INJURIES TO URETER IN GYNAECOLOGY

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SURGICAL ANATOMY

Course

Length- 25-30 cm (12-15 cm each part)

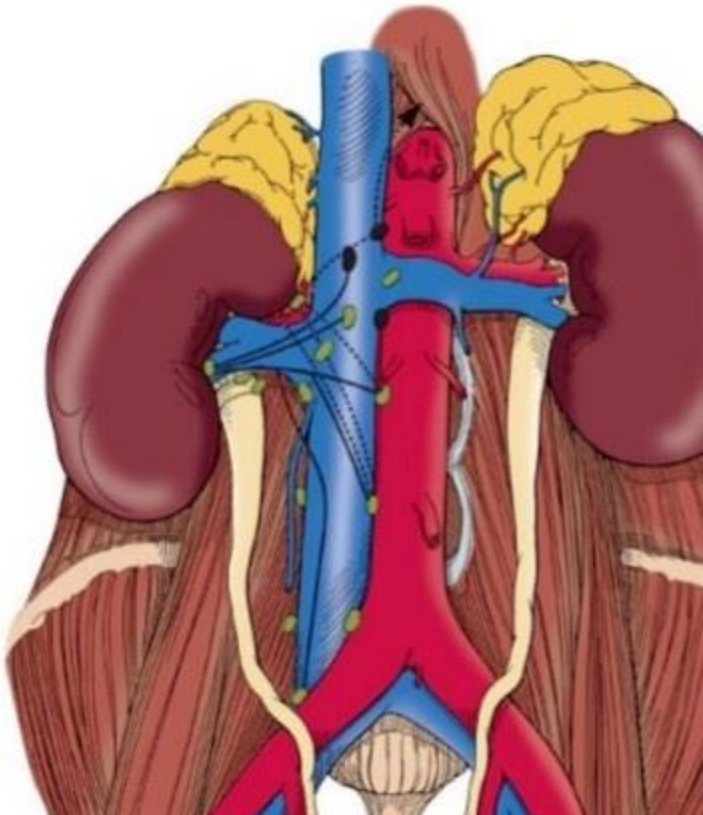
Diameter- 5 mm

Abdominal Part

- Extends from renal pelvis to pelvic brim
- Anterior to **psoas muscle and genitofemoral nerve**

Rt side	Lt side
↓	↓
Lat to lower part of **IVC** (sometimes over IVC)	Lat to **aorta**, behind **Inf mesnteric vessels**

- Enters pelvis behind **ovarian vessels**, and **root of mesentery** (Rt) or **sigmoid mesocolon** (Lt)



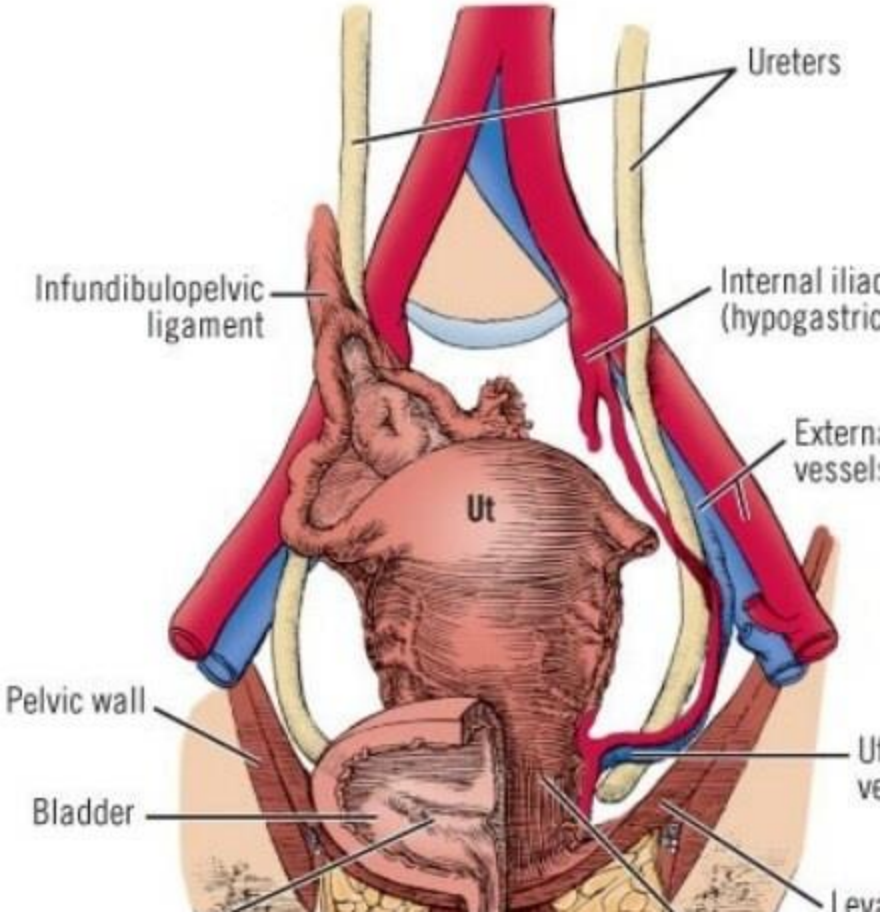
Pelvic Part

- Extends from pelvic brim to the bladder
- Passes in loose areolar tissue on the **lateral pelvic wall** in close contact with

Peritoneum (medially)

Int Iliac artery (posteriorly) over SI joint

lateral to sacrum (**obturator neuro-vascular** bundles



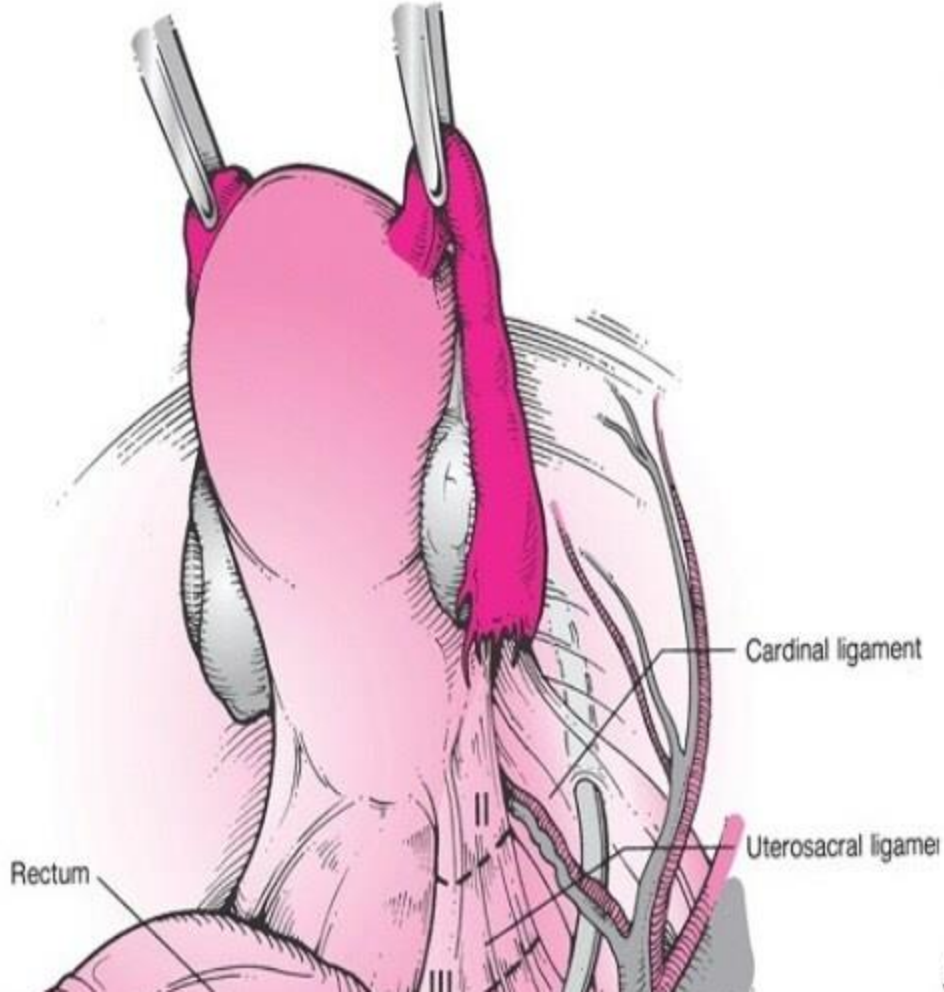
Pelvic Part (Contd.)

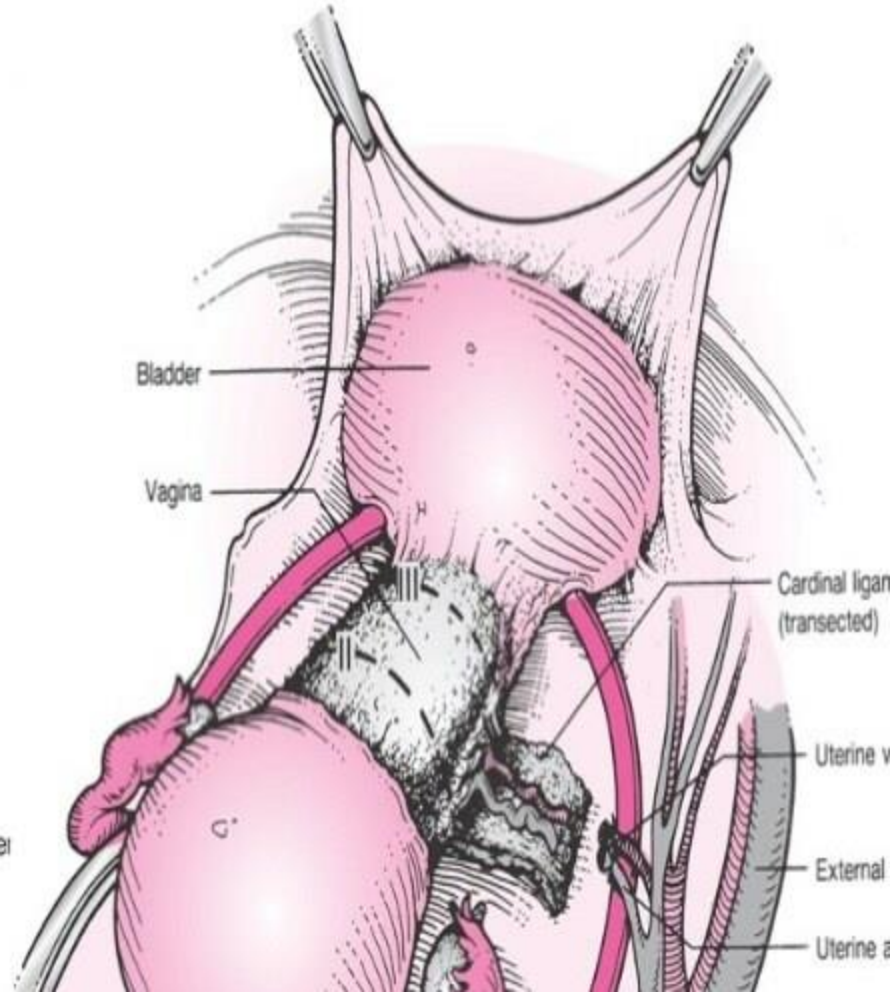
- Passes downwards upto ischial spine,

passes medial to **Internal Iliac artery**

crossed antro-superiorly by **uterine artery** at the base of **broad ligament** (**1.5 cm away from internal cervical os**)- "Bridge over the River"

