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IATROGENIC URETERIC INJURIES IN GYNECOLOGICAL SURGERY

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ABSTRACT

Although the ureter is protected from injury by virtue of its elasticity and sheltered position, it is highly vulnerable during surgical procedures performed in pelvis. Nearly all gynecological surgical procedures have been reported to cause ureteral injury. Incidence of ureteral injury for benign conditions is low but it is on the rise owing to the enthusiastic use of therapeutic laparoscopy in gynaecology. Factors associated with increased risk of ureteral injury include malignancy, hemorrhage, endometriosis, adhesions from previous surgery, enlarged uterus and distorted anatomy. During surgery ureter may be transected, lacerated, avulsed, ligated or diathermized. Injury may become obvious intra-operatively but most cases are diagnosed in postoperative period. The morbidity associated with such an injury may be serious resulting in prolonged hospital stay, re-operation and potential loss of renal function. Injury recognized intra-operatively should be repaired during the same procedure. When the diagnosis of ureteral injury is made post-operatively,.then either endourological or open surgical procedures may be performed with good success. In the presence of risk factors pre-operative intravenous urography, ureteric stenting may be carried out but sound knowledge of abdominal and pelvic anatomy is the best prevention for ureteric injury.

KEY WORDS Gynaecology; iatrogenic; injury; ureter

INTRODUCTION

Intra-operative ureteric injuries may complicate gynecological, urological, vascular and general surgery[1,2]. The retro peritoneal course of ureter, its close proximity to the female reproductive organs makes it particularly vulnerable to iatrogenic injuries in gynecological procedures. The morbidity associated with such injury may be serious, resulting in increased hospital stay, compromise of the original surgical outcome, secondary invasive intervention, re-operation, potential loss of renal function and deterioration of the patient's quality of life[3].

THE ANA[T]OMY OF URETER

The ureter is arbitrarily divided into segments for the sake of description into abdominal and pelvic ureter. The “abdominal”ureter extends from the renal pelvis to iliac vessels and the "Pelvic" ureter extends from the iliac vessels to the bladder. In the

retroperitoneum, the ureter lies anterior to the psoas muscles and lateral to the tip of transverse processes of lumbar vertebrae. The ovarian vessels cross anteriorly as they run obliquely towards the pelvis. At the pelvic brim, the ureter crosses anterior to the common iliac vessels just at their point of bifurcation. In the female pelvis, the ureter lies anterior to the hypogastric artery and directly posterior to the ovary. It then crosses under the broad ligament just posterior to the uterine vessels. At this point ureter lies only 1-2 cm from the uterine cervix and is at the greatest risk of injury during gynecological procedures. Intramural ureter has an oblique course with a submucosal tunnel preventing vesicoureteric reflux during bladder filling[4].

Histologically the ureter is lined by transitional epithelium.Outside epithelium the smooth muscle layer is a complex network of interweaving bundles that become longitudinally orientated as they approach the ureterovesical junction. The outer adventitia contains loose connective tissue, blood vessels, lymphatics and nerves.

Multiple sources contribute to the blood supply of the ureter. From superior to inferior, they include the renal and ovarian vessels, the aorta and the iliac vessels, uterine, vaginal and hemorrhoidal arteries. The veins and lymphatic drainage parallels the arterial supply. Autonomic nerves are present within the ureteral wall primarily from sympathetic plexus but the role of autonomic nerves is poorly understood. Normal ureteral peristalsis does not require outside autonomic input but rather originate and is propagated from intrinsic smooth muscles. Pace maker sites are located in the minor calyx of renal collecting system. In addition, the smooth muscle of the ureter is a functional syncitium[5]. The smooth muscle throughout the ureter has the pacing potential, becoming dominant when the ureter has been injured or transected[6].

INCIDENCE & ETIOLOGY

Nearly all gynecological procedures have been reported to cause uretenc injury (table I). The reported incidence rate varies between 0.4-2.5% of all gynecological procedures[1] but reported figures piobably underestimate the true incidence. Many injuries are missed at the time of operation and some never beccme symptomatic[7].

Recently with the introduction of therapeutic laparoscopy and minimally invasive techniques, the incidence of major . iatrogenic ureteric injury in gynecology has risen sharply[8].

