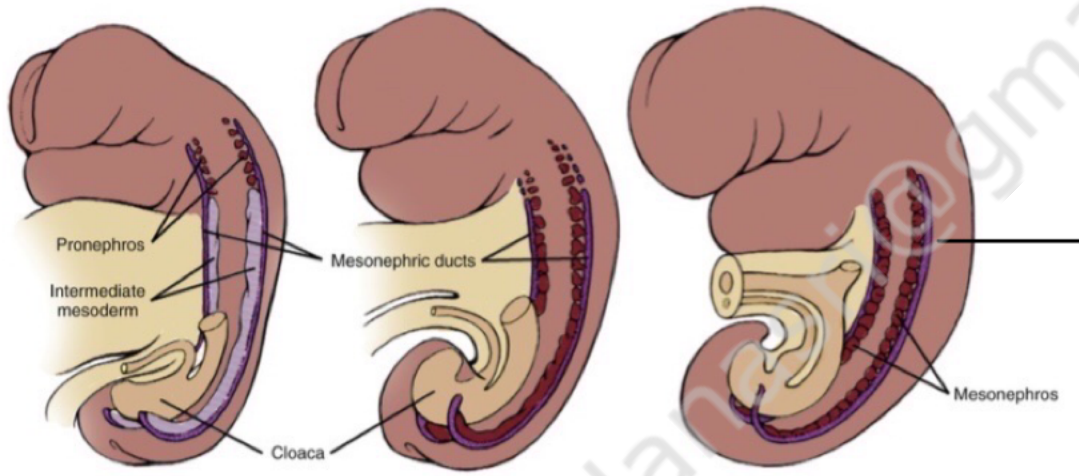
CONGENITAL ANOMALIES OF KIDNEY & URETER

DEVELOPMENT OF KIDNEY & URETER

Intermediate Mesoderm

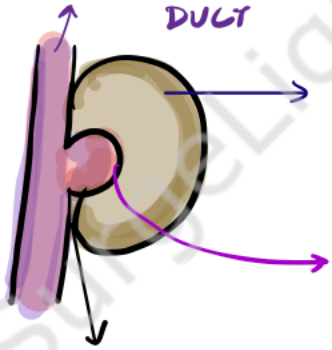
RIDGES

- GONADAL (medial)
- Nephrogenic (Lateral)
  - PRONEPHROS (Cervical upto 4th week) → REGRESS
  - MESONEPHROS (Thoracolumbar) → CRANIOCAUDALLY
  - METANEPHROS (Caudal) → Develops into KIDNEY



MESONEPHRIC DUCT

Mesonephros
- Males → Efferent ducts of testis, Paradidymis
- Females – Epoophoron, Paroophoron } Non functional epithelial cysts in broad ligament



METANEPHRIC MESENCHYME (PELVIS)
→ mesenchymal → epithelial conversion – NEPHRONS

Ureteric Bud → Collecting duct, Calyces, pelvis, ureter

ABNORMAL SIGNALLING BETWEEN URETERIC BUD & METANEPHRIC BLASTEMA → MULTICYSTIC KIDNEY DISEASE

- Kidneys migrate from their origin in the pelvis to the upper lumbar regions
  (Vascularised by transient successive aortic sprouts during ascent)

CONGENITAL ANOMALIES

1) Renal agenesis - B/L, / U/L
2) Multicystic disease
3) Ascent anomalies - • Ectopic Kidney / Crossed renal ectopia
   • Horseshoe kidney
4) Ureter - Duplex renal pelvis & ureter
   Ectopic ureter
   Retrocaval ureter
   Megaureter

RENAL AGENESIS

UNILATERAL

Failure of connection b/w metanephric blastema & ureteric bud
AD trait
ABSENCE
a/i absent ipsilateral ureter and hemi-trigone, ipsilateral testis, vas deferens, adrenal

BILATERAL

Incompatible with life
- a/i pulmonary hypoplasia & Potter facies (OLIGOHYDRAMNIOS)

RENAL APLASIA - small dysplastic kidney

ANOMALIES OF RENAL ASCENT

ECTOPIC KIDNEY

NORMALLY,
- Fetal kidney arises in pelvis and ascends to lumbar region (by 6-9 weeks)
- Renal pelvis, which initially faces anteriorly, rotates MEDIALLY

Failure / any degree of arrest of ascent
↓
ECTOPIC KIDNEY
↓
a/i Rotational abnormality

CAN BE:
- PELVIC
- ILIAC
- ABDOMINAL
- CONTRALATERAL / CROSSED
- THORACIC ** very rare

L > R

May be a/i hydronephrosis, stones

a/i anomalous blood supply

a/i reproductive anomalies

usually detected incidentally

CROSSED ECTOPIA

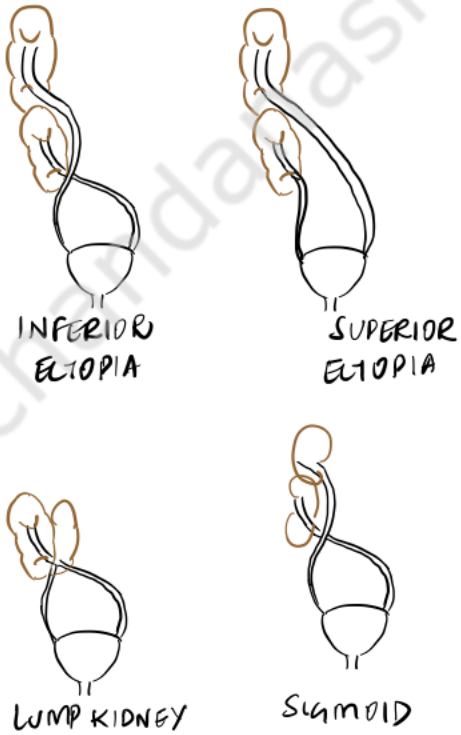
KIDNEY IS LOCATED ON THE SIDE OPPOSITE THAT IN WHICH ITS URETER IS INSERTED INTO BLADDER

usually fused to the other kidney

Most cases incidentally detected

Asymptomatic abdominal mass

TYPES



HORSESHOE KIDNEY

Lower poles of both kidneys are connected by a parenchymatous or fibrous isthmus

Kidneys fail to rotate ⇒ Calyces point posteriorly

- Variable blood supply

Ascent is halted by IMA - L4-L5 level

may be a/i other congenital anomalies

DUJO ⇒ hydronephrosis d/t atypical ureteral course / aberrant vessel - extrinsic compression

Wilms tumour m/c

Generally asymptomatic

Symptoms a/i
- hydronephrosis
- calculi
- infection

URETERAL & COLLECTING SYSTEM ANOMALIES

ECTOPIC URETER

- Any ureter (single / duplex) that does not enter trigonal area of bladder

IN A DUPLEX SYSTEM - UPPER POLE URETER IS ECTOPIC

Females - anywhere from bladder neck to perineum, including vagina
↓
presents as incontinence, prolapse of ureterocele

Males - proximal to external sphincter
→ presents as infection

Complications - ureteral obstruction
→ HUN
Ureterocele
VUR - upper tract damage

URETEROCELE - Cystic dilatation of distal aspect of ureter

- within the bladder
- spanning the bladder neck & urethra (submucosally)

Imaging
→ Adder sign
HUN

WEIGERT MEYER RULE (for Duplex systems)
Ectopic ureter / ureterocele a/i upper pole is caudal to the lower pole ureteral orifice

℞ - Ureteral reimplantation
Ureteroureterostomy

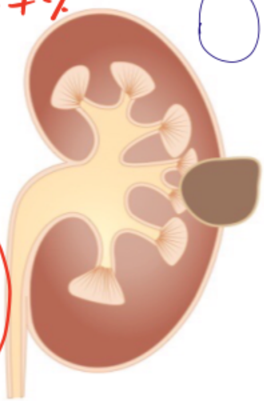
Renal Tumors

Renal Cysts

Renal Cysts
- Genetic
  - ADPKD
  - ARPKD
- Sporadic / Acquired
  - ACKD - Acquired cystic Kidney disease