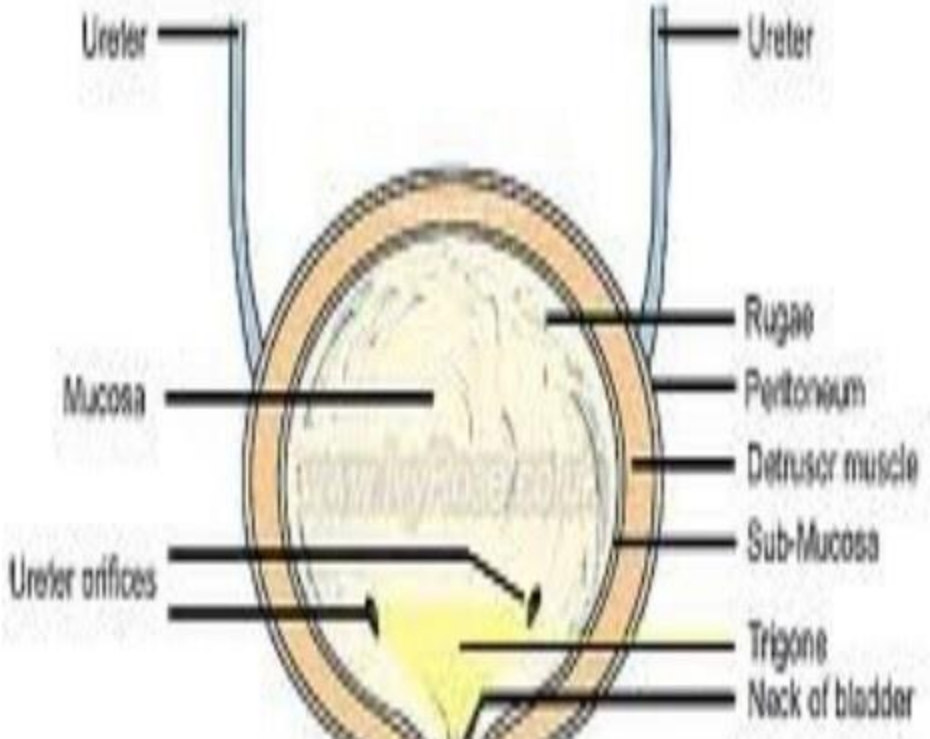
- Then enters a **tunnel of paracervical tissue**, referred to as "Tunnel of Mackenrodt's ligament", Anterior Bladder Pillar, "Web/ Tunnel of Wertheim"
- In the tunnel, lies medially and anteriorly over **anterior vaginal fornix** (Left ureter comes in more proximity due to dextrorotation)*


Cardinal ligament
Uterosacral ligame
Rectum


Bladder
Vagina
Cardinal ligan
(transected)
Uterine v
External
Uterine a

Pelvic Part (Contd.)

- Enters the bladder, in the **superolateral part of the trigone**
- An angulation, called **"knee/ genu of the ureter"**, in the lowest 1-2 cm, palpable bimanually through vagina

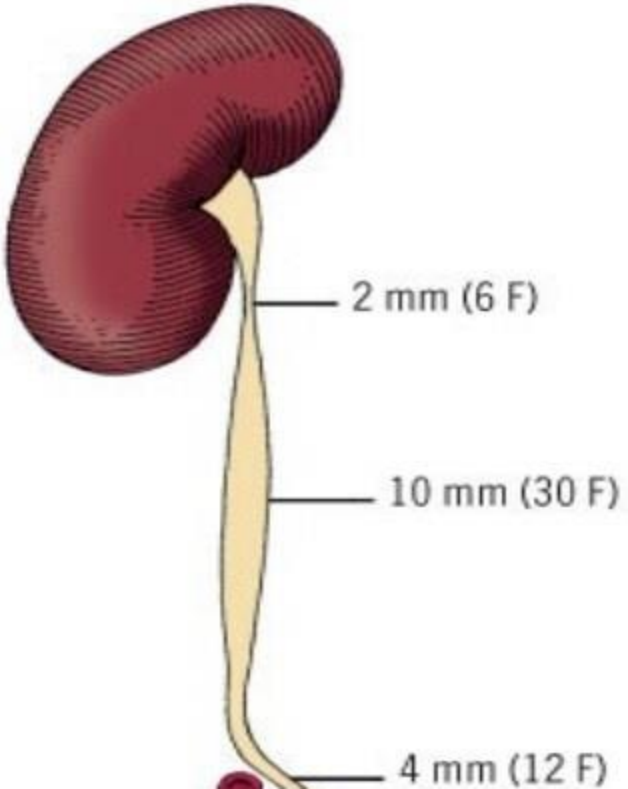


Identification

Courses vary among normal individuals*

* Sampson JA, John Hopkins Med Bull 1904;156:72

- Peristalsis
- Pale glistening appearance
-Longitudinal vessels on the surface



Blood Supply

Aretrial supply

From all vessels it traverses

Form longitudinal anastomosis in adventitial sheath

Abdominal part-

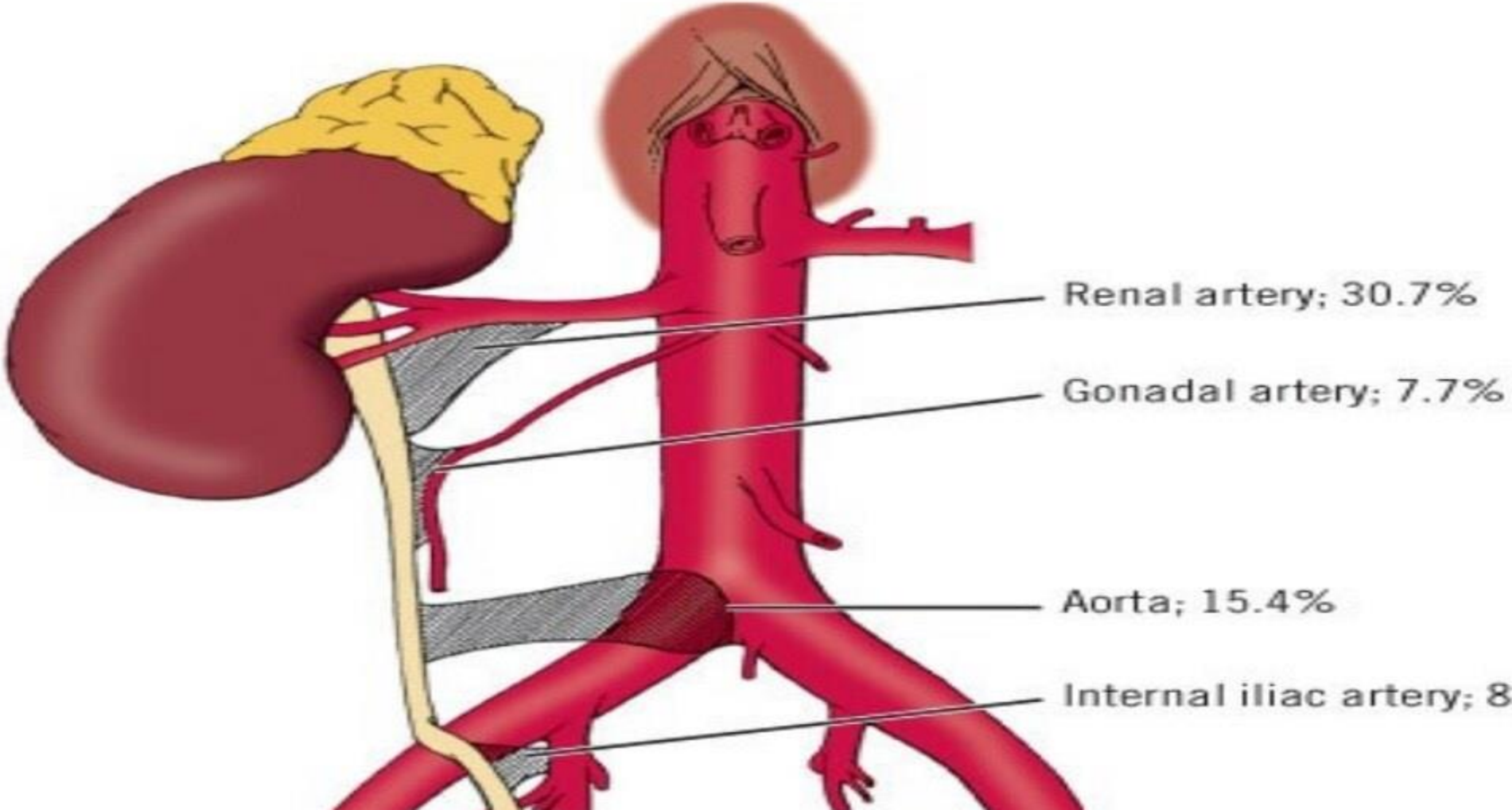
- vessels come from **medial** side
- Dissection to be done from **lateral** aspect