SITE OF INJURY

At operation, sites at risk include the ovarian vascular pedicle at the infundibulo-pelvic ligament, the uterine relation with the u;enne artery, the vaginal fornices and lateral rectal pedicles[9].

Approximately 90% of the ureteric injuries occur in distal portion of the ureter where it passes beneath the uterine vessels[10]. The left ureter has a much closer relationship to the cervix than right and is therefore more liable to injury[10"13]. 5-10% of uretenc injuries are bilateral[14].

The likelihood of injury tends to be related to the difficulty of operation or inexperience of the surgeon[15]. Although any gynecological procedure can cause urinary tract injury but it is more common after abdominal hysterectomy[1617]. Main risk factors are enlarged uterus, pelvic adhesions and massive hemorrhage[12]. Endometriosis reduces the mobility of ureter and distorts the normal anatomy and this makes it liable to injury[2]. Genitourinary tract abnormality and previous radiotherapy also puts the ureter at increased risk of injury. The injury rate is much higher for malignant conditions. The reported incidence after radical hysterectomy varies between 5-30%[18,19]. This is because of distortion of anatomy, extensive mobilization of the ureters and bladder from cervix and vaginal wall and resulting

devascularization15. Nevertheless, 75% of the ureteral injuries due to obstetric or gynecological surgery occur during procedures described by the surgeon a& "uncomplicated"[7].

MECHANISM OF INJURY

The ureter may be cut; Ligated or crushed at the time of surgery[2,20].lt is also at risk of vascular necrosis if the periureteric tissues carrying the tenuous anastomotic blood supply are stripped or diathermized. In addition injudiciously placed hemostatic stitch may occlude ureter directly or by causing kinking[14].

PATHOPHYSIOLOGY

The pathophysiology of ureteral injury depends upon many factors including the type of injury and when the injury is identified. If the injury of ureter is minor, spontaneous resolution and healing may occur. If the ureter has been inadvertently ligated and recognized in a timely fashion, th'e, deligation of suture can be done without any consequences.-If complete ligation of ureter occurs, obstruction will result in ipsilateral pain, hydronephrosis and progressive deterioration of renal function. If the urine in the obstructed system becomes infected pyonephrosis may occur. In cases where necrosis of the ischemic ureteric segment occurs urinary fistula may arise communicating with any nearby structures or the skin. Alternatively urinary extravasation will occur. If the; urine is unable to escape it will accumulate as a localized urinoma or as urinary ascites. If infection occurs peritonitis[1] may ensue. In cases where adventitial layer of ureter has been stripped or diathermized, ischemic stricture may develop with subsequent obstruction and hydronephrosis of the ipsilateral kidney. Uremia may result when bilateral ureteric injury causes total urinary obstruction. It may also result from a unilateral injury occuring in a solitary functioning kidney.

DIAGNOSIS

latrogenic ureteric injury may become apparent either intra operatively or may be diagnosed later in postoperative period.

INTRA OPERATIVE DIAGNOSIS

If there is difficulty in visualizing a suspected injury in ureter at the time of operation, 10 ml indigo carmine or methylene blue with 20 mg of furosemide may help to locate a ureteric injury. Examination of blue dye indicates ureteral discontinuity. Intra operative retrograde ureteropyelogram may be performed to assess the integrity of ureter.

POSTOPERATIVE DIAGNOSIS

In majority of cases iatrogenic injury is diagnosed after the operation[21].The patient may present with loin pain, prolonged ileus, fever or rising serum creatinine. Sloughing of the ureteric segment may occur leading to a urinary fistula from the wound (ureterocutaneous) orfrom vagina (ureterovaginal) at any time during the first 30 days. In cases of bilateral ureteral in;jry or a ureteric injury in a solitary functioning kidney anuria is the first clinical sign. Urinary ascites, paralytic ileus and peritonitis may occur. Alternatively urine may accumulate as a urinoma that can be asymptomatic or patient may have malaise, pyrexia, vague gastrointestinal symptoms and mass. 5% of patients with ureteric injury remain asymptomatic and may be diagnosed years later with a non functioning or hydronephrotic kidney[22].