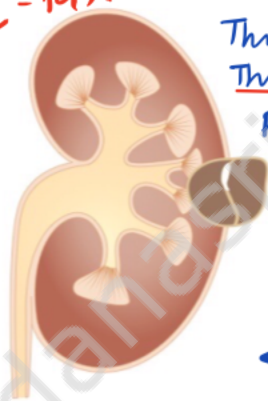
Bosniak Classification - aids in evaluation of Renal Cysts
- characterisation
- assessing the risk of malignancy

I - 1.7%
- Simple benign cysts
- Thin walls
- No
  - septatations
  - calcifications
  - solid components



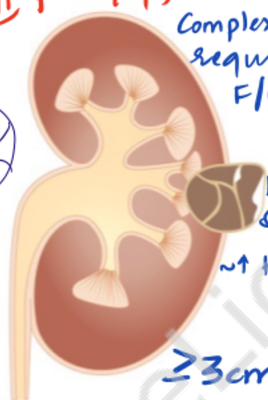
I ~0% are malignant

II - 19%
- Thin wall
- Thin septations
- Fine calcifications
- Minimal wall enhancement
- <3cm



II ~0% are malignant

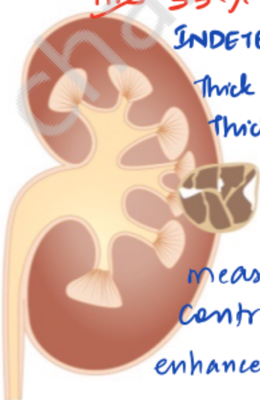
II F - 19%
- Complex cysts requiring F/U
- Hairline septae
- ↑ thickness
- ≥3cm



IIF ~5% are malignant

F = Follow up

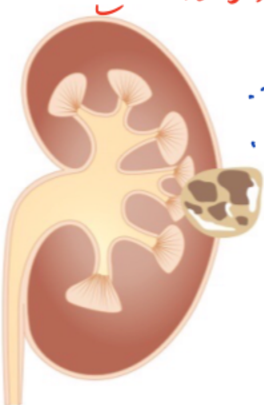
III - 33%
- INDETERMINATE
- Thick septae
- Thick wall
- measurable contrast enhancement



III ~50% are malignant

Require - active surveillance
- Excision / Ablation

IV - 92.5%
- Thick septae
- irregular walls
- Soft tissue necrosis



IV ~100% are malignant

Require excision / ablation

Indications for Surgery in Renal Cysts

1) Malignancy risk
2) Local symptoms - pain / infection / hypertension / hemorrhage / traumatic rupture

Procedures:
- Aspiration
- Decortication
- Resection
- Sclerotherapy
- Arterial embolisation
- Nephrectomy

SOLID BENIGN TUMORS

1) ONCOCYTOMA

m/c benign enhancing renal mass
- Histologically similar to chromophobe RCC (IHC can distinguish)

a/i Birt-Hogg-Dube Syndrome
- Pulmonary cysts
- Spontaneous pneumothoraces
- Fibrofolliculomas

Mx -
- Active Surveillance
- Biopsy
- Partial Nephrectomy

2) ANGIOMYOLIPOMA (AML)

Benign tumor composed of
- Dysmorphic blood vessels
- Smooth muscle
- Adipose tissue

- Sporadic
- Syndromic
  - Tuberous Sclerosis Complex (TSC)
  - Lymphangioleiomyomatosis (LAM)

- Imaging - MRI (IOC)
  - Fat poor AML mimics RCC

- Management: depends on size, symptoms
  - Bleeding - Angioembolisation
  - Malignancy risk - Nephron sparing Sx
  - Multifocal Syndromic AML - Everolimus

3) PAPILLARY ADENOMA KIDNEY

Well circumscribed cortical lesions <0.5cm

- similar to papillary RCC - common lineage
  ? premalignant

4) METANEPHRIC ADENOMA

Rare
♀ > ♂
May exist on a continuum : Wilm's tumor & papillary RCC

5) CYSTIC NEPHROMA, MIXED EPITHELIAL STROMAL TUMORS

6) LEIOMYOMA

7) RENINOMA → Hypertension

MALIGNANT TUMORS

Classification

- Renal Cell Carcinomas
  - Clear cell
  - Papillary
  - Clear cell papillary RCC
  - Chromophobe
  - Collecting duct
  - Renal Medullary Ca
  - Sarcomatoid / Rhabdoid
  - Unclassified
- Urothelial cell Cancers
  - Transitional cell Ca
  - SCC
  - Adenocarcinoma
- Sarcomas
  - Leiomyosarcoma
  - Liposarcoma
- Nephroblastic tumors
  - Wilm's Tumor
  - Nephrogenic rests
- Renal Cell + Nephroblastic tumors
  - PNETs
  - Neuroendocrine Ca
  - Carcinoid
  - Neuroblastoma
- Hematopoietic + Lymphoid
  - Lymphoma
  - Leukemia
  - Plasmacytoma
- Germ cell tumors
  - Teratoma
  - Choriocarcinoma
- Metastasis / Secondaries

RENAL CELL CARCINOMA (Grawitz tumor)

Hypernephroma

- 2-3% of adult malignancies
- M : F = 2 : 1
- Sporadic > Familial (4-6%)
  - von Hippel Lindau
  - Hereditary papillary RCC
  - Birt Hogg Dube syndrome
  - PTEN, TSC

	Wilm's	RCC
Children	90%	1-6%
2nd Decade	50%	50% ✓
After that	–	

- Risk factors:
  - Tobacco exposure
  - Obesity
  - Hypertension
- Characteristic features
  - → Refractory to Cytotoxic therapy
  - → Immunogenic - amenable to immunotherapy
  - → Angiogenic - amenable to ANTI-VEGF
  - → Dependence on MTOR pathway - molecular Rx : Everolimus

PATHOLOGICAL SUBTYPES

1) Clear Cell Carcinoma
   - 70-80%
   - a/i VHL

   | Clear cell papillary RCC
   | ~5%
   | a/e VHL

HPE: Well circumscribed, lobulated, golden yellow
Necrosis, hemorrhage, cystic degeneration

→ Bad prognosis (in comparison to papillary)

→ Paradoxically, responds better to VEGFR, checkpoint inh, IL2

2) Papillary RCC

a/e
- Type-1 HPRC — 5-10% — Better prognosis
- Type-2 HLRCC — 5-10%

Fleshy tumor with fibrous pseudocapsule
Necrosis & Hemorrhage → common

* Multicentricity * ~40%

3) Chromophobe RCC (3-5%) → Better prognosis

BHD 5°, PTEN

Well circumscribed, homogenous, tan/light brown; Perinuclear halo

4) Carcinoma of Collecting Ducts of Bellini } Poor prognosis
<1%
Desmoplastic

5) Renal Medullary
→ seen in pts ↓ sickle cell trait; advanced ds at dx

6) Sarcomatoid/Rhabdoid
→ sarcomatoid diff ⇒ aggressive local & metastatic behavior

7) Unclassified — Poor Prognosis

CLINICAL PRESENTATION

- Incidental (~60%)
- Symptoms of localised/locally advanced disease
  - Hematuria
  - Flank Pain
  - Abdominal mass } 'Too late' triad
  - Perinephric hematoma
- Obstruction of IVC
  - Bilateral lower extremity edema
  - Non-reducing varicocele / (R) side varicocele
- Symptoms of Systemic Disease
  - Persistent Cough
  - Bone pain
  - Constitutional Symptoms
  - Weight loss

• Paraneoplastic Syndromes (~ 10-20%)

RCC was known as internists tumor d/t predominance of systemic > Local manifestations

more common in metastatic disease

Rx - Surgical excision / Systemic antineoplastic Rx

- m/c PNS in RCC → ↑ESR - > 50%.
- Hypercalcemia - ~ 13%.
  - overproduction of 1,25-DHCC
  - osteolytic metastatic Bone involvement