Renal Art

Pelvic part-

- vessels come from **lateral** side
- Dissection to be done from **medial** side

Sup and Inf vesical Art


Renal artery; 30.7%
Gonadal artery; 7.7%
Aorta; 15.4%
Internal iliac artery; 8

Venous drainage

Follows same course as the arteries

Lymphatics

Abd part- Lumbar LN

Pelvic part- Ext and Int Iliac LN

Nerve supply

Sympathetic (T10-L2)-

- Pelvic plexus
- Inf mesenteric plexus

Structure

Mucosa-

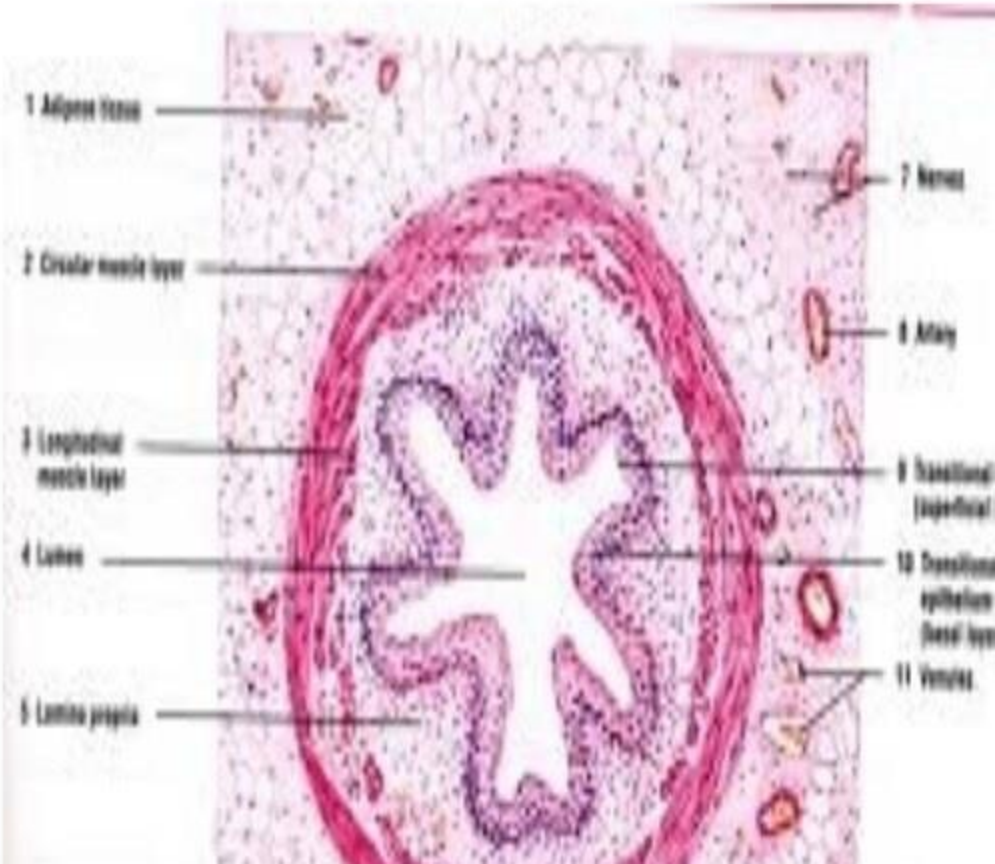
- Transitional epithelium
- No submucosa

Muscle-

- Outer longitudinal
- Middle circular
- Inner longitudinal

Adventitial layer-

- From visceral layer of



INJURIES

Facts and Figures

- **Earliest record-** Berard, 1841; Simon 1869
- 0.5-1.0% of all pelvic operations
- **Gynaecologic cases-** 75% of injuries
- More serious than injury to bladder/ rectum
- **Benign gynae operations-** 0.4-2.5%*

* Drake MJ, Noble JG, 1998

* Chan Jk, Morrow J, Manetta A, 2003

- **Malignant gynae operations-** 30%**

Facts and Figures (Contd.)

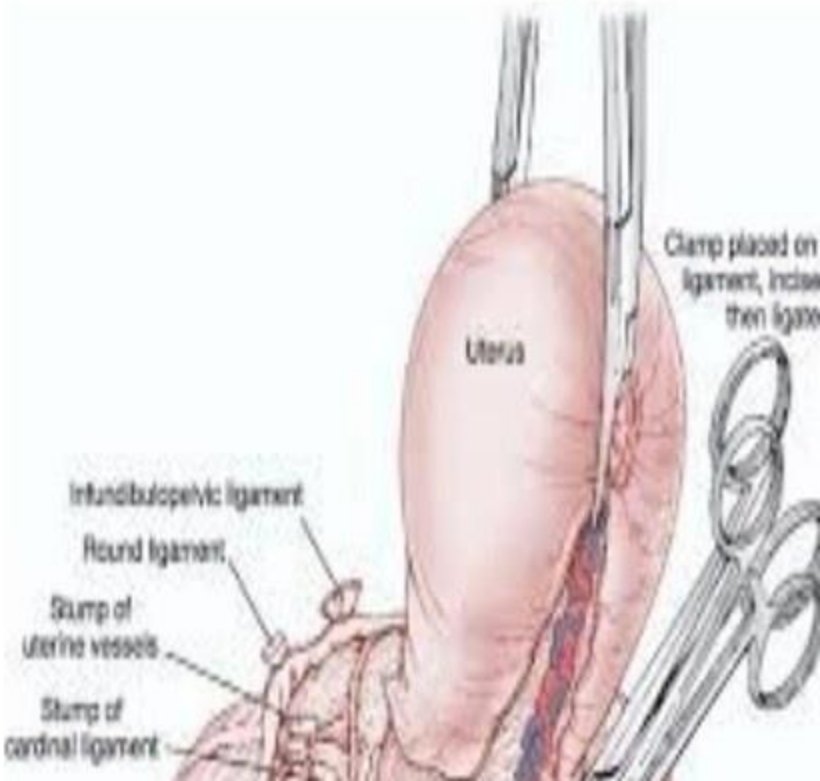
- **Most common surgery-** Simple abdominal hysterectomy (0.5-1.0%) [cf VH- 0.1%]
- **Most common site-** pelvic brim near IPL
- **Most common activity-** Attempt to obtain haemostasis
- **Most common injury-** Obstruction
- **Most common side-** Right/ Left
- **Bilateral-** 5-10% cases

Common sites

1. **At the pelvic brim-** dorsal to IPL (parallel to ovarian vessels) (<1cm from surgeon's needle)
2. **Lateral pelvic wall-** just above uterosacral ligament
3. **Base of Broad lig-** crossing by uterine artery
4. **Tunnel of Mackenrodt's lig-** over ant vaginal fornix

Mechanism of injury

1. **Crushing with clamp-** necrosis
2. **Ligature-** sutures/ linear stapler
3. **Transection-** Partial/ Complete
4. **Angulation with secondary obstruction** (kinking)- partial/ complete
5. **Ischaemia-** Diathery, Stripping of adventitia
6. **Segmental Resecton-**



Grading of ureteric injuries*

- **Grade I –** Hematoma; contusion or hematoma without devascularisation
- **Grade II –** Laceration; less than 50 percent transection
- **Grade III –** Laceration; 50 percent or greater transection
- **Grade IV –** Laceration; complete transection with less than 2cm of devascularisation
- **Grade V –** Laceration; avulsion with greater than

Predisposing factors

A] Pathology

- **Large fibroid-** Low corporeal, cervical, Br Lig
- **Large adnexal mass**
- **Dense Adhesion-** PID
  Past surgery
  Severe endometriosis
- **Pelvic malignancy-** involves ureter

  deviates its course
- **Residual ovarian syndrome**

B] Surgical Risks

Abdominal-

- **Simple Hysterctomy-**

1. Reapplication of clamp to uterine artery (after initial slippage)
2. Suturing at vaginal fornices

- **Obstetric hysterectomy-**

1. Distorted anatomy
2. Vascularity

Table 1. Incidence of ureteric injury in obstetric and gynaecological operations [2,7-12]

Type of surgical operations	Incidence (approx rates)
Abdominal hysterectomy	0.2%
Radical hysterectomy	1.3%
Laparoscopic assisted hysterectomy (LAVH)	0.45-1%
Other laparoscopic surgery	0.03%
Vaginal hysterectomy	0.1%
Vaginal vault suspension surgery	0.4%

M. F. Carley, D. McIntire, J. M. Carley and J.

B] Surgical Risks (Contd.)

Abdominal-

- **Adnexectomy-**

  -Complex, adhered mass

- **Incontinence surgery-**

  -Burch coplosuspension- high elevation of sutures

  -Overzealous dissction in space of Retzius (**Retropubic Sx**)

  -Excessive **lateral mobilization of bladder**

- **POP surgery-**

  -Uterine suspension- USLS

B] Surgical Risks (Contd.)

Abdominal-

- **Wertheim's hysterectomy-**
  - -Below **uterine artery**
  - -In **tunnel of Wertheim**
  - -Over **anterior fornix**
- **Radical trachelectomy-**
  - -More risk than Wertheim
- **Pelvic LN dissection-**

B] Surgical Risks (Contd.)

Vaginal-

- **Hysterectomy-** Relatively uncommon, except in procidentia
- **Anterior colporrhaphy-** Too lateral and too deep sutures

Distance from surgeon's needle <0.9cm*

*Hofmeister FJ, 1982

- **VVF repair**
- **POP Surgery-**

Culdoplasty- While taking bites in USL

Vaginal USLS

B] Surgical Risks (Contd.)