INVESTIGATIONS

If the injury is recognized intra operatively additional laboratory investigations are rarely required. If the injury is suspected postoperatively, laboratory tests including complete blood counts, serum electrolyte, blood urea and serum creatinine estimation are needed to assess for the possible infection and renal impairment. Urinalysis is not particularly helpful for diagnosis, one study reported that in 88% cases of ureteric injury it was

normal[23]. If the pelvic drain out put is high through a surgically placed drain, estimation of urea and creatinine of the fluid should be carried out to ascertain the nature of fluid. Elevated urea and creatinine level of fluid that is more than serum will immediately indicate the fluid to be urine.

Ultrasonography of the renal tract is the simplest and least invasive method for a suspected ureteral injury displaying the presence of hydronephrosis or of retro peritoneal fluid collection (urinoma) attributable to urinary extravasation, However, it does not assess the renal function, nor does it assess the continuity of the ureter.

Intravenous urography (IVU) is the best imaging study to evaluate for the continuity of the ureter. Hydronephrosis, hydro ureter, ureteral integrity, extravasation usually can be seen readily through an IVU. Cystogram and voiding cystogram at the end of IVU may be useful to rule out vesicovaginal fistula and to evaluate the status of the bladder before a bladder elongation technique is considered. However, IVU may be normal in 7% cases[23]..

In some cases retrograde ureteropyelography or nephrostography provide useful further information. CT scan can also assess for both function of ipsilateral kidney and drainage of the ureter. But CT images are a series of cross sections, visualization of ureteral integrity and continuity often is more difficult than an IVU. So to evaluate the course of the ureter, retrograde pyelography is often necessary. Tc99 labeled DTPA renal scan or MAG 3 is required to assess the differential function of the ipsilateral kidney when there is non-visualization of contrast on IVU.

If the patient has urinary leakage from the vagina, an attempt should be made to diagnose a uretero-vaginal or vesicovaginal fistula by cystoscopy. Both types of fistulas may be present simultaneously. Urodynamic evaluation may be required in certain cases as a mean of differentiating between hydronephrosis due to ureteral obstruction and hydronephrosis due to bladder denervation after major pelvic surgery and to evaluate detrusor and sphincter function before any surgical reconstructive procedure is chosen[24]

TREATMENT

The aims of treatment are preservation of renal function and restoration of anatomical continuity of ureter. The type of treatment will depend upon the etiology of the injury and the time at which it is diagnosed.

TREATMENT OF INJURY RECOGNIZED INTRA OPERATIVELY

If a clamp or ligature constricting the ureter is discovered, the clamp or ligature should be removed immediately and the ureter shc'jld be examined. If the ureteral peristalsis is present and it is believed that only trivial damage has occurred, the ureteric injury may be managed expectantly. If doubt over possible injury persists, the bladder may be opened.

The flux of urine from the ureteric orifice or the retrograde passage of catheters will then confirm or deny clinical suspicion[25] . Intravenous administration of dyes such as methylene blue or indigo carmine can be used to verify the presence of a small ureteral section[24]. A partial laceration can be closed with absorbable sutures. If the ureter is non viable, then complete excision of non viable segment and end to end anastomosis is performed with absorbable sutures over a stent. Too many stitches to make the anastomosis watertight should be avoided, as they may compromise the ureteral blood supply and consequently the healing process. The ureter should be mobilized carefully, preserving the adventitia and the ureteral vessels within it and handled with fine vascular forceps to avoid ischemia. The ends must be spatulated to reduce the risk of stricture formation. A drain is

placed near the repair.

For longer defects anastomosis results in unacceptable tension and risk of devascularization. Below the level of iliac vessels even for short defects it is safe to create ureteroneocystostomy and placing ureter in submucosal tunnel[14].

Whenever the length of the injury precludes the creation of tension free anastomosis, use of one of the techniques of bladder elongation is considered(Fig 1).

Boari flap can be used to bring the bladder closer to cut end[26]. For successful outcome a wide based posterior flap with intact blood supp'y is used[27]. In cases of bilateral injury double flap can be used. Boari flap is contraindicated in patients with known bladder carcinoma, prior pelvic irradiation, or any condition with a thick hypertrophied bladder wall. Psoas hitch procedure can be used in case where a flap is not raised.