  Nausea, anorexia, fatigue, ↓DTR

  Rx - Vigorous hydration f/b Diuresis ε FUROSEMIDE
  - Bisphosphonates, Corticosteroids, Calcitonin
    - ↳ Zolendronate 4mg IV Q4wk
  - Denosumab
  - Nephrectomy
  - Metastatectomy / focussed radiation therapy

- Hypertension
  - ↑ Renin production by tumor
  - Compression / Encasement of Renal Artery
  - A V fistula within the tumor
  - Polycythemia, hypercalcemia
  - Ureteral Obstruction
  - ↑ICP d/t CNS mets

* Causes for HTN in RCC *

- Polycythemia
  - d/t ↑ production of erythropoietin
    - Tumor cells
    - Adjacent parenchyma in response to hypoxia

- STAUFFER SYNDROME (3-20%) - Non metastatic hepatic dysfunction (d/t tumor cytokines)

  60-70% resolves after nephrectomy

  ↑ ALP, ↑ Bsb, ↓ Albumin, ↑ PT, Thrombocytopenia, Neutropenia

  HPE - non specific hepatitis / necrosis

- Others - Cushing s°, Hyperglycemia, Galactorrhea
  - Neuromyopathy, Cerebellar ataxia
  - Clotting disorders

SCREENING

1) ESRD
2) VHL — Known cases / Relatives & other familial SO – Tuberous sclerosis
3) ADPKD

Diagnosis

- CT ± selective use of MRI

- CECT – Perinephric fat stranding
  Distinct enhancing soft tissue density
  Adrenal involvement
  Enlarged hilar / Retroperitoneal nodes
  Renal vein tumor thrombus
  CT sensitivity – 78%
  IVC involvement – 96% CT sensitivity

MRI – better for imaging tumor thrombus
Retroperitoneal nodes

TEE – for cephalic extent of IVC thrombus

- CXR → CT thorax → If sympt

- Bone-scan – reserved for pts ± ↑ ALP
  Bone pain
  Poor performance

- PET – suboptimal sensitivity

ADVERSE PROGNOSTIC FACTORS

most important prognostic factor ← PATHOLOGIC STAGE

- Clinical
1) Poor Performance score
2) Systemic Symptoms
   - Anemia
   - Hypercalcemia
   - ↑ LDH
   - ↑ ESR
   - ↑ CRP
   - ↑ ALP
   - Thrombocytosis

- Anatomic
1) Large tumor size
2) Venous involvement
3) Extension into contiguous organs (incl. adrenals)
4) LN mets
5) Distant mets – greater mets burden

HISTOLOGIC
- ↑ Nuclear Grade
- Sarcomatoid features
- Histological tumor necrosis
- Vascular invasion
- Inv of Perirenal fat, collecting system
- +ve margin

STAGING OF RENAL CELL CARCINOMA

T

- T_x - cannot be assessed
- T_0 - No e/o 1° tumor

- T_1
  - T_{1a} - <4 cm
  - T_{1b} - 4-7 cm
- T_2
  - T_{2a} - 7-10 cm
  - T_{2b} - >10 cm

Confined to Kidney

- T_3 → Veins, Perinephric fat
  - T_{3a}
    - Renal vein or segmental branches
    - Pelvicalyceal system
    - Perirenal fat
  - T_{3b} - Infradiaphragmatic IVC
  - T_{3c} - Supradiaphragmatic IVC

DOES NOT GO BEYOND GEROTA'S FASCIA

- T_4 - Invades beyond Gerota's fascia - incl. adrenal involvement

N

- N_0 - Regional nodes (−)
- N_1 - Regional nodes (+)

M

- M_0 - Distant mets (−)
- M_1 - Distant mets (+)

Stage Grouping

I	T_1	N_0	M_0
II	T_2	N_0	M_0
III	T_1, T_2	N_1	M_0
	T_3	Any N	M_0
IV	T_4	Any N	M_0
	Any T	Any N	M_1

ROBSON'S STAGING → Not used anymore

- I - Confined to Kidney
- II - Invades perinephric fat / Involves adrenal
- III
  - III A - Renal vein / Branches / IVC involvement
  - III B - LN involvement
- IV
  - IV A - Local invasion - Beyond Gerota
  - IV B - Distant Mets

Management of Renal Cell Carcinoma

LOCALISED RCC – AUA 2017 Guidelines

Evaluation & Diagnosis

- High Quality Multiphase Cross sectional Imaging
- CBC, CMP, UA
- Metastatic workup
- Assign CKD stage – GFR, proteinuria

Renal Mass Biopsy

Indications
→ When mass is suspected to be
- Hematologic
- Metastatic
- Infectious

Multiple Core Biopsies >> FNA

Not necessary in
young healthy pts – Sx anyway
old frail pts – No Sx anyway

- **Active Surveillance (AS)**
  - an option for initial mangement in pts ↓ renal masses suspicious for cancer ≤3cm (ideally < 2cm)
  - Means – repeat imaging in 3–6m to look for interval growth ± RMB
  - Preferred in
    - Elderly ↓ Life expectancy < 5y
    - ↑ Comorbidities & Periop risk, poor PS
    - Marginal renal function

    } when
    - Tumor < 3cm
    - Growth < 5mm/y
    - Non infiltrative
    - Favorable histology

- **Thermal Ablation (TA)**
  - Percutaneous ablation – RFA / Cryoablation
  - Get Renal Mass Biopsy before TA
  - Indications – cT1a < 3 cm

- **Partial Nephrectomy (PN)**
  - cT1a tumors (T1b, T2 → Debatable - PN vs RN)
  - Goal is preservating of renal function i nephron sparing approach
  - Anatomic / functional solitary kidneys
  - Bilateral tumors
  - Familial RCC → Consider tumor enucleation
  - Pre-existing CKD / Proteinuria
  - Young pts i Multifocal masses comorbidities

  } to preserve renal function

  functional remnant of ~20-30% of one kidney necessary to avoid ESRD

  Procedure:
  - Temporary occlusion of vascular pedicle (avoid prolonged warm ischemia)
  - Tumore excision i rim of (N) parenchyma
  - Closure of collecting system & ligation of transected vessels
  - Capsular reconstruction

  → Margin size immaterial as long as final margins are NEGATIVE

  Prolonged ischemia anticipated → consider EXTRACORPOREAL APPROACH

- **Radical Nephrectomy (RN)**
  - pts i • ↑ Oncological potential - ↑ Tumor size
    Adverse histology
    Adverse imaging features
    - Good renal function
      (N) Contralateral kidney
      i new baseline eGFR predicted to be ≥45 ml/min/1.73m²
    - Tumors in non functional kidneys
    - Large tumors replacing majority of Parenchyma
    - Renal vein thrombus

  Procedure:
  Complete Removal of:
  - Kidney OUTSIDE GEROTA'S FASCIA
  - Ipsilateral adrenal gland ← (±)
  - Complete Regional Lymphadenectomy from
    - cms of diaphragm
    to
    - aortic bifurcation

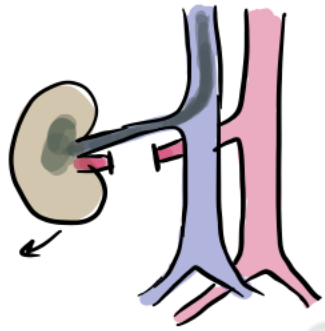
  consider pre-op angioembolisation

  Ligate Renal Artery before Renal Vein

TREATMENT OF LOCALLY ADVANCED RCC

- Inferior Vena Cava Involvement

Staging of IVC Thrombus:
- I - Adjacent of ostium of Renal vein
- II - Below hepatic veins
- III - Above hepatic veins, but below diaphragm
- IV - Above diaphragm



- If tumor thrombus is below main hepatic veins
  - easier to do thrombectomy
- Thrombus extending above main hepatic veins
  - more extensive dissection
  - Consider
    - venovenous bypass [extracorporeal diversion of venous blood from below the caval clamps to the central veins – axillary (subclavian) V / IJV]
    - Cardiopulmonary bypass
    - Circulatory arrest

- Surrounding tissues involved (T_4)

  Complete en-bloc removal ± resection

- Bulky LN – LN dissection

NEOADJUVANT & ADJUVANT Rx – ?