Laparoscopic-

Very uncommon (0.3-0.4%)

Mainly thermal injury

- **Adhesiolysis**
- **Uterosacral transection- LUNA**
- **Presacral neurectomy**
- **Colposuspension**

Sequalae Of Injury

- **Spontaneous healing-** minimum injury
- **Hydroureter/ Hydronephrosis-** gradual loss of renal function- due to obstruction
- **Urinoma** (localized collection) / Urinary ascites , infection - trasection/ necrosis with extravasation
- **Fistula**

  - Uretero-uterine

    uretero-vaginal

PREVENTION

"The venial sin is injury to the ureter; the moral sin is failure of recognition"

-Higgins

Primary

Most Important

- **Pre-operative-** limited role
- **Intra-operative-** Not difficult in most cases

Secondary

- Immediate diagnosis and repair, if injured by the earliest time
- To prevent serious morbidity
- **Most skillfull**

Pre-operative

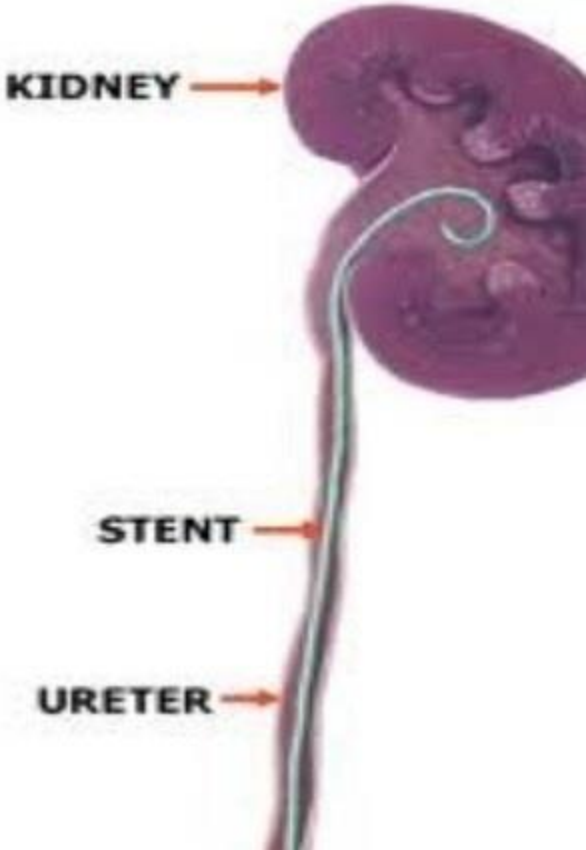
Imaging

- **IVP**
- **CT scan**
- ➢ In high risk cases (pelvic Tx, Ca, endometriosis)
- ➢ Also detects congenital anomaly
- ✓ Does not dispel surgeon's responsibility to identify ureter during Sx
- ✓ Cost-effectiveness ?
- **Retrospective review-** 493 benign hystercetomy- 60% had IVP*
- ➢ 77% had abnormal findings (uterus >12 wk, adnexal mass>4 cm)

Pre-operative (Contd.)

Ureteric stenting

- To facilitate identification and dissection
- ❖ **Kuno K, Menzin A, Kauder HH, Sison C, Gal D, 1998-** does not statistically affect rate of injury
- ❖ **Bothwell WN, Bleicher RJ, Dent TL, 1994-** even with stent, rate of injury 1%
- cannot prevent injury



Intra-operative

Proper anatomical knowledge of the surgeon

- **Most important way**
- Direct visualization/ palpation

Uriglow

- Ureteric catheter with inbuilt light source
- Better visualization
- **Low RK, Moran ME, 1993-**

Intra-operative (Contd.)

Adequate exposure of pelvic organs

- Adequate incision
- **Avoidance of blind clamping and suturing** to achieve haemostasis
- Care during **diathermy/ laser** (zone of thermal injury 2-5 mm)

Meticulous care during dissection

- Structures at risk should always be dissected sufficiently to

Intra-operative (Contd.)

Proper surgical steps

Abdominal operations

- **Divide round ligament near lateral pelvic side wall** (lat to ovarian vessels), then open the lateral peritoneum
- **Identify ureter on the medial leaf of the peritoneum**
- **Palpate ext iliac artery with index finger** (superficial, consistent, pulsatile))- move the finger cephalad- the first structure to be exposed, crossing and in contact with it, will be the ureter
- **Place index finger over the ureter while clamping IPL**
- **Adequate medial mobilisation of bladder**

Intra-operative (Contd.)

Proper surgical steps

Vaginal operations

- **Adequate development of vesico-uterine space** to protect ureters
- **Downward traction on the cervix** and counter-traction upward beneath the bladder
- **Ureters can be palpated applying gentle traction on the cervix,** along with upward traction on the uper vagina, exposing the entry pint of the ureter into the trigone

Intra-operative (Contd.)

Proper surgical steps

Vaginal operations

Ant colporraphy-

- Not to start too laterally or to insert sutures too deeply while plicating bladder

Culdoplasty-

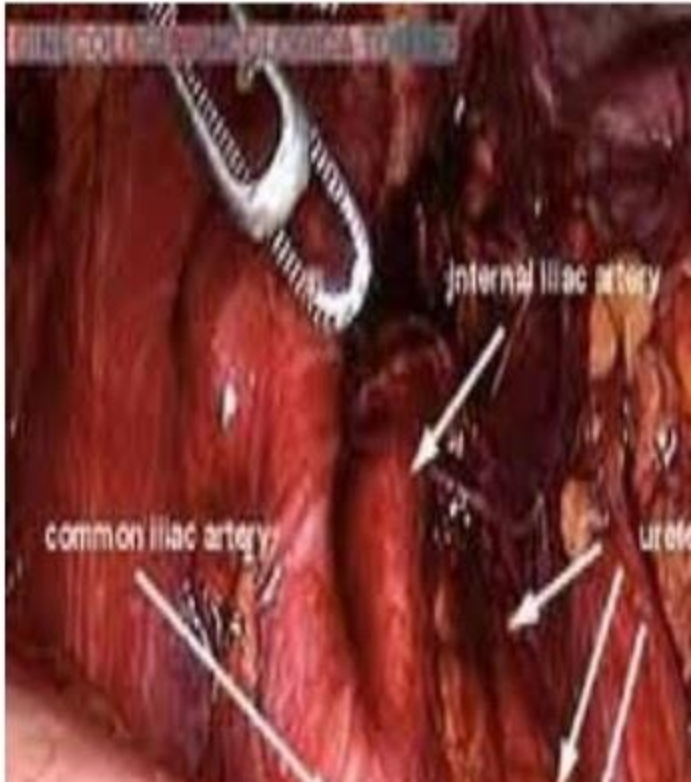
- Palpate ureter vaginally
- Alllis clamp in USL and pull upwards to make it taut

Intra-operative (Contd.)

Proper surgical steps

Laparoscopic operations

- **Identify ureters-** if not identified, retroperitoneal dissection
- **Uterine manipulator** with a vaginal vault delineator to stretch the cervico-vaginal junction in cephalad direction→ upward movement of the vaginal fornix →increasing the distance between the uterine arteries and ureter
- **Uterine artery and cardinal**



Intra-operative (Contd.)

Special measures

Complex adnexectomy

- **Use retroperitoneal space-** ureter is seen on the medial leaf of Br ligament
- **If mass is adehered to the medial leaf**

➢ Dissect the ureter from the medial leaf

➢ **If not possible to mobilize ureter-**

1. Leave a small posrtion of Tx adhered to

Intra-operative (Contd.)

Hysterectomy for difficult fibroid

- **Myomectomy-** incision adjacent to uterus/ Cx- stay within myometrial capsule
- If myomectomy not possible, **trace ureter along the whole length** in pelvic part
- **Intrafascial hysterectomy**

Obstetric hysterectomy

- **Supracervical hysterectomy**
- **Total hysterectomy**- extend hysterotomy incision

Intra-operative (Contd.)

Others

- **Avoid- overzealous dissection into space of Retzius** (always stay close to symphysis)
- **Avoid high elevation of Burch colposuspension sutures**
- **Avoid excessive lateral mobilization of bladder**
- **Keep paravaginal dissection minimum**

DIAGNOSIS

Intra-operative Diagnosis

Simple Inspection

- **Identify and detect severity of injury**

❖ Dilated proximal to the obstrction

❖ Peristalsis- does not exclude delayed avascular necrosis

Intra-operative Diagnosis (Contd.)

IV dye test-

- 5 ml Mythelene blue/ indigocarmine or phenazopyridine
- Inspect after 3-5 minutes

➢ Denotes site of leakage

➢ If obstructed- no leakage, gradual swelling

Intra-operative Diagnosis (Contd.)

Intra-ureteric dye test

- Identify ureter over common iliac artery- stretch it- insert 21G IV cannula into the lumen- inject 5-10 cc of methylene blue solution

❖ **Intact ureter- dye comes into Foley's catheter**

Intra-operative Diagnosis (Contd.)

Intra-op Cystoscopy

- After high risk Sx

❖ No clear consensus

❖ Increases operative time, needs extra skill

❖ Can miss non-obstructive, partially obstructive, late injuries (secondary necrosis)

Intra-operative Diagnosis (Contd.)

Peri-operative USG*

- Laparscopic US probe

➢ **Ureteric diameter >3 mm**

➢ **No peristalsis in 5 min follow up**

➢ **No clear echodense caudally progressing contraction segments**

*Helin-Martikainen HL, Kirkinen P, Heino A. Ultrasonography of the ureter after surgical trauma. Surg Endosc 1998;12:1141-1144

Post-operative Diagnosis

- **U/L injury often missed,** except transient rise in serum creatinine- eventually loss of ipsilateral kidney function
- **Typical time to diagnose-** 7-10 days (mean 10-21 days)- Dowling RA, Coriere JN, Sanler CM, 1986

Clinically

- **Nonspecific**
- **Asymptomatic** (incidental findings)
- **U/L cramp/ loin pain** (hydronephrosis) (0-21 days)
- **Unexplained swinging pyrexia** (0-21 days)
- **Adynamic ileus/ peritonitis** (0-7 days)

Post-operative Diagnosis (Contd.)

Investigations

- **Blood -**
  - **TLC-** slight ↑
  - **Creatinine-** Slight ↑ (0.8 mg/dl/day)- more with B/L injury
- **IVP-**
  - Mainstay of diagnosis
  - Extravasation, hydro- ureter/ nephrosis, delayed function, stricture
  - May be normal in 7% cases
- **CT contrast-**

Post-operative Diagnosis (Contd.)

