Ureteric injury in obstetric and gynaecological surgery

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Ureteric injury is rare in obstetric and gynaecological practice but, when it occurs, it has serious implications in terms of both morbidity and litigation. In this review, we evaluate the incidence, aetiology, preventive strategies, diagnosis and management of ureteric injury by systematically reviewing the literature. The incidence of ureteric injury varies between 0.1% and 30%, depending on the type of surgery. Prevention can be attempted by preoperative and intraoperative precautions, although the effectiveness of these measures has not been fully evaluated. Diagnosis of ureteric injury may be made intraoperatively but 70% are diagnosed postoperatively. Management depends on the timing of diagnosis, the aetiology, the length and location of the injury, the extent of the causative operation and the condition of the woman.

Introduction

Many obstetricians and gynaecologists share a common fear of injury to the ureter. Its incidence is low but ureteric injury may have serious implications in terms of morbidity and litigation. The morbidity arising from ureteric injury includes increased hospital stay, secondary invasive interventions, reoperation, potential loss of renal function and deterioration of the woman’s quality of life.1,2 Ureteric injury is the most common complication of gynaecological surgery leading to litigation. It accounts for 17% of nonobstetric legal action initiated against obstetricians and gynaecologists in the USA.3 Intraoperative injury to the ureter is possible not only during complicated surgical procedures but also during uncomplicated procedures. Hence, it is not just the domain of the gynaecological oncologist or interventional laparoscopist. Preventive strategies, early diagnosis and appropriate management can limit the morbidity associated with ureteric injury.

Despite comprehensive literature searches, we were unable to locate up-to-date, rigorously developed guidelines or systematic reviews on the subject of ureteric injury in obstetric and gynaecological practice. Our objective was, therefore, to review the evidence on the incidence, aetiology, preventive strategies, diagnosis and management of ureteric injury in obstetric and gynaecological surgery.

Methods

An electronic search of the Cochrane Database of Systematic Reviews (2003), Medline (1966–2003) and EMBASE (1980–2003) was conducted using a combination of medical subject headings and text words. Three subsets of citations were generated:

1. studies of the ureter (‘ureteric’, ‘ureter’ and ‘urinary’)
2. studies of complications (‘complications’, ‘injury’, ‘trauma’ and ‘harm’)
3. studies in obstetrics and gynaecology (‘obstetrics’, ‘gynaecology’ and ‘gynecology’). These subsets were combined using ‘AND’ to generate a subset of citations relevant to our review question. Studies were included if they evaluated the incidence, aetiology, preventive strategies, diagnosis and management of ureteric injury in obstetric and gynaecological practice. The reference lists of all known primary and review articles were examined to identify cited articles not captured by electronic searches. Articles cited frequently were used in the Science Citation Index to identify additional citations. No language restrictions were placed in any of our searches.

Meta-analysis and formal grading of evidence was not feasible owing to the extensive variation in research questions and study designs. We found 79 relevant primary articles from our literature searches, which form the basis of our review.
Incidence

Ureteric injury has an incidence of 0.2–1.0% during any abdominal or pelvic surgery. Obstetric or gynaecological surgery accounts for approximately 50% of all these injuries. The reported incidence may be low because many ureteric injuries are not recognised or reported. Despite the prevalence of ureteric injury being higher following gynaecological cancer surgery, it is benign gynaecological surgery that accounts for most cases. Reports show conflicting results when comparing the incidence of ureteric injury following laparoscopic surgery with the incidence following open gynaecological surgery. Some studies report similar figures while others report a significantly higher incidence after laparoscopic surgery. Despite the incidence of all major complications associated with laparoscopy declining, the incidence of ureteric injury has stayed constant at approximately 1%. Table 1 outlines the risk of ureteric injury associated with various obstetric and gynaecological procedures.

Although injury to the ureters during laparoscopic surgery is infrequent, 38% occur during the treatment of endometriosis.

Aetiology

The close attachment of the ureter to the peritoneum makes it particularly vulnerable during abdominopelvic surgery. Ureteric injuries are possible even in the most straightforward procedures. Certain factors have been recognised as increasing the risk:

- an enlarged uterus
- previous pelvic surgery
- ovarian neoplasms
- endometriosis
- pelvic adhesions
- distorted pelvic anatomy
- coexistent bladder injury
- massive intraoperative haemorrhage.