Evidence not very Good
- VEGF agents
- Targetted Therapy

METASTATIC DISEASE

- Solitary mets – Extirpative surgery
- Palliative Cytoreductive Surgery – Doubtful role
- Systemic therapy – Immunotherapy
  Targetted therapy

WILM's TUMOUR / Nephroblastoma

- Embryonal renal neoplasm
- From METANEPHRIC BLASTEMA (remnants of immature kidney)
- 13% present i B/L tumors → 60% are synchronous
- More than 80% of Wilm's tumors – < 5y (Median age 3.5y)

Genetics

1) WT1 gene
   - Chromosome 11p13
   - necessary for ureteric bud outgrowth & nephrogenesis
   - DENYS DRASH SYNDROME
     - Male pseudohermaphroditism
     - Renal Mesangial Sclerosis
     - Nephroblastoma
   - WAGR syndrome

Wilm's Tumor, Aniridia, Genital Anomalies, Retardation of Mental function
↳ Renal fusion anomalies
Cryptorchidism
Hypospadias

2) WT2 gene
   - Chromosome 11p15
   - Beckwith-Wiedeman Syndrome – hemihypertrophy, Nephroblastoma

3) WTX Gene – X chromosome

– Screening recommended in Syndromic pts

PATHOLOGY – Wilm's tumor compresses adjacent (N) renal parenchyma – PSEUDOCAPSULE

Classic / Favorable Histology

- Islands of UNDIFFERENTIATED BLASTEMA
  - Tissues like skeletal muscle
  - Cartilage
  - Squamous epithelium
- Variable epithelial differentiation
  - Tubules
  - Rosettes
  - Glomeruloid structures
- Stromal component

Anaplastic Wilm's Tumor

1) Nuclear enlargement ≥3x of surrounding cells
2) Hyperchromasia of enlarged nuclei
3) Abnormal mitotic figures

Associated i resistance to chemotherapy
Poor prognosis

Pathology after pre-operative chemotherapy

- Stromal & epithelial predominant – HAVE POOR RESPONSE TO CHEMO
- excellent prognosis if excised in toto

Blastema after chemo
↓
High relapse

(usually blastema predominant tumors have good response to chemo → if they have not responded – bad Px

- **Nephrogenic Rests** (NRs)

  - Precursor lesions

    Perilobar Intralobar

  - Multiple NRs in one Kidney ⇒ NRs in other Kidney
    ↳ Risk of contralateral Wilms Tumor

CLINICAL FEATURES

- >85% are symptomatic on presentation
  ABDOMINAL MASS
  ABDOMINAL PAIN
  HEMATURIA – 20%.
- 25% have Hypertension on diagnosis
- fever, anorexia, weight loss
- IVC thrombus – persistent varicocele
- Atrial thrombus – congestive heart failure
- Syndromic features

~8% newly diagnosed WT → acquired von-Willebrand disease

- LUNG – m/c site of metastasis
- Tumor stage & HPE → most important determinants of outcome

IMAGING

All solid renal tumors of childhood have common imaging features

USG – first line
↓
CT abdomen & Pelvis ± Oral & IV contrast
OR
MRI abdomen & Pelvis ± Gadolinium
→ avoids radiation but requires sedation

Poor sensitivity but modest specificity for detecting pre-op tumor rupture

STAGING (CHILDREN'S ONCOLOGY GROUP) – SURGICAL STAGING

I – CONFINED TO KIDNEY – renal capsule is intact, no extension – COMPLETELY RESECTED

II – EXTRACAPSULAR PENETRATION – Renal sinus extension, tumor thrombi – COMPLETELY RESECTED

III – RESIDUAL TUMOR IN ABDOMEN – lymph nodes, spillage, peritoneal implants
NOT COMPLETELY REMOVED

IV – HEMATOGENOUS METS – to lungs, liver, bone, brain

V – B/L RENAL INVOLVEMENT AT DIAGNOSIS

STOP → different staging method

TREATMENT

Surgical Considerations

1) Initial Rx for most children ; Wilms tumor is **RADICAL NEPHRECTOMY**

Surgical staging → Need for RT
→ Selection of appropriate chemo

- No need for routine exploration of opposite kidney if imaging (N)
- Selective sampling of Retroperitoneal nodes
- AVOID SPILLAGE

2) Pre-op chemotherapy – can be given in :
- Children for whom renal sparing surgery is planned
- Tumors inoperable at surgical exploration
- Tumor extension into IVC above hepatic veins
- Bilateral tumors

3) ADJUVANT Rx

Stage I & II (FH) → Vincristine + Dactinomycin × 18 wks (NO XRT)

Stage II (FA) / III / IV } Vincristine + Dactinomycin + Doxorubicin × 24 wks + XRT to tumor bed
→ additional RT to Metastatic sites

Stage II – IV ; Diffuse anaplasia → Vincristine + Doxorubicin + Etoposide + Cyclophosphamide × 24 wks
+ XRT → whole lung & abdomen

NEUROBLASTOMA

- M/c extracranial solid tumor in infants & children
- Arise from neural crest cells
- Malignant neoplasm of sympathetic ganglia

65% Abdominal → 50% adrenal medulla
5% Neck
20% chest
5% Pelvis

- Genetics - MYCN amplification - Chromosome 2p24

CLINICAL PRESENTATION

- Asymptomatic
- Constitutional symptoms
- Local symptoms
  d/t mass
  - enlarging mass
  - abdominal pain
  - lymphadenopathy
  - Horner's (Neck)
  - Neurological deficits
- Paraneoplastic
  - Hypertension & tachycardia - Catecholamines
  - VIP - Intractable diarrhea
  - Encephalomyelitis, neuropathy
  - Opsoclonus, Myoclonus, nystagmus - antibodies to cerebellar tissue
- Metastasis
  Bone marrow invasion - anemia, easy bruising
  - Raccoon eyes ← orbital involvement

Diagnosis

- ↑ Dopamine, VMA, Homovanillic acid
- ↑ LDH (>1500 U/mL)
- ↑ Ferritin (>142 ng/mL)
- ↑ Neuron specific enolase (>100 ng/mL)

USG → CT/MRI → spinal extension

I^{131} - MIBG scan - detection of primary & mets
Meta-iodo-Benzyl-Guanidine

STAGING - MODIFIED SHIMADA - International Nephroblastoma Staging

Primary excision

1 - LOCALISED TUMOR, NODES NEGATIVE, COMPLETE EXCISION

2
- 2A - LOCALISED TUMOR, NODES NEGATIVE, INCOMPLETE EXCISION
- 2B - LOCALISED TUMOR, [IPSILATERAL NODES POSITIVE] < COMPLETE EXCISION / INCOMPLETE EXCISION

Incisional Biopsy

3 - UNRESECTABLE UNILATERAL TUMOR ± +VE CONTRALATERAL NODES

(OR)

MIDLINE TUMOR ± B/L INVOLVEMENT

4 - DISTANT NODES
BONE, BONE MARROW
LIVER, SKIN

4S - LOCALISED PRIMARY ± SKIN/LIVER/MARROW

CHEMO - Induction - Cyclophosphamide, Doxorubicin, Etoposide, Platins, Vincristine

- Local Radiation
- Immunotherapy - IL-2
- Stem cell Rescue therapy

RENOVASCULAR HYPERTENSION

Renovascular Hypertension is a clinical syndrome resulting from reduced renal perfusion characterised by marked rise in arterial pressure with / without associated ischemic / hypertensive renal injury