It will keep the tension off the repair. It is simple to perform and gives good results[28t31]. If the lesion occurs above the pelvic brim then depending 01 the length of the defect, the options for the repair include end-to-end anastomosis of ureter, transureteroureterostomy or ileal substitution[32]. The intact isolated ileal segment is a reliable replacement for ureter but should not be used in patients with renal impairment.

Absorption of urine across ileum occurs and a patient with compromised renal function may get into overt renal failure[33]. The ileum be used in an isoperistaltic manner and the bladder be capable of emptying completely[34].

In case of right sided ureteral injury, vermiform appendix can be used to bridge the defect[35,37]. If the ureteric repair cannot be performed safely or if specialist help is not available, situation may be salvaged by draining the proximal ureter through lateral abdominal wall, later definite surgery can be performed[25].

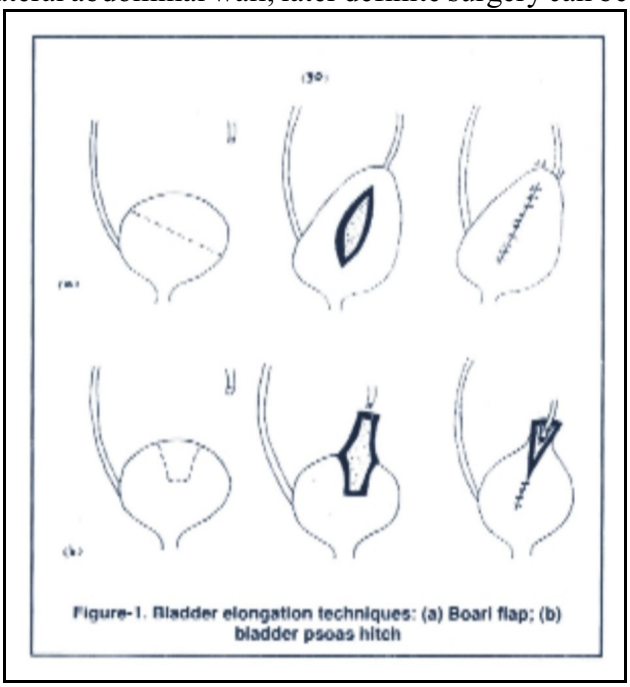

Figure-1. Bladder elongation techniques: (a) Boari flap; (b) bladder psoas hitch

MANAGEMENT OF URETERIC INJURY DIAGNOSED POST OPERATIVELY

When the diagnosis of injury is made postoperatively then the surgical treatment will depend upon the type, duration and location. If the patient is unsuitable for surgery because of sepsis or hemodynamic instability, urinary diversion in the form of a per cutaneous nephrostomy can be performed, to divert urine and help to treat a urinary source of sepsis. In stable patients either open surgery or endourologic procedures can be employed. Now a days conservative endoscopic measures are being employed for injuries that previously always required open surgical repair. Retrograde ureteric stenting can be used as the first approach to control the injury. Other endourological procedures include retrograde orantegrade stenting, balloon dilatation and /or cold knife and endoureterotomy with a hot (Grunwald) electrode. Giberti and colleague reported an 88% cure rate for patients managed

endoscopically while the results for immediate intra operative repair and for delayed repair were 90% and 87% respectively. In their study patients who were treated by endourological techniques multiple procedures had to be employed in many patients to achieve successful outcome. Lask et al[38] reported 80% spontaneous recovery in patients treated with per cutaneous nephrostomy alone and early open repair was recommended[21].

Successful endoscopic treatment of ureterovaginal fistula by retrograde/antegrade internal ureteric stenting has been reported by various authors[3940]. In 9 patients with complete ureteric occlusion, Lingeman et al [41] reported successful outcome with endoureterostomy. Four patients had associated ureterovag nal fistula. In their technique simultaneous antegrade and retrograde ureteroscopy was used and "cut to light" technique was used. Beaghler et al[42] performed endoscopic ureterostomy by combining ureteroscopic and fluoroscopic technique for ureteral strictures and obliterated segments of ureter.