Table 1. Risk of ureteric injury in obstetric and gynaecological procedures

<table>
<thead>
<tr>
<th>Subspecialty</th>
<th>Procedure</th>
<th>Incidence (%)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstetric</td>
<td>Emergency caesarean section</td>
<td>0.027–0.09</td>
<td>39,40</td>
</tr>
<tr>
<td></td>
<td>Caesarean hysterectomy</td>
<td>0.5–8.0</td>
<td>16,18</td>
</tr>
<tr>
<td></td>
<td>Keilland rotational forceps</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>Gynaecological</td>
<td>Abdominal hysterectomy</td>
<td>0.04–3.0</td>
<td>1,8</td>
</tr>
<tr>
<td></td>
<td>Vaginal hysterectomy</td>
<td>0.02–0.47</td>
<td>8,41</td>
</tr>
<tr>
<td></td>
<td>Subtotal hysterectomy</td>
<td>0.03</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Wertheim's hysterectomy</td>
<td>1–30</td>
<td>34,42</td>
</tr>
<tr>
<td>Urogynaecology</td>
<td>Burch colposuspension</td>
<td>0.09–3.3</td>
<td>23,43</td>
</tr>
<tr>
<td>Laparoscopy</td>
<td>Transvaginal tape</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adnexitomy</td>
<td>2.9</td>
<td>8,27</td>
</tr>
<tr>
<td></td>
<td>Laparoscopically assisted vaginal hysterectomy</td>
<td>1.39–6.0</td>
<td>8,27</td>
</tr>
<tr>
<td></td>
<td>Adhesiolysis</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diathermy ablation of endometriotic deposits</td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

Sites of injury

Injury occurs most frequently in the lower third of the ureter (51%), followed by the upper third (30%) and the middle third (19%). The most common sites of injury are:

- lateral to the uterine vessels
- the area of the ureterovesical junction close to the cardinal ligaments
- the base of the infundibulopelvic ligament as the ureters cross the pelvic brim at the ovarian fossa
- at the level of the uterosacral ligament.

Most studies show the most common site of injury to be lateral to the uterine vessels, but Daly et al. report this to be at the ovarian fossa. During laparoscopy the ureter is injured most frequently adjacent to the uterosacral ligaments.

Types of injury

The ureter may be injured in one of several ways. Intraoperatively, there may be ligation or kinking by a ligature; crushing by a clamp, division, complete or partial transection, devascularisation or diathermy-related injury. The incidence of different forms of injury are complete transection, 61%; excision, 29%; ligation, 7% and partial transection, 3%.

In the postoperative period, avascular necrosis may occur following extensive dissection of periureteric tissue with impairment of the anastomotic blood supply. Another mechanism of injury is the kinking and subsequent obstruction over a haematoma or lymphocele.

Classification

According to the Organ Injury Scaling System developed by the Committee of the American Association for the Surgery of Trauma, ureteric injuries are classified as follows:

- grade I haematoma; contusion or haematoma without devascularisation
- grade II laceration; < 50% transection
- grade III laceration; ≥ 50% transection
- grade IV laceration; complete transection with < 2 cm of devascularisation
- grade V laceration; avulsion with > 2 cm of devascularisation.

This anatomical classification does not, however, appear to have clear prognostic implications.

Prevention

Preoperative and intraoperative measures can be taken to try to reduce the risk of ureteric injury (Box 1). Appropriate investigations should be
performed preoperatively, depending on the underlying pathology and proposed operation. For example, when there is suspected pathology of the urinary tract, a preoperative intravenous urogram (IVU) or ultrasound scan can identify ureteric dilatation and disclose anatomical variations. In their review of 493 women, Piscitelli et al.11 found that abnormal IVU findings are most likely to occur in women with a uterine size of 12 weeks or larger, when adnexal masses are 4 cm or larger and in women with an abnormal pelvic examination.

A preoperative IVU does not appear to have a role in preventing ureteric injuries in routine procedures.12,16 Similarly, prophylactic ureteric catheterisation has not been shown to reduce the risk of ureteric injury in routine cases.17 Ureteric catheterisation may, however, assist the identification of ureteric injury intraoperatively and optimise the subsequent management in cases where dissection is difficult.18

Intraoperative measures to prevent injury include an appropriate operative approach, adequate exposure, full examination of the disease in the pelvis and seeking early urological assistance where appropriate.18 Blind clamping of blood vessels has been identified as the predominant cause of ureteric injury in obstetric procedures.19 Thus the control of bleeding by specifically identifying bleeding points rather than blind clamping is likely to reduce this risk.