CAUSES

1) Atherosclerotic Renal Artery Stenosis (60-80%)
2) Fibromuscular Dysplasia
3) Rare causes
   - Arterial aneurysm
   - AV malformation
   - Extrinsic renal artery compression

ATHEROSCLEROSIS

- M, F ; 40-70y old
- Proximal 1/3rd of Renal Artery involved
  (70%, aostric plaque impinging renal ostium)
  (30% - non ostial narrowing)

FIBROMUSCULAR DYSPLASIA

- (F) ; 25-50y
  (Types: Medial, perimedial & Intimal fibroplasia
  Medial Hyperplasia) Medial Fibroplasia - mlc, least deadly
- Involves distal 1/2 of main Renal A
  may extend into branches

RENOVASCULAR HYPERTENSION SHOULD BE SUSPECTED IN THE PRESENCE OF :

1) Severe / refractory HTN & Gr III-IV HTN Retinopathy
2) Abrupt onset of severe HTN in a normotensive / well controlled hypertensive
3) HTN onset <20y (early) or >50y (late) ; esp c out family hx
4) Unexplained worsening of Renal function in a/c ACEIs / ARBs ✓
5) Paradoxical worsening of HTN c diuretics ✓
6) Unexplained / recurrent Heart failure c Flash pulmonary edema
7) Systolic-Diastolic Abdominal bruit radiating to flanks
8) Diffuse vascular disease

PATHOPHYSIOLOGY

↓ RENAL BLOOD FLOW
↓ GFR
Activation of Renin Angiotensin aldosterone system
↓ Renin
Angiotensinogen → Angiotensin I —ACE→ Angiotensin II

Angiotensin II → Aldosterone → Na & H_2O retention → Hypertension
Angiotensin II → Vasoconstriction → Hypertension
Hypertension → Vascular injury

INVESTIGATIONS

- RFT - impairment is a late feature
- Renal Artery Duplex USG - measure peak systolic velocity

	Renal A PSV	Renal-Aortic Ratio : $\frac{\text{Renal A. PSV}}{\text{Aorta PSV}}$
(N)	< 180 cm/s	< 3.5
< 60 % stenosis	≥ 180 cm/s	< 3.5
≥ 60 % stenosis	≥ 180 cm/s	> 3.5
Complete occlusion	No signal	No signal

- Captopril Renal Scanning - functional study to asses renal function before and after Captopril administration (RENOGRAM)

Captopril ⟶ (⊖ Inhibits) Angiotensin mediated efferent arteriolar vasoconstriction
↓
↓ GFR

POSITIVE TEST: Captopril → ↑ the time to peak activity to > 11 min
→ ↑ the GFR ratio between sides to > 1.5 (compared to baseline)

Study limited if significant parenchymal disease is present

- Renal vein Renin level
  By selective catheterization of Renal vein
  Ratio of Renal vein Renin between 2 kidney > 1.5 (RVRR)
  Not useful in presence of B/L disease
- Renal Systemic Renin Index (RSRI)

  Single kidney RSRI > 0.24
  or $K_1 + K_2$ RSRI > 0.48

- DSA
- MR Angio

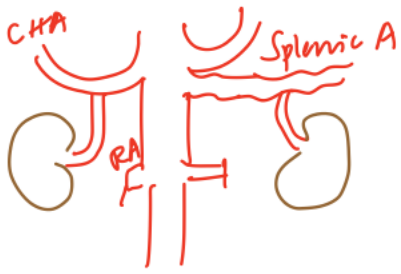
TREATMENT

INDICATIONS : Refractory / Progressive / Severe Hypertension
Flash Pulmonary Edema
Renal insufficiency
FMD
> 70 % stenosis

INTERVENTION

ENDOVASCULAR

- Renal Artery Balloon Angioplasty
  ±
- Renal Artery Stenting



SURGICAL

Renal Artery Revascularisation

1) ENDARTERECTOMY (Transrenal / Transaortic)

2) AORTORENAL BYPASS
   - Autologous vein conduit
   - Prosthetic conduit

3) HEPATORENAL BYPASS ± CONDUIT
   CHA (SIDE) ⟶ RENAL A (END)

4) SPLENORENAL BYPASS

5) REIMPLANTATION OF RENAL A

- For pts who can't tolerate aortic clamping
- For pts ± severely calcified aorta

Other Renal Causes of Hypertension

- Glomerulonephritis
- Chronic Tubulointerstitial Disease
- Polycystic Kidney Disease
- Diabetic Nephropathy
- Obstructive Uropathy
- Renal Malignancies

} RAAS activation

Other causes of Surgically correctable Hypertension

- Hyperaldosteronism 2lt adrenal adenoma
- Pheochromocytoma
- Coarctation of Aorta

UROLITHIASIS

Epidemiology

1) M : F - 2-3 : 1

2) Whites > Hispanics > Asians > African americans

3) Age - incidence peaks in 4th - 6th decades

4) ↑ in hot, arid, dry climates - mountains, deserts, tropics

5) Occupational risk factors - Heat exposure & dehydration

6) Obesity, Diabetes, Metabolic Syndrome - F > M
   - ↑ BMI - ↑ excretion of urinary oxalate, uric acid, Na, phosphorous
   - ↑ excretion of promoters of stone formation

PATHOGENESIS

SUPERSATURATION OF URINE WITH STONE-FORMING SALTS { when concentration exceeds the solubility product

- ↓ volume
- ↓ Citrate
- ↑ Calcium
- ↑ Oxalate
- ↑ Phosphate
- ↑ Uric acid

(+) →

NUCLEI / CRYSTALS

(-) Magnesium
Citrate
NEPHROCALCIN
TAMM-HORSFALL MUCOPROTEIN
UROPONTIN / OSTEOPONTIN
BIKUNIN

GROWTH & AGGREGATION

at 'anchoring' sites - Renal papillae

(+) ← MATRIX - non-crystalline component - mucoproteins, proteins, carbohydrates, urinary inhibitors

CALCULI

Randall Plaques - nidus for stone formation
SUBEPITHELIAL plaques in the renal papilla - prolonging the time of exposure of crystals to supersaturated urine → facilitating growth & aggregation

- Nephrocalcin - Acidic glycoprotein synthesised in PCT, Thick ascending LOH
- TAMM-HORSFALL PROTEIN / UROMODULIN - most abundant urinary protein - expressed by Thick ascending LOH & DCT

STONE COMPOSITION

CALCIUM CONTAINING
- Calcium oxalate (60%)
- Hydroxy apatite (20%)
- Brushite (2%)
  (Calcium Hydrogen phosphate dihydrate)

NON-CALCIUM CONTAINING
- URIC ACID (7%)
- STRUVITE (7%)
- CYSTINE (1-3%)
- OTHERS (<1%) Triamterene, Silica

Shapes
1) Calcium Oxalate Monohydrate - HOURGLASS
2) Calcium Oxalate Dihydrate - Envelope
3) CALCIUM PHOSPHATE APATITE - AMORPHOUS
4) BRUSHITE - NEEDLE SHAPED (Like BRISTLES OF A BRUSH?)
5) STRUVITE - RECTANGULAR / COFFIN SHAPED
6) CYSTINE - HEXAGONAL
7) URATE - Amorphous shards / plates

ETIOLOGY

1) Hypercalciuria (>200mg/d)
   - Absorptive Hypercalciuria - ↑ GI calcium absorption - 20-40%
   - Renal Hypercalciuria - ↓ Renal calcium reabsorption - 5-8%
     (Renal Phosphate leak)
   - Resorptive Hypercalciuria - 1° Hyperparathyroidism - 3-5%
   - Hypercalcemia-induced Hypercalciuria - Hypercalcemia of malignancy, thyrotoxicosis, Vit D toxicity, Granulomatous diseases: TB, Sarcoidosis, Leprosy, silicosis; Glucocorticoids

2) Hypocitraturia - idiopathic, Distal RTA, chronic diarrhea, Thiazides
   Metabolic acidosis ↑ Citrate tubular reabsorption 10-50%