If endoscopic techniques are unavailable or unsuccessful open surgical procedures can be used. Also there are situations that primarily require open surgery. The timing of open surgery has been debatable. Delayed repair was suggested on the grounds that it will reduce inflammation and tissue edema. But many authors[43t45] are in favor of early repair, perhaps because tissue planes are easier to find before fibrosis becomes too dense. The site and the length of ureteral injury are of major importance in the choice of treatme.it motions mentioned earlier. In cases of uretrovaginal fistula ureteroneocystostomy is uniformly successful. In patients with ureterocutaneous fistula, various surgical options include end-to-end anastomosis, Boari flap, Psoas hitch etc. Open excision of ureteral stricture and primary anastomosis can be attempted. If the stricture is too long and surrounded by fibrous tissue it may then be necessary to incise the stricture, place a stent and close the defect with vascularized tissue such as omentum or a bladder flap raised on the superior vesical pedicle[46].

When the only reconstructive solutions are complex in a frail patient with a normal contra lateral kidney, expeditious nephrectomy may minimize operative risk and future complications[9]. However many authors do not advocate nephrectomy for any type of ureteric injury since the preservation of kidney should be the aim of a surgeon[47].

Recently various authors have reported laparoscopic techniques for the repair of iatrogenic ureteral injuries. These include laparoscopic ureteroureteral anastomosis[48t49], laparoscopic ureteroneocystostomy[50] and laparoscopic Boari flap[51]. The long term results of such procedures are yet to be seen.

POST OPERATIVE CARE

For most cases treatment of excessive drainage from drain site is simple observation. Persistent drainage from drain site implies obstruction either at or beyond the anastomotic site. The most common causes of obstruction are stricture at the anastomosis, lack of bladder decompression or technical error. Drains should be kept in till the volume decreases to negligible level. Internal ureteric stents should be removed after 2 to 3 months as per the findings on radiological studies. Nephrostogram performed via nephrostomy will allow assessment of any extravasation or stricture formation. If there-is no extravasation of contrast and unimpeded flow of contrast into bladder is visualized, then nephrostomy tube can be removed. All procedures either reconstructive or endoscopic should be covered with prophylactic antibiotics.

FOLLOW UP

In all cases long term follow-up is needed to detect stricture, reflux and delayed hypertension. IVU should be performed at 3 & 6 months and at 1 year. Treatment of any complication has to be individualized.

PREVENTION OF INJURY

As injuries to the ureter prolong treatment duration and usually require further corrective surgery, they frequently result in litigation. Lynch et al[52] reported that 6% of all claims in Britain were from urinary tract injuries.

To avoid ureteral injuries during pelvic gynecological procedures many preventive measures have been

suggested. Several authors looked into the routine use of intravenous urography (IVU) prior to hysterectomy but it was not found to be cost effective and also there is no controlled evidence that urography results in lower ureteric injury rate. Similarly prophylactic ureteric stenting has been suggested[9"53]but such strategy remains unproven to decrease injury and adds costs and time. However their use may allow early identification of injury and in selected cases could be justified.

Transilluminable stent has been described for use during laparoscopic surgery or to warn of proximity to the ureters during open surgery[54].

To decrease the incidence of iatrogenic injury, a sound knowledge of abdominal and pelvic anatomy is best prevention. One should be aware of the factors increasing the likelihood c[f] lower urinary tract injury during surgery and must recognize his limits[55]. The ureter is best safe guarded by routine intra operative exposure, which will also allow immediate recognition of injury to it. Intra operative recognition of the injury is of utmost importance as immediate repair is relatively easy and uniformly successful[47,56]. If injury to the ureter occurs prompt urological referral is essential[57]. Early repair will decrease patient morbidity and minimize the possibility of legal action. In countries with well trained staff, full range of endourologic equipment and compliant patient, modern endourologic techniques may be suitable for repair of urreteric injuries. But in developing countries, the socioeconomic factors and unavailability of endourologic equipment will preclude such treatment option in majority of patients and open surgical techniques had to be employed. To decrease the incidence of iatrogenic ureteric injuries adequate surgical tuning and use of meticulous surgical technique is recommended.

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