When dissecting masses, it is important to stay close to the pathology and, whenever possible, to identify the ureter in its course before dissection. Adequate mobilisation of the bladder in a downward and outward direction is likely to reduce the risk of ureteric injury because the ureters are moved away from the uterine vessels and thus away from the operative field.20 There is evidence that direct visualisation of the ureters is not feasible; intravenous administration of methylthioninium chloride or indigo carmine (5 ml) is an accurate means of demonstrating ureteric patency.24 Intraoperative transurethral cystoscopy or telescopy (through cystotomy) using an abdominal approach may be required to visualise evacuation of dye-stained urine from both ureteric orifices. Bubbles or blood-tinged urine coming through the ureteric orifices may indicate ureteric injury. The use of intraoperative cystoscopy and telescopy during urogynaecology procedures has shown an incidence of urinary tract injury of 2.6–8%,25,26 whereas its use in major benign gynaecological procedures found otherwise undetected injury in 0.4% of cases.21 A decision analysis model has shown that routine cystoscopy is cost-effective if the rate of ureteric injury exceeds 1.5% for abdominal hysterectomy or 2% for vaginal hysterectomy or laparoscopically assisted vaginal hysterectomy.27 Cystoscopy should therefore be considered in complex cases (Table 1).
Postoperative diagnosis

Postoperative symptoms of ureteric injury tend to be variable (Box 2). Flank pain and fever are the most common symptoms. Haematuria, a reliable indicator of renal trauma, is absent in approximately 30% of ureteric injuries.1,28 Women may occasionally present with a retroperitoneal urinoma29 (localised collection of urine), which can be confirmed by an ultrasound scan. Postoperative anuria, though uncommon, should prompt urgent evaluation. Urine leakage, other than from the urethra, should prompt the search for a fistula. A late presentation is the development of hypertension secondary to obstructive uropathy. It should be noted, however, that typical symptoms might occur in only 50% of women with ureteric injuries.

In suspected cases, investigations are needed to establish renal function, to rule out hydronephrosis and to evaluate continuity of the ureter. Commonly used investigations for assessing ureteric patency are shown in Box 3.

Intravenous urogram

Hydronephrosis, ureteric integrity and drainage (in a series of sagittal images) and any extravasation can usually be seen on an intravenous urogram (IVU). Whereas extravasation of dye is characteristic of ureteric injury, findings may be more subtle, ranging from delayed function to no abnormality at all, even when ureteric injury is present.

Computed tomography

A computed tomography (CT) scan with intravenous contrast can also assess ureteric patency. Contrast extravasation confined predominantly to the medial peri-renal space is the most consistent finding.30 The absence of contrast material in the distal ureter on delayed CT images is diagnostic of a complete ureteric transection.

Visualising ureteric integrity and continuity is often more difficult with CT than with an IVU because CT images are a series of cross-sections. Rapid sequence spiral CT fails to demonstrate this, hence delayed films need to be explicitly requested.31 CT scanning has the advantage of imaging for other concomitant conditions.

Retrograde ureterogram

When the results of an IVU and CT scan are inconclusive, a retrograde ureterogram may be necessary to evaluate the course of the ureter. This identifies the anatomic site of obstruction, even when missed on an IVU or CT scan, by delivering a higher density of contrast material to the injured site. A retrograde ureterogram is, however, more invasive than either an IVU or CT scan and requires cystoscopy.

Renal ultrasound

Renal ultrasound is perhaps the best noninvasive method to visualise the kidney. Hydronephrosis and retroperitoneal urinomas are shown with great sensitivity. Renal ultrasound cannot, however, assess either renal function or continuity of the ureter.

Cystoscopy

Postoperative anuria, caused by bilateral ureteric obstruction, usually requires cystoscopic evaluation. Ejaculation of urine from both ureteric orifices is diagnostic of ureteric patency. If in doubt, a retrograde ureterogram may be performed.

Contrast-dye tests

Contrast-dye tests are normally combined with cystoscopy and may be particularly useful if a urinary fistula is suspected. The path of the fistula can usually be determined by the simultaneous administration of intravenous indigo carmine (a blue
dye) and placement in the bladder of Congo red
through a transurethral catheter.

A full blood count and an electrolyte profile
must be taken in suspected cases of ureteric
injury. A full blood count may serve as a guide to
infection. Postoperative estimation of serum
urea, creatinine and sodium may aid diagnosis in
several ways. Measuring serum creatinine levels
on the second postoperative day might be useful
in evaluating ureteric patency. Increases of
greater than 0.2 mg/dl may be indicative of
unilateral ureteric obstruction. If the ureters
are patent bilaterally, creatinine elevations are
normally less than 0.3 mg/dl. Serum creati-
nine levels are, however, influenced by factors
other than ureteric obstruction. These include
intraoperative blood loss, fluid replacement and
the use of potentially nephrotoxic medication
such as nonsteroidal inflammatory drugs,
furosemide and aminoglycosides.