Investigations

- **Cystoscopy-**
- Urine coming out through ureteric openings
- If not, give 20 cc furosemide
- If still not, retrograde uretric catheter (>10 cm)
- **Retrograde uretrogram/ antegrade nephrostogram-** fistula, stricture
- **Fistulogram**
- **Double dye test (oral phenazopyridine HCl) and**

MANAGEMENT

Basic Principles of repair

- Meticulous dissection preserving ureteric sheath with its blood supply
- Handle gently with non-crushing clamps/ forceps
- Tension-free anastomosis by ureteric mobilisation
- Minimum amount of fine (3-0) absorbable interrupted suture to attain a watertight closure
- Use peritoneum/ omentum to support anastomosis, especially if the periureteric tissue is rigid and fibrotic, for better healing
- Stent the anastomotic site with a ureteric cathter (3-6 weeks)- then remove by flexible cystoscopy and do IVP to confirm patency
- Drain the anastomotic site with a closed suction drain to

Biology of repair

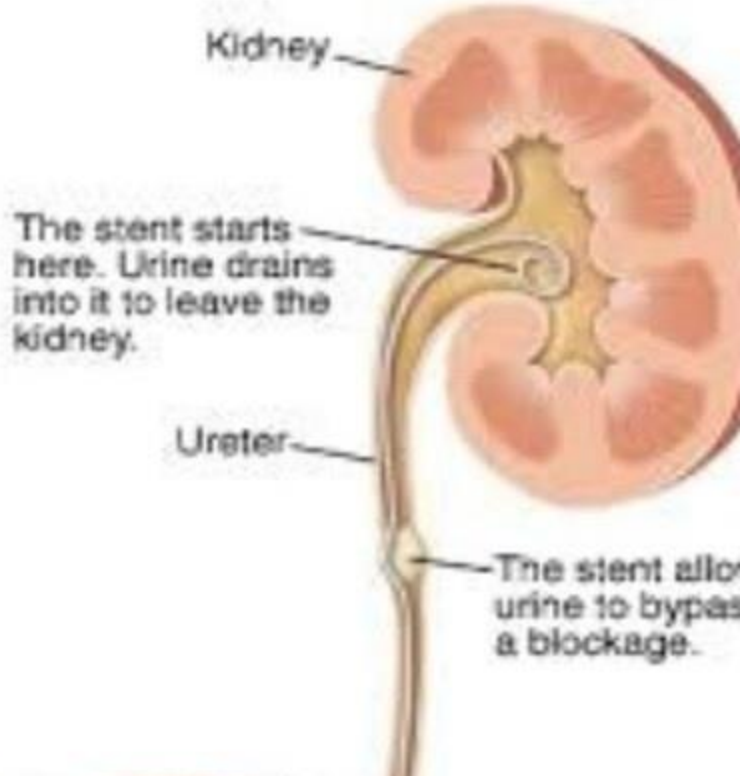
- **Careful mucosa-to-mucosa approximation**
- **Minimal urinary leakage**
- **No tension in suture line**

- Uro-epithelium can regenerate itself in <2 weeks
- Smooth muscle will grow across the gap

Intra-operative Management

A] Minor Injury

1. **Deligation-** If inadvertent ligation → if in doubt, put a stent
2. **Oversewing with suture-** If mucosa-sparing wall-injury
3. **Ureteric stent placement-** For



Intra-operative Management (Contd.)

B] Major Injury (Open Repair)

↓ ↓

Partial transection **Total Transection**

(Button Hole)

↓

Uretero-uretroostomy over a stent-

- Stenting through the hole (ureterostomy) already present → Repair the hole

B] Major Injury (Open Repair)

↓ ↓

Total transection **Partial transection**

↓ ↓ ↓

Upper **Middle** **Lower**

(Above brim)

↓

a) Short Defect- Spatulated end-to end anastomosis (uretro-ureterostomy)-

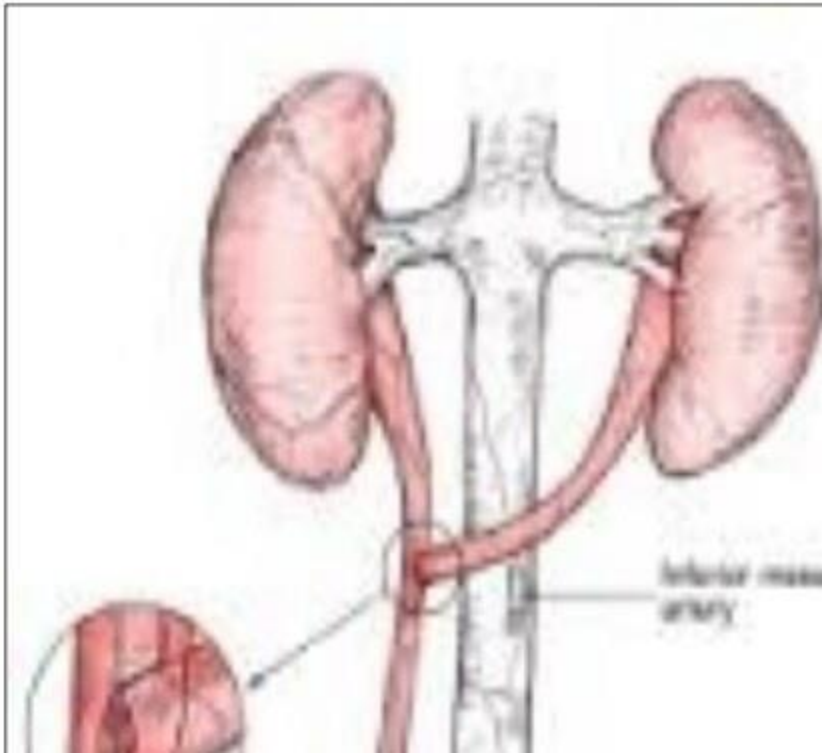
- Proximal/ distal ureter is mobilised → Both ends are spatulated (incised longitudinally to have eliptical circumference)

b) Long defect- (Complicated/ no tension-free mobilisation)

1. Trans-uretro-uretrostomy- anastomosis with C/L ureter

Uretero-uretrostomy

Trans-uretero-uretrostomy



Ileal transposition
(Syn- Uretero-ileo-neo-cystostomy/ Uretero-entero-neo-cystostomy)

- Healthy, viable segment of distal ileum with vascular arcade is "collected" after side-to-side stapled anastomosis
- Proximal segment of ileal loop is opened
- Ureter is spatulated
- Full thickness of ureter is pulled through a hole made in the anti-mesenteric border of the ileum and sutured over a stent
- Sero-muscular suturing is done
- Distal end of the ileal loop is opened and puled

over the stent through an incision (over bladder dome and mucosal suturing done

B] Major Injury (Open Repair)

↓ ↓

Total transection

Partial transection

↓ ↓ ↓

Upper Middle Lower

(At pelvic brim)

↓

a) Short Defect- **Spatulated end-to end anastomosis** (uretro-ureterostomy)-

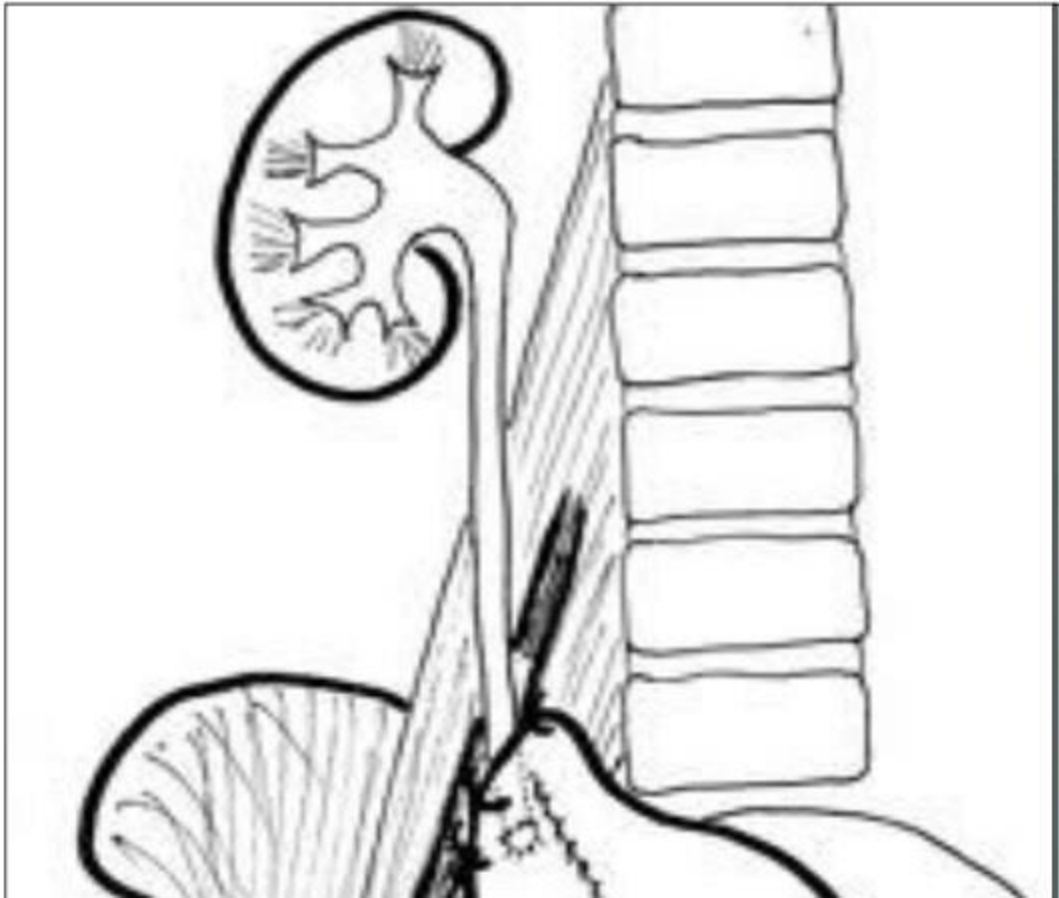
b) Long defect- (Complicated/ no tension-free mobilisation)

Ureteric reimplantation (Syn- Uretero-neo-cystostomy)