3) Hyperuricosuria - ↑ Dietary purines, ↑ Uric acid production - 10-40%
   (>600mg/d)

4) Hyperoxaluria (>40mg/d) 2-15%
   - Primary oxaluria - ↑ production
   - Dietary oxaluria - ↑ intake
   - Enteric oxaluria - ↑ absorption

5) Hypomagnesuria (<80mg) - ↓ intestinal Mg^{2+} absorption 5-10%

6) Low urinary pH (<5.5) 15-30%

7) Low urine volume - inadequate fluid intake - 10-50%

8) Infection ± urease producing bacteria - 1-5%

9) Cystinuria - ↓ Renal cystine absorption - 3%
   (>250mg/d) → Inherited disease

STRUVITE STONES

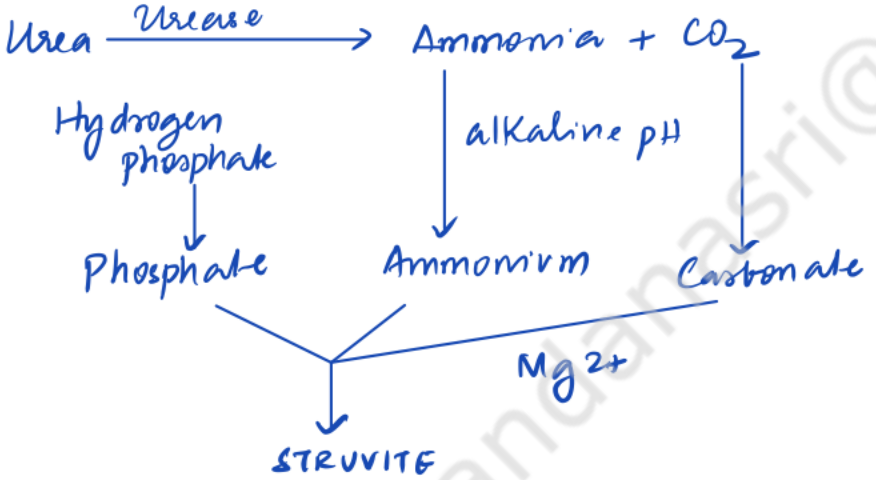
(Named after H.C.G von Struve)

- Magnesium ammonium phosphate Hexahydrate + Calcium Phosphate (as carbonate apatite)
- occur in case of infection i urea-splitting bacteria

Proteus
- P. mirabilis → m/c isolate
- Klebsiella
- Pseudomonas
- Staph. aureus

Though E.coli is a very common cause of UTI, it does not form urease usually

- E.coli in struvite stones is usually d/t metachromous infection.



℞ - AHA
- Acetohydroxamic acid
- oral urease inhibitor
↓
may reduce urinary saturation of struvite & retard stone formation
250mg TID
- Complication - DVT

STRUVITE is very commonly found in STAGHORN CALCULI

(STAGHORN CALCULI are large renal stones occupying most/all of the renal collecting system)

ANATOMIC PREDISPOSITION TO STONES

1) PUJ obstruction
2) Horse shoe Kidney
3) Calyceal Diverticula
4) Medullary Sponge Kidney
5) Pregnancy

DRUG STONES

Indinavir
Ephedrine
Triamterene
Silicate antacids
Trimethoprim - sulfmethoxazole

DRUGS CAUSING STONES

- Carbonic anhydrase inhibitors
- TOPIRAMATE
- Furosemide
- Vit C
- Vit D
- Laxatives
↓
Ammonium acid urate stones (laxative abuse)

- Clinical features
  - Asymptomatic - 10% screened population
  - Obstruction - Ureteric Colic
    Infection

DIAGNOSIS

- **IMAGING**

RADIOGRAPHY

1) X-Ray KUB (Plain)
   - Sensitivity - 57%.
   - Specificity - 76%.

Limitations
- cannot see some stone types - uric acid
- obscured stones d/t bone & bowel

2) IVP
   - Sensitivity - 70%.
   - Specificity - 95%.

3) USG - Sensitivity 61%.
   Specificity 97%.

See - HUN
But - misinterprets stone size
- limited by Bowel gas

4) CT
NCCT / CT KUB Plain → Gold standard
Sensitivity - 98%.
Specificity - 97%.

Dual energy CT
↳ can detect stone composition

Uric acid stones - radiolucent on conventional radiography
- seen on CT

Drawbacks: Expensive, Radiation exposure concerns
cannot see protease inhibitor stones
pure matrix stones

- **INDICATIONS FOR METABOLIC STONE EVALUATION**

1) Recurrent Stone formation
2) Strong family history of stones
3) Intestinal disease
4) Pathological Fractures
5) Osteoporosis
6) UTI + Calculi
7) Gout
8) Solitary Kidney
9) Anatomic abnormalities
10) Renal Insufficiency
11) Stones composed of Cystine, Urate, Struvite
12) Children

Management

General Recommendations for Stone Formers

1) ↑ Fluid intake – to ensure U/O of ≥ 2.5L/d
2) Avoid saturated sugar drinks
3) Avoid nondairy animal protein
4) DASH diet – ↓ Na intake

CONSIDERATIONS IN TREATMENT OF UROLITHIASIS

Stone-related factors

1) Size
2) Number
3) Location
4) Composition

Renal-anatomic factors

1) Obstruction/stasis
2) Hydronephrosis
3) PUJO
4) Calyceal diverticulum
5) Horseshoe kidney
6) Renal ectopia
7) Lower pole

Patient factors

1) Infection
2) Obesity
3) Coagulopathy
4) Age-extremes
5) Hypertension
6) Renal reserve
7) Pregnancy

Rx: RENAL CALCULI

Minimally Invasive Approaches

- Shock Wave Lithotripsy
- Ureterorenoscopy
- PCNL
- (Lap) Robotic Assisted Stone Surgery

Indications for Intervention & Approach Considerations

1) Asymptomatic non-staghorn calculi
   weigh risk of progression/ complications & complications of intervention

2) STAGHORN CALCULI
   → MUST BE TREATED
   → a/c recurrent UTIs
   renal functional deterioration
   } Rx of choice - PCNL

3) STONE BURDEN
   ≤1 cm ⟶ Rx SWL → URS → PCNL
   1-2 cm ⟶ Rx URS = SWL → PCN
   >2 cm ⟶ Rx PCNL - first line

3) Lower pole stones - difficult to approach by SWL/URS
   → PCNL is effective

4) Matrix stones - PCNL

5) Cystine stones, Brushite stones } - URS > PCNL

6) Caliceal Diverticular stones : PCNL > URS

7) Horseshoe Kidney - PCNL

Rx - URETERIC CALCULI

1) Conservative therapy succeeds in stones ≤ 5mm
   (upto 10mm - may pass)
   Medical expulsive therapy - α blockers
2) Fever / signs of UTI ⇒ impending sepsis
   - emergent decompression - stent / Nephrostomy

PROXIMAL URETER
< 1 cm —— SWL / URS
> 1 cm —— URS - Ante / Retrograde
SWL

DISTAL URETER
< 1 cm - SWL / URS
> 1 cm - URS > SWL

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY

Principle: A source external to the patients' body generates a shock wave (NON LINEAR PROPAGATION, faster than sound waves), transmitted through the body and focussed onto the stone

↓

Stone fragmentation (Stones upto 1.5cm)

COMPONENTS

1) SHOCKWAVE GENERATORS: TYPES → 1) ELECTROHYDRAULIC / SPARK-GAP (→ need to be coordinated : ECG)
   2) ELECTROMAGNETIC
   3) PIEZOELECTRIC

Typical pulse: Initial pulse: 40 MPa
fib : 10 MPa
} × 4 microseconds → STONE 'COMMINUTION' by
1) Microcracks
2) compression
3) Shear stress
4) Superfocusing
5) Cavitation