Postoperative uraemia occurs when ureteric
injury causes total urinary obstruction. This may
be caused either by a bilateral ureteric injury or
from a unilateral injury occurring in a solitary
functioning kidney. Anuria is the only immedi-
ate sign of imminent uraemia and women with
anuria require immediate intervention to pre-
serve their renal function.

Hyponatraemia may occur after ureteric injury
and tends to follow the spillage of dilute urine
into the retroperitoneum. Reabsorption of free
water from this dilute retroperitoneal urinoma
causes a decrease in serum osmolality and serum
sodium, which produces a sodium-sparing and
free water-excreting response by the kidneys.

Management

Renal deterioration is inevitable unless urine
flow is restored because the ureter is the sole
conduit from the kidney. There are major
variables guiding a surgeon’s approach to the
management of ureteric injuries: time of diagno-
sis, actiology, length and location of the injury,
extent of the causative operation and the condi-
tion of the woman. The precise nature of the
injury should be defined before deciding the
best method of repair. A complete assessment of
renal function and delineation of the ureter’s full
length are performed by radiography and labora-
tory investigations.

There is no specific medical therapy for ureteric
injury, although potential concomitant condi-
tions such as infection and renal failure should be
treated medically. General principles of ureteric
reconstruction are given in Box 4.

Management of ureteric injury by the urologist
depends on the length and location of the
injury71 (Table 2). When ureteric injury is recog-
nised at the time of surgery, immediate recon-
struction or reimplantation delivers the best
results. Retrograde ureterography is a useful
test to localise the lesion and determine further
management.

<table>
<thead>
<tr>
<th>Box 4. General principles of ureteric repair44</th>
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<tbody>
<tr>
<td>1. Tension-free anastomosis by ureteric mobilisation</td>
</tr>
<tr>
<td>2. Ureteric dissection preserving adventitial sheath and its blood supply</td>
</tr>
<tr>
<td>3. Minimal use of fine absorbable suture to attain watertight closure</td>
</tr>
<tr>
<td>4. Use of peritoneum or omentum to surround the anastomosis</td>
</tr>
<tr>
<td>5. Drain the anastomotic site with a passive drain to prevent urine accumulation</td>
</tr>
<tr>
<td>6. Stent with a ureteric catheter</td>
</tr>
<tr>
<td>7. Consider a proximal diversion</td>
</tr>
</tbody>
</table>

All transected ureters need stenting to maximise
urinary diversion. A double-J stent may be used
for this purpose. A passive retroperitoneal drain,
such as a Penrose drain, should be used to limit
urinoma formation. Active drains may prolong
leakage by exerting negative pressure and should
be avoided. The bladder needs to be decompres-
sed using a Foley’s or Malecot’s catheter.

When recognition of ureteric injury has been
delayed, repair should not be delayed. Exceptions include sepsis, extensive haematoma
or abscess formation at the site of injury, or when
the woman is haemodynamically unstable. In
these situations it is preferable to perform percu-
taneous nephrostomy drainage of the renal pelvis
or a retrograde ureteric stent placement, and
delay surgery until the complication is resolved.

Complications commonly encountered follow-
ing surgery for ureteric injury are given in Box 5.

<table>
<thead>
<tr>
<th>Table 2. Management options for ureteric injury</th>
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<tbody>
<tr>
<td>Injury</td>
</tr>
<tr>
<td>Needle injury</td>
</tr>
<tr>
<td>Partial transection</td>
</tr>
<tr>
<td>Complete transection (no loss of length)</td>
</tr>
<tr>
<td>≤5 cm from vesicoureteric junction</td>
</tr>
<tr>
<td>&gt;5 cm from vesicoureteric junction</td>
</tr>
<tr>
<td>Complete transection (loss of length)</td>
</tr>
<tr>
<td>Transureteroureterostomy</td>
</tr>
<tr>
<td>Ureterocalycostomy</td>
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</table>
Conclusion
Berard (1841) and Simon (1869) recorded the earliest ureteric injury repairs in obstetric and gynaecological surgery. The ureter and its course were poorly understood at this time but many contributions have since been made to increase understanding of the aetiology, prevention, diagnosis and management of iatrogenic ureteric injuries.

If a woman is not making satisfactory postoperative recovery, the possibility of ureteric injury should be considered. Radiographic investigations form the basis of diagnosis because symptoms and laboratory investigations tend to be non-specific. These should be performed sooner rather than later if there is the slightest suspicion of ureteric injury. The surgeon must keep detailed operative notes on intra-operative surgical difficulties, specifically stating visualisation of the ureters. An explanation to the woman of her injury and its implications should always be made and documented.

It has been said that ‘the venial sin is injury to the ureter, but the mortal sin is failure of recognition’. Familiarisation with the issues discussed in this review may lead to appropriate management and reduction in morbidity.

References