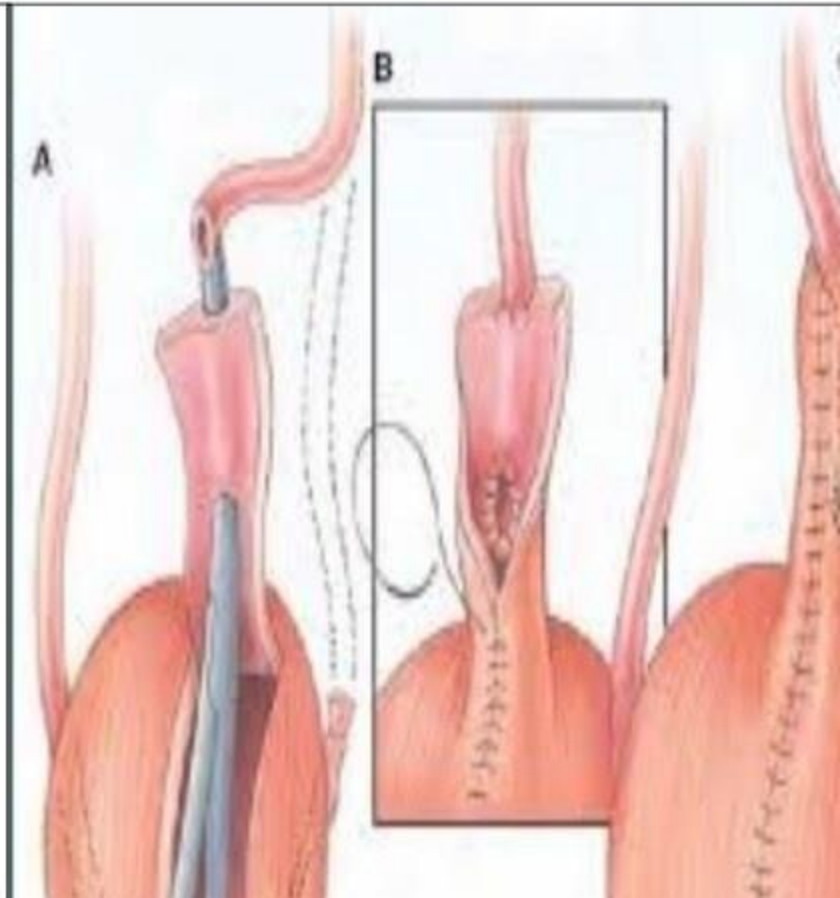
- Lumen of the distal ureter is closed permanently
- Proximal ureteric end is pulled through an incision over the bladder dome over a stent
- Bladder drainage for 10 days
- The ureter and bladder are kept in close proximity by

1. **Psoas Hitch-** Bladder is freed from attachments in retropubic space→ ventral surface is sutured to the psoas tendon, avoiding bite through mucosa
2. **Boari procedure-** Broad-based flap is dissected off the bladder to reach the injured ureter (↓ tension)

Psoas Hitch



Boari Flap



B] Major Injury (Open Repair)

↓ ↓

Total transection

Partial transection

↓ ↓ ↓

Upper Middle **Lower**

(Within 5 cm of UV junction)

↓

Ureteric reimplantation

Post-operative Management

Diagnostic workup (USG, CT, IVP, dye test)

↓ ↓

Obstruction, no leak

Leakage, no obstruction

↓

Determine timing of repair

- Early - 24-48 hr
- Delayed- after 6 week

No difference in studies

↓ ↓

Partial transection Total Transection

Diagnostic workup (USG, CT, IVP, dye test)

↓ ↓

Obstruction, no leak Leakage, no obstruction

↓

Retrograde ureteric catheterisation- by flexible cystoscopy

Percutaneous nephrostomy- by fluoroscopic guidance

↓

Try to pass ureteric stent (ante/ retro-grade)

↓ ↓

Passed Not passed → **Surgical uretrolysis**

↓

Try to pass thin guidewire beyond the obstruction

↓ ↓

Ureteric Fistula Repair

- **Initial stage- Stent placement** (within 4 weeks) with continuous bladder drainage for 6 weeks- heals 88% cases*

* Chang R, Marshal FF, Mitchell S. 1987

- **If fails-** repair after local inflammation subsides
- **Reimplantation/ Anastomosis**
- Spontaneous cessation of dribbling- may be an **OMINOUS SIGN**

Medico-legal aspects

- First step- Initial consultation for operation
- Inform the patients
- The legal view increasingly appears that- most, if not all ureteric injuries are due to negligence on the part of the gynaecologist involved
- **"In a professional man, an error of judgement is not necessarily negligent"**

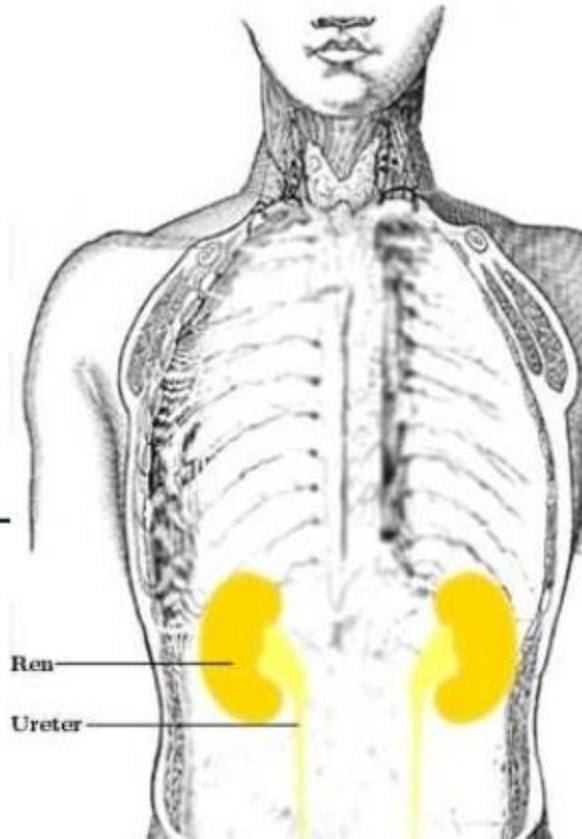
❖ Needs proper identification and dissection

❖ Prompt repair, if required

PREVENTION OF INJURY TO THE URETER

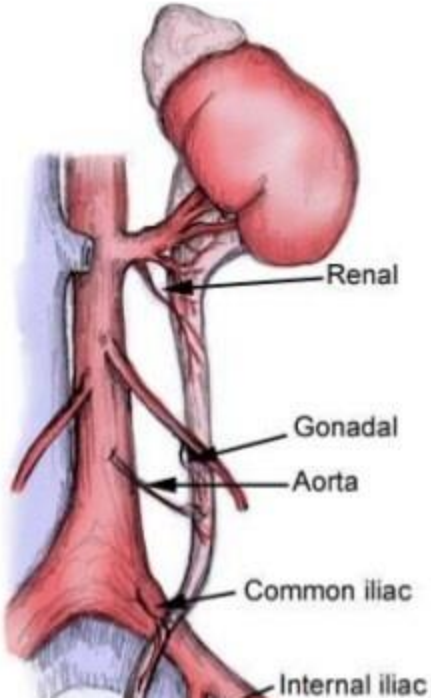
By Derick En'Wezoh

Clinical Anatomy 2014



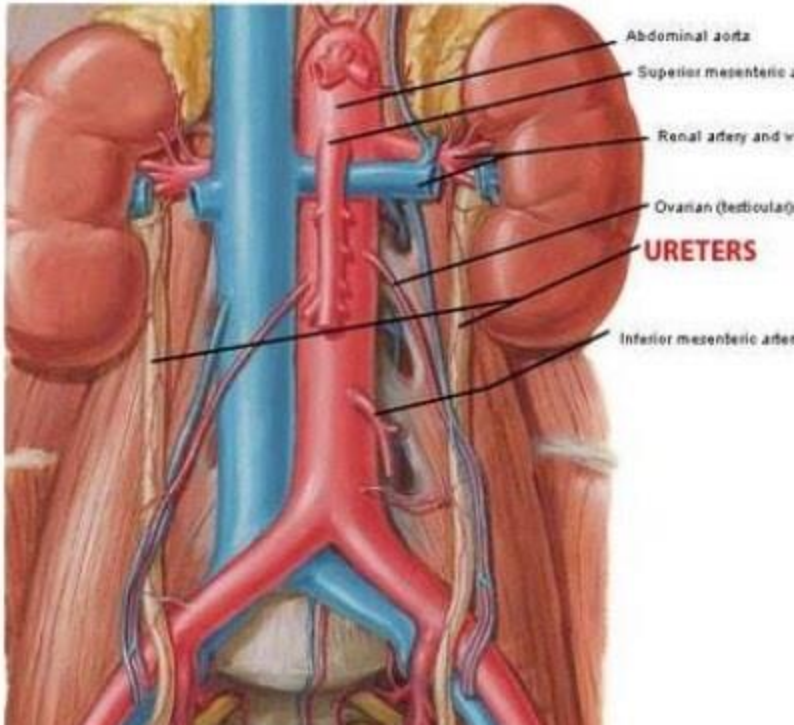
The Ureter

- **Precursor:** Ureteric bud
- **Structure:** Retroperitoneal
- **Blood Supply:**
  - *Upper:* Renal a.
  - *Middle:* Common iliac a. & branches of aorta
  - *Lower:* Internal iliac a. & others
- **Innervation:** nerves from T12-L2