2) IMAGING SYSTEMS: (To localize stone) TYPES → 1) FLUOROSCOPY
   2) USG
   3) FLUORO + USG

"STEINSTRASSE" ↓ 'Street of Stones' in German

DOSE: 60 – 90 shocks/min
500 – 2500 shocks at 14 – 18 kV

ADVERSE EFFECTS

- Acute & Chronic Renal damage - Infection, Hematuria
- Extrarenal Damage - liver & skeletal muscle

Contraindications

1) Pregnancy
2) Bleeding diathesis / Uncorrected Coagulopathy
3) Untreated UTI
4) Renal / Aortic Aneurysms
5) Obstruction distal to stone
6) Skeletal malformations (inability to target stone)

Factors predicting poor ESWL success

1) Stone composition: CYSTINE, BRUSHITE, MATRIX, CALCIUM OXALATE MONOHYDRATE
2) Stone attenuation >1000 HU
3) Skin to stone distance >10cm
4) Renal anatomic abnormalities - Horseshoe kidney
   Calyceal diverticulum
   unfavorable lower pole anatomy

PERCUTANEOUS NEPHROLITHOTOMY

Indications of Percutaneous Renal Access

1) Simple Drainage of obstructions - intrarenal, PUJ, Ureter
2) Diagnostic
   - Whittaker test for obstructive vs non-obstructive HN
3) Therapeutic Instillations of chemotherapeutic agent for upper tract urothelial lesions
4) PCNL

PRE OP - NCCT for access & treatment planning

Position < Prone → POSTERIOR CALYX ACCESS
Supine ± lateral elevation & tilt → ANTERIOR CALYX ACCESS

PUNCTURE

- Puncture into upper pole calyx - most versatile
- Image guidance - Fluoroscopy / USG < Supracostal / Subcostal
  URS assisted Fluoroscopy
- Blind access via Lumbar △ of Grynfelt (Superior △)

Percutaneously place a needle into upper tract collecting system
↓
Guidewire over needle, remove needle
↓
dilate tract, place catheter / working post
↓
Instruments
↳ lithotripter
↓
Crush stones
↓
Irrigate
↓
Drain

POST-PROCEDURAL DRAINAGE

Balloon catheter
Cope Catheter
Malecot Catheter
Nephroureteral Stent
Circle Nephrostomy tube

COMPLICATIONS

- Bleeding
- Infection
- Pleural & Lung parenchymal injury - supracostal approach
- Solid visceral (liver / spleen injury)
- Collecting system injury

URETERORENOSCOPY

Flexible ureteroscope → ureteral orifice is intubated

- Anterograde
- Retrograde

URS & PCNL utilise intracorporeal lithotripters

- Electrohydraulic
- LASER
- Ultrasonic
- Ballistic

Indications for Open Surgery / Lap & Robotic Stone Removal

- Pyelolithotomy & Pyeloplasty
- Stones in poorly functioning polar areas
- Non functional kidneys
- Pelvic kidneys & large stone volumes

HYDRONEPHROSIS

- aseptic dilatation of the Pelvicalyceal system due to obstruction to the flow of urine

TYPES

CONGENITAL

UPPER TRACT OBSTRUCTION
- PUJO
- VUR (functional obstruction)

LOWER TRACT OBSTRUCTION
- Posterior urethral valve

ACQUIRED

UPPER TRACT OBSTRUCTION

INTRINSIC

INTRALUMINAL
- Calculi
- Clots
- Papillary tissue
  - Papillary necrosis
  - T2DM
  - Analgesic abuse
  - Sickle cell

INTRAMURAL
- Tumors
- Infections
- Granulomas
- Strictures

EXTRINSIC

- Vascular Compression
  - Aberrant vessels at PUJ
  - Retrocaval ureter
  - Ovarian veins
  - Aneurysms of aorta & iliac vessels
- Pelvic Pathologies
  - Ca Cervix
  - Ovarian tumors
  - Ca Prostate
  - Endometriosis
  - PID
  - Prolapse
  - Pregnancy
- Intra-abdominal
  - Crohn's Disease
  - Pancreatitis
  - Appendicitis
  - Diverticulitis
- Retroperitoneal
  - Fibrosis
  - lymphnodes
  - Tumors
  - Hematomas

LOWER TRACT OBSTRUCTION

- Urethral Causes
  - Strictures
  - Stones
  - Clots
  - Periurethral abscess
  - Phimosis
  - Paraphimosis
  - Meatal stenosis
  - Drugs
- Prostate
  - BPH
  - Carcinoma
- Bladder
  - Carcinoma
  - TB
  - Schistosomiasis
  - Calculi
  - Neurogenic bladder

CAUSES OF BILATERAL HN

- Any cause of lower urinary tract obstruction
- B/L Upper tract obstruction
  - Idiopathic Retroperitoneal fibrosis (ORMOND'S DISEASE)
  - B/L PUJO
  - Pregnancy – ↑ circulating progesterone (upto 20wk)

URETEROPELVIC JUNCTION OBSTRUCTION

Functionally significant impairment of urinary transport from renal pelvis to ureter arising from a congenital intrinsic abnormality of the ureter

PATHOGENESIS

- Aperistaltic segment of ureter [presence of abnormal muscle / fibrous tissue in ureter wall]

↓

Failure of development of normally propagating wave of peristalsis

Stricture → ← Kinks & valves d/t infolding of ureteral mucosa

adventitial bands → ← ABERRANT LOWER POLE VESSELS

↓

OBSTRUCTION

INVESTIGATIONS

- PRENATAL USG - may detect HN
- USG - Initial evaluation
  - visualisation of dilated collecting system
  - delineation of level of obstruction
- CT - detailed anatomic & functional information
  - cortical thinning
- Diuretic renography (Tc99m-MAG-3)
  - differential renal function
  - obstruction

