect on continence, and factors predisposing to occurrence. Urology 2001;57:742–6.

[72] Msezane LP, Reynolds WS, Gofrit ON, Shalhav AL, Zagaja GP, Zorn KC. Bladder neck contracture after robot-assisted laparoscopic radical prostatectomy: evaluation of incidence and risk factors and impact on urinary function. J Endourol 2008;22:97–104.

[73] Ficarra V, Novara G, Artibani W, et al. Retropubic, laparoscopic, and robot-assisted radical prostatectomy: a systematic review and cumulative analysis of comparative studies. Eur Urol 2009;55: 1037–63.

[74] Chrouser KL, Leibovich BC, Sweat SD, et al. Urinary fistulas following external radiation or permanent brachytherapy for the treatment of prostate cancer. J Urol 2005;173:1953–7.

[75] Marguet C, Raj GV, Brashears JH, et al. Rectourethral fistula after combination radiotherapy for prostate cancer. Urology 2007;69: 898–901.

[76] Gomez-Iturriaga Pina A, Crook J, Borg J, Lockwood G, Fleshner N. Median 5 year follow-up of 125iodine brachytherapy as monotherapy in men aged <or = 55 years with favorable prostate cancer. Urology 2010;75:1412–6.

[77] Fonteyne V, Villeirs G, Lumen N, De Meerleer G. Urinary toxicity after high dose intensity modulated radiotherapy as primary therapy for prostate cancer. Radiother Oncol 2009;92: 42–7.

[78] Shelley M, Wilt TJ, Coles B, Mason MD. Cryotherapy for localised prostate cancer. Cochrane Database Syst Rev 2007:CD005010.

[79] Polat O, Gül O, Aksoy Y, Ozbey I, Demirel A, Bayraktar Y. Iatrogenic injuries to ureter, bladder and urethra during abdominal and pelvic operations. Int Urol Nephrol 1997;29:13–8.

[80] Hautmann RE, de Petriconi RC, Volkmer BG. 25 years of experience with 1,000 neobladders: long-term complications. J Urol 2011;185: 2207–12.

[81] Hadjizacharia P, Inaba K, Teixeira PG, Kokorowski P, Demetriades D, Best C. Evaluation of immediate endoscopic realignment as a treatment modality for traumatic urethral injuries. J Trauma 2008;64:1443–9, discussion 1449–50.

[82] Rieder J, Brusky J, Tran V, Stern K, Aboseif S. Review of intentionally self-inflicted, accidental and iatrogenic foreign objects in the genitourinary tract. Urol Int 2010;84:471–5.
[83] Gokalp A, Yildirim I, Aydur E, Göktepe S, Başal S, Yazicioğlu K. How to manage acute urethral false passage due to intermittent catheterization in spinal cord injured patients who refused insertion of an indwelling catheter. J Urol 2003;169: 203–6.
[84] Maheshwari PN, Shah HN. Immediate endoscopic management of complete iatrogenic anterior urethral injuries: a case series with long-term results. BMC Urol 2005;5:13.
[85] Pansadoro V, Emiliozzi P. Iatrogenic prostatic urethral strictures: classification and endoscopic treatment. Urology 1999;53: 784–9.
[86] Weiss HA, Larke N, Halperin D, Schenker I. Complications of circumcision in male neonates, infants and children: a systematic review. BMC Urol 2010;10:2.
[87] Atikeler MK, Geçit I, Yüzgeç V, Yalçin O. Complications of circumcision performed within and outside the hospital. Int Urol Nephrol 2005;37:97–9.
[88] Ceylan K, Burhan K, Yilmaz Y, Can S, Kuş A, Mustafa G. Severe complications of circumcision: an analysis of 48 cases. J Pediatr Urol 2007;3:32–5.
[89] Ben Chaim J, Livne PM, Binyamini J, Hardak B, Ben-Meir D, Mor Y. Complications of circumcision in Israel: a one year multicenter survey. Isr Med Assoc J 2005;7:368–70.
[90] Perera CL, Bridgewater FH, Thavaneswaran P, Maddern GJ. Safety and efficacy of nontherapeutic male circumcision: a systematic review. Ann Fam Med 2010;8:64–72.
[91] Circumcision policy statement. American Academy of Pediatrics. Task Force on Circumcision. Pediatrics 1999;103:686–93.
[92] Senel FM, Demirelli M, Oztek S. Minimally invasive circumcision with a novel plastic clamp technique: a review of 7,500 cases. Pediatr Surg Int 2010;26:739–45.