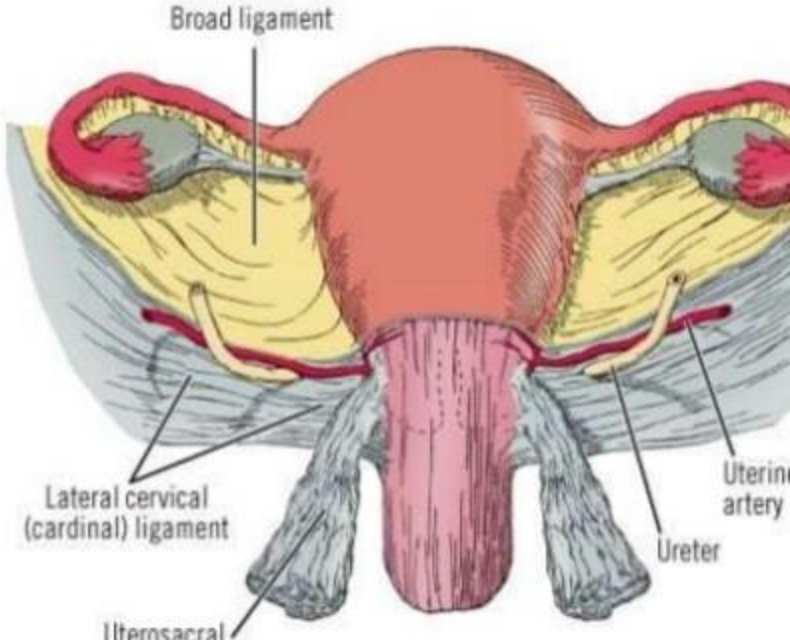
The Abdominal Ureter

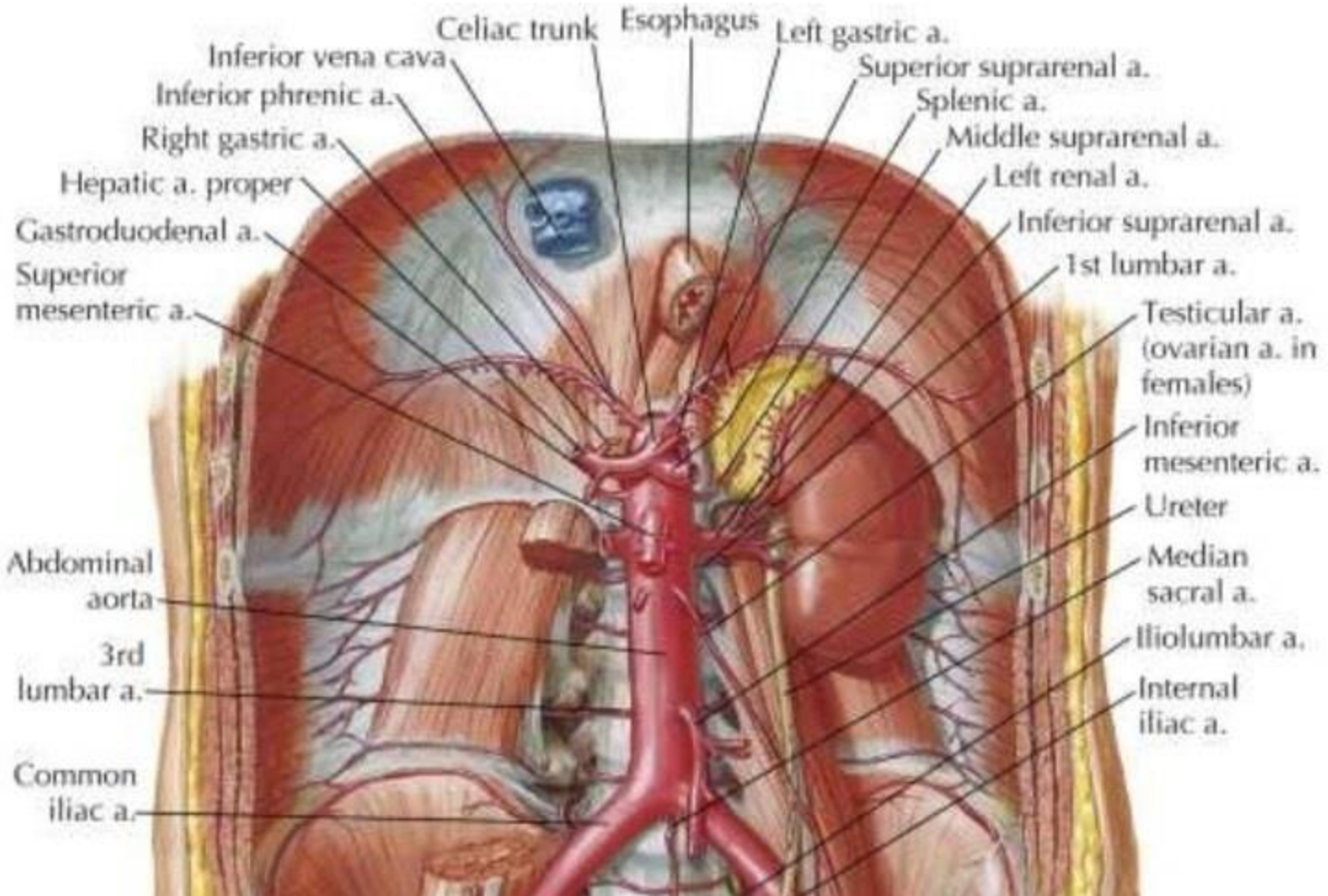
- Travels retroperitoneal
  - Begins proximally at level of renal pelvis
  - Posterior to renal vessels
  - Ureteropelvic junction at level of 2nd lumbar vertebrae
  - Continues anteriorly on psoas major m.



The Pelvic Ureter

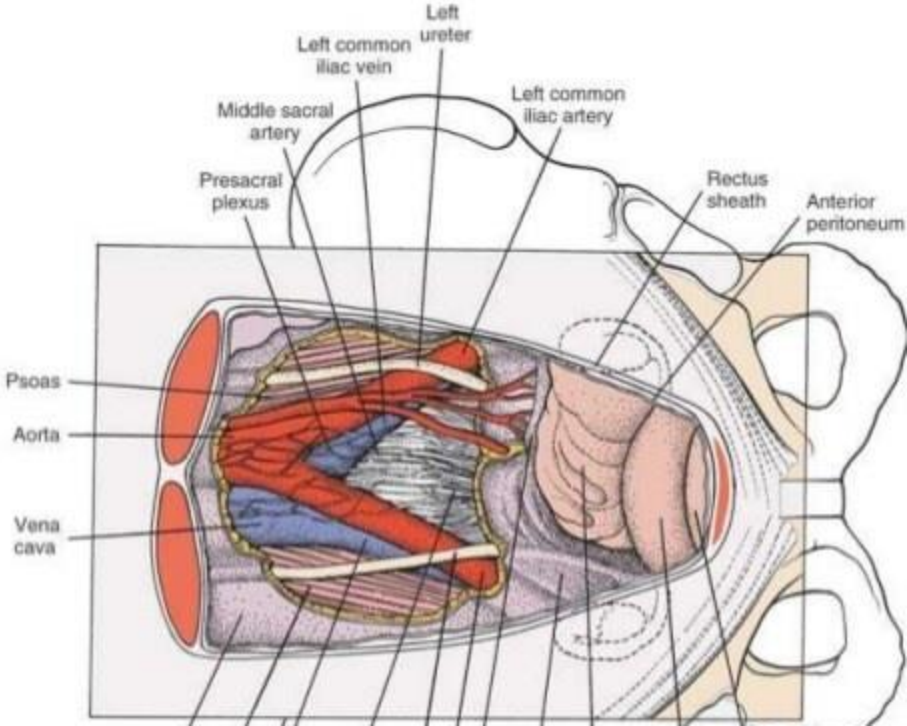
- Enters the pelvis at pelvic brim
  - Anteriorly crosses lateral to medial of the bifurcation of the common iliac arteries
  - Descends into pelvis with peritoneal sheath (ureteric fold)




Celiac trunk
Esophagus
Left gastric a.
Inferior vena cava
Superior suprarenal a.
Inferior phrenic a.
Splenic a.
Right gastric a.
Middle suprarenal a.
Hepatic a. proper
Left renal a.
Gastroduodenal a.
Inferior suprarenal a.
Superior mesenteric a.
1st lumbar a.
Testicular a. (ovarian a. in females)
Inferior mesenteric a.
Ureter
Abdominal aorta
Median sacral a.
3rd lumbar a.
Iliolumbar a.
Internal iliac a.
Common iliac a.

Operations Prone to Ureteral Injury

- Gynecologic Surgery
- Pelvic Surgery
- Colorectal Surgery
- Prostate Surgery
- **Orthopedic Surgery**
  - Anterior retroperitoneal approach to the lumbar



Risk Factors for Ureteral Injury

- **Patient Risk Factors**
  - Prior pelvic surgery
  - Endometriosis
  - Urinary tract abnormalities
  - History of pelvic irradiation
  - Obesity

- **Procedure Risk Factors**

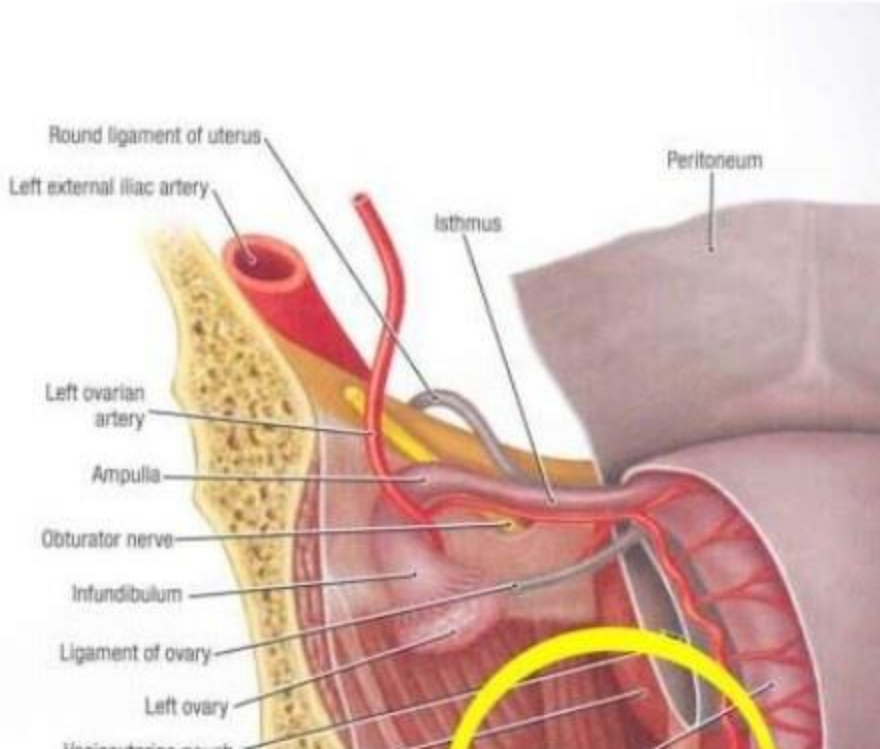
Original Research

Urinary Tract Injury During Hysterectomy Based on Universal Cystoscopy

Okechukwu A. Ibeanu, MD, MPH, Ralph R. Chesson, MD, Karolynn T. Ea Fatuma Busangu, MD, MPH, and Thomas E. Nolan, MD, MBA

Examined incidence/location of urinary tract injury during hysterectomy in 839 patients.

- Ureteral Injury Rate of 1.8% (15/839 cases)
- Junction of ureter and uterine artery represented



Rates of Urinary Tract Injury From Gynecologic Surgery and the Role of Intraoperative Cystoscopy

D. T. Gilmour, M.D., F.R.C.S.C., S. Das, BSc, and G. Flowerdew, DSc

Review of 47 studies reporting ureteral and bladder injury in gynecologic surgery. 2-3X more ureteral injuries found with the use of intraoperative cystoscopy.

	29.5 Studies Without Cystoscopy	17.5 Studies With Cystoscopy
Surgery Type	Ureteric Injury Rate	

The incidence of urinary tract injury during hysterectomy: A prospective analysis based on universal cystoscopy

Babak Vakili, MD,[a,b,*] Ralph R. Chesson, MD,[a,b] Brooke L. Kyle, MD,[a,b,c]
S. Abbas Shobeiri, MD,[a] Karolynn T. Echols, MD,[a,b] Richard Gist, MD,[c]
Yong T. Zheng, MD,[a,b] Thomas E. Nolan, MD, MPH[a]

Evaluated incidence of urinary tract injury 2/2 hysterectomy using cystoscopy in 471 patients. Only 12.5% of ureteral injuries were detected before cystoscopy.

Approach	Ureteral Injury	
Abdominal	6/272	2.2%
Vaginal	2/142	1.4%
Laparoscopic	0/49	0.0%

Laparoscopic ureteral injury and repair: Case reviews and clinical update

Aarathi Cholkeri-Singh, MD, Narendra Narepalem, MD, and Charles E. Miller, MD

From the Departments of Obstetrics and Gynecology (Drs. Cholkeri-Singh and Miller); and Urology (Dr. Narepalem), Advocate Lutheran General Hospital, Park Ridge, Illinois.

Reviewed several articles discussing laparoscopic ureteral injury.

Complications of Unrecognized Ureteral Injuries:

- Urethral strictures
- Fistula formation

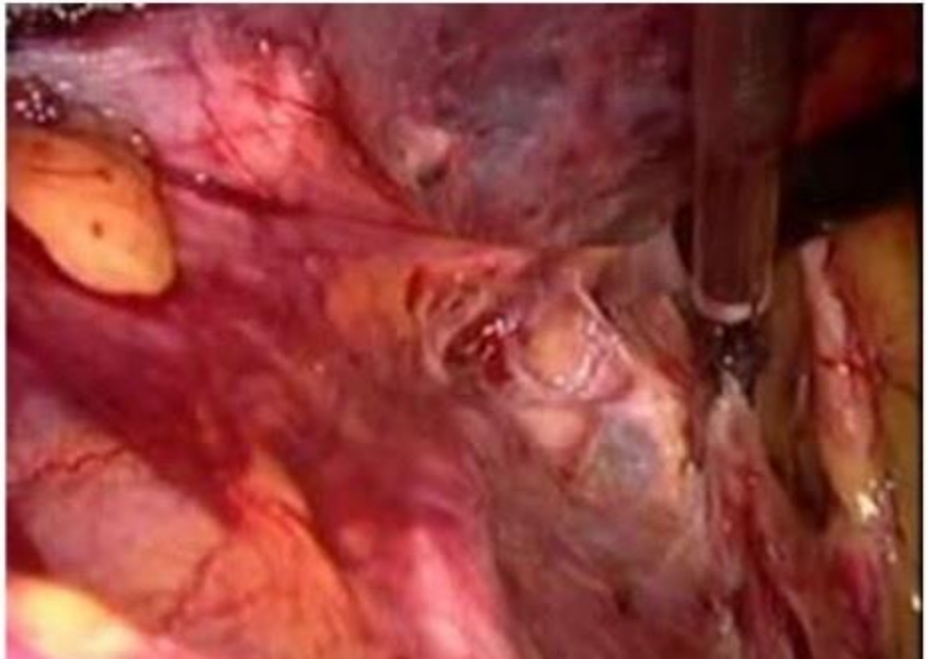
Key Points from the Literature

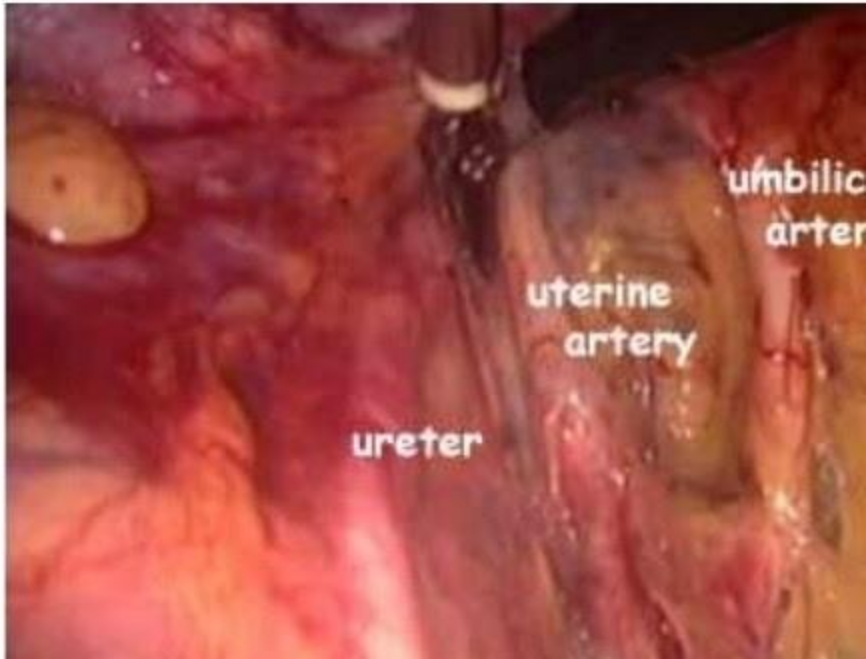
- Ureteral injury during hysterectomy is common
- The most common anatomical site of injury is at the ureter/uterine artery junction
- Without the use of cystoscopy, many ureteral injuries go undetected
- Undetected ureteral injuries can have significant consequences

1° Approach to Injury Prevention

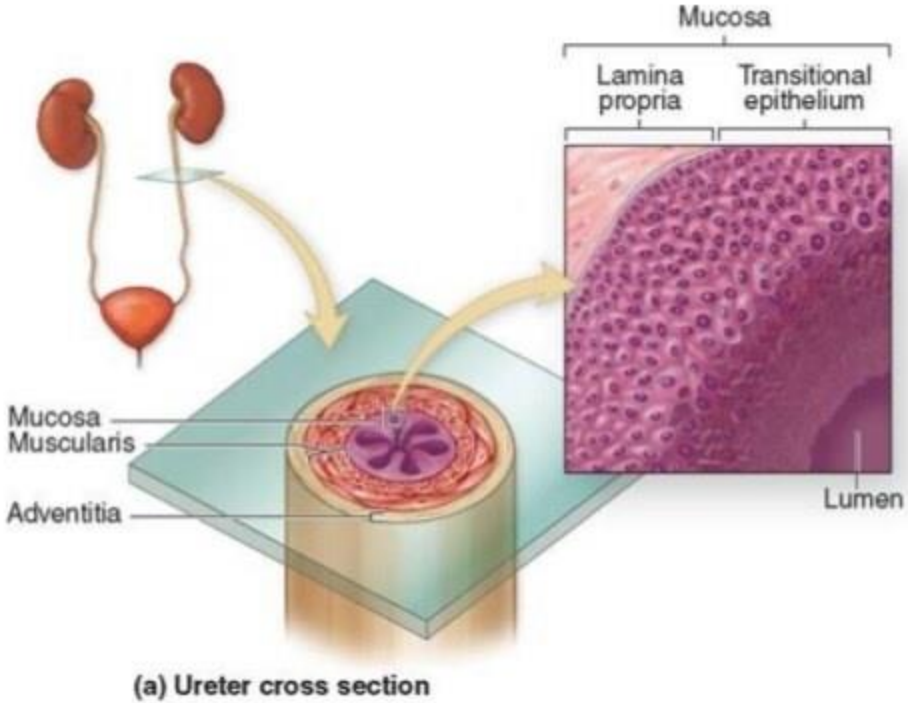
- Knowledge of anatomy
- Careful surgical dissection
- Use of ureteral catheters

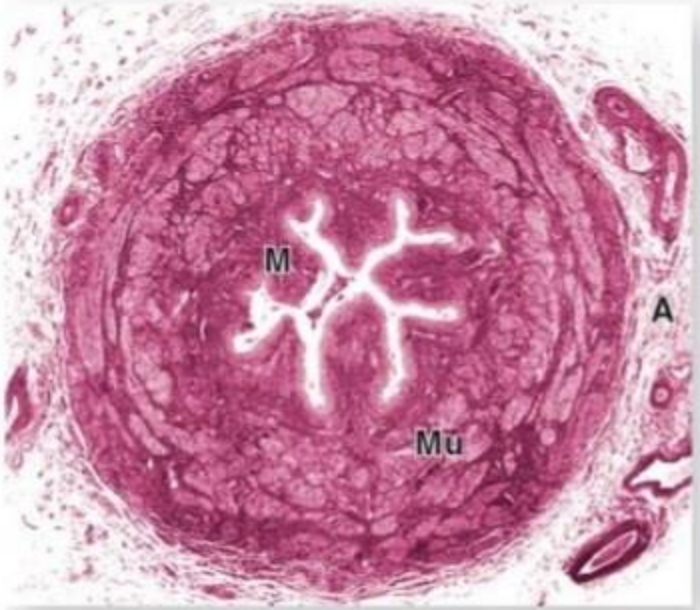
Laparoscopic Hysterectomy





Ureteral Histology





Junqueira's Basic Histology: Text & Atlas, 13e.


خسته نباشید