Previously - IVP - Calyceal blunting / flattening

- Normal cup, Flat, Bulge

Pelvicalyceal dilatation : in Extrarenal pelvis; Intrarenal pelvis

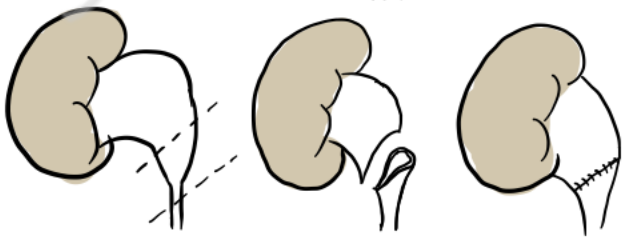
MANAGEMENT

- Minimally invasive - Endoscopic pyelomyotomy
  - Percutaneous pyelomyotomy

} ± ureteral stenting / drainage

BUT SUCCESS RATES ARE VERY POOR

- PROCEDURE OF CHOICE : DISMEMBERED PYELOPLASTY (ANDERSEN-HYNES) ← Open, Lap, Robotic

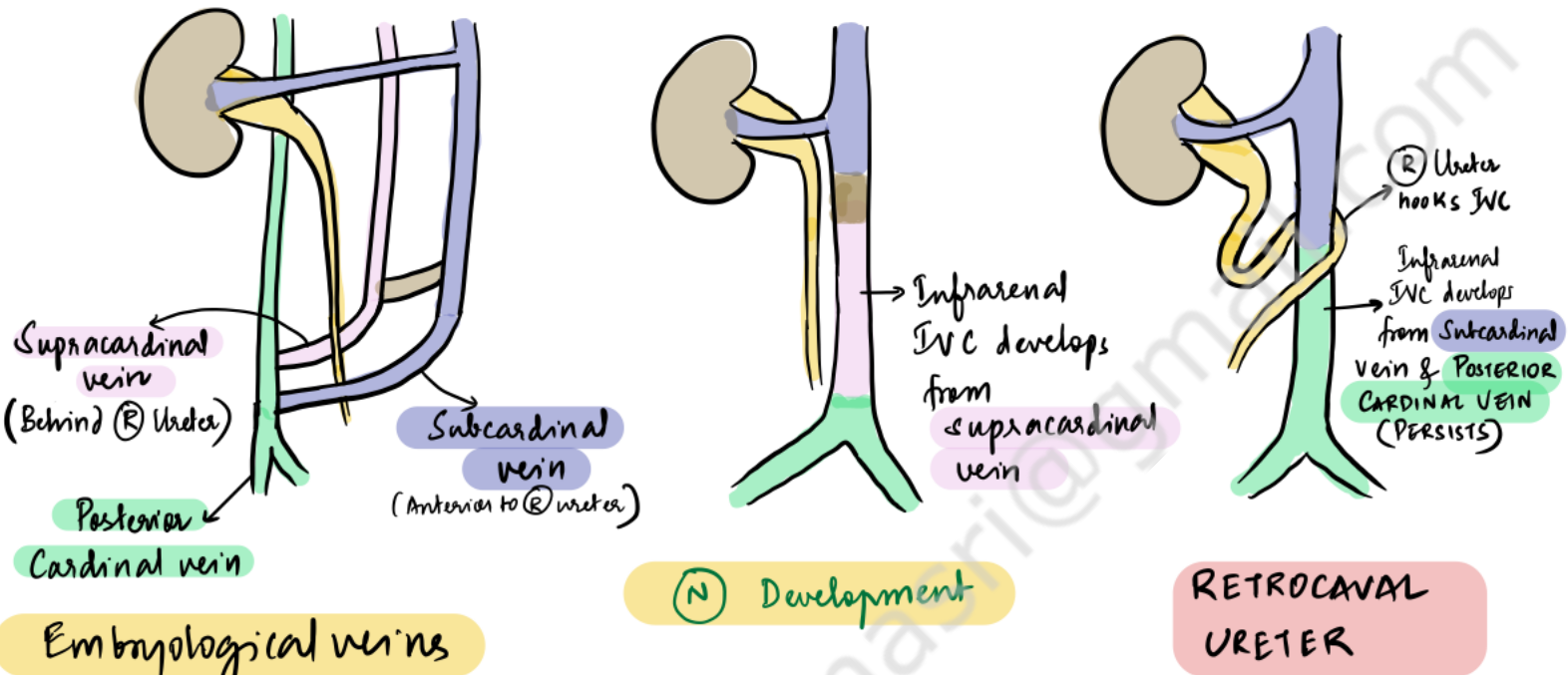


- Complete excision of an anatomically / functionally abnormal UPJ
- Anterior / posterior transposition can be achieved when obstruction is due to aberrant vessels

- Others: Foley-V-Y plasty, Spiral Flap, Vertical Flap, Intubated Ureterotomy, Ureterocalicostomy,

RETROCAVAL URETER

A congenital abnormality where the ureter hooks around the infrarenal IVC due to an anomalous IVC embryological development - persistent posterior cardinal vein



Dx Characteristic 'S' shaped deformity of Ⓡ Ureter

Intervention is indicated in the presence of significant PUJ obstruction

Rx - Surgical Pyelopyelostomy

After dissection, the renal pelvis is divided & the ureter is transposed to the Ⓝ position anterior to the IVC

Pyelopyelostomy is then performed circumferentially with absorbable sutures in a tension free manner ± internal ureteral stent

CHYLURIA

Presence of chyle in the urine

ETIOLOGY

CAUSES OF CHYLURIA

PARASITIC

Wuchereria bancrofti

Others: Echinococcus
Cysticercus
Ascaris lumbricoides

NON-PARASITIC

- Congenital lymphatic malformations
- Lymphourinary fistulas due to
  - TRAUMA
  - ABSCESS
  - NEOPLASM
  - TB

Chyluria is presumed to be filarial unless proven otherwise

PATHOGENESIS: Obstruction / stenosis / stricture of Major lymphatic ducts in the Retroperitoneum

- m/c d/t filarial parasites → work-up for filaria
- Raised intralymphatic pressure → lymphatic varices → Rupture of lymphatic varices into urinary tract → m/c: Kidney (Renal tubules); also: ureter, bladder, prostate

CHYLOUS URINE

- Post prandial milky urine
  - milkiness clears with fat-free diet
  - Sedimentation → top white fatty layer
  - Biochemistry → Urinary triglycerides / chylomicrons (N <10mg/dL)

EVALUATION (→ for lymphatic filariasis (see lymphedema notes))

- IVU } Dilated paracalyceal lymphatics
- RGP } → should be done carefully
- lymphangiography
- lymphoscintigraphy

Not routinely indicated in filarial chyluria – only if etiology / dx is doubtful

MANAGEMENT

- Filariasis ⟶ Rx ⅈ DEC
- Initially - medical / conservative Rx

Dietary modification → omission of LCFAs / TGs

→ Inclusion of MCFAs ✓

↓

absorbed directly into portal vein - bypassing lacteals & lymphatic system

- INTERVENTION - Recommended in severe / refractory chyluria (failed Rx)

passage of chyluous clots, urinary symptoms, malnutrition

Generally required for non parasitic chyluria:

- Endoscopic Sclerotherapy - $AgNO_3$ in renal pelvis
- Surgical lymphatic disconnection - Open surgical ligation of varices
- Lymphatic microsurgery to relieve lymphatic obstruction

Nodovenous & lymphovenous shunts

Genitourinary Tuberculosis

Development of Genitourinary Disease – MODES OF SPREAD

① Hematogenous spread
- usually, long period of LATENCY before activation
- typical sites for hematogenous seeding
  - KIDNEY
  - EPIDIDYMIS
  → other organs of GU tract become infected via contiguous spread from these sites

② Ascending / retrograde infection from urinary system

Eg: GUTB after bladder irrigation i BCG (live attenuated M. bovis)
→ 0.9% of pts receiving Bladder BCG

③ Contiguous spread from other organ systems
- from TB spine – psoas abscess
- Gastrointestinal TB from enterorenal / enterovesical fistulae

④ Direct Inoculation (very rare)
Autoinoculation of external genitalia from infected stool / urine

TYPICAL SYMPTOMS OF FEVER, WEIGHT LOSS, NIGHT SWEATS, MALAISE – <20% pts

Sterile pyuria ± Hematuria is found in 90% GUTB pts in developing countries

DIAGNOSIS

1. Gold standard – Urine AFB Culture
   - First void urine is best sample (most concentrated)
   - 3-5 samples on consecutive days for max. yield
   - Culture immediately after collection

   → when followed, sensitivity is 80-90%

   ↓ actual figures
   sporadic shed → (~10%) sensitivity ☹

   Culture Media: LJ medium 4-6 wk
   Middlebrook – 3wk
   BACTEC – 10 days

2. NAAT – detection within 1-2d

Aids detection in low bacillary load even when culture fails to isolate organisms

But, non respiratory specimens like urine contain natural inhibitors - interfering i amplification - ↓ sensitivity

Also, nucleic acids shed by dead bacilli test +ve → cannot be used to monitor Rx

- Suitable for use as an adjunct to culture - NOT REPLACEMENT

3. TISSUE BIOPSY

FNAC + TB NAAT

Caseating granulomas

4. SCREENING TESTS

Tuberculin skin test } Do not distinguish
Inf γ release assay } LATENT vs ACTIVE TB

Quantiferon
T-SPOT

5. RADIOGRAPHY

- Plain - Kidney - Calcifications (>50% of cases)

- Initially, punctate
- TB mass - globular
- Papillary necrosis - Δ^r, ring-like
- Cement / Putty Kidney - Calcific rim

Calculi take up strange shapes - d/t deformed & fibrosed pelvis

- IVU - gold std for imaging in early TB

- Calyceal erosions - moth eaten appearance
- Filling defects
- Pipestem ureter / Corkscrew ureter
- Phantom calyx
- Hiked up renal pelvis : sharp PUJ angulation - Kerr's Kink

- CT urography - calcifications, scarring, signs of obstruction
But IVU better for early TB

6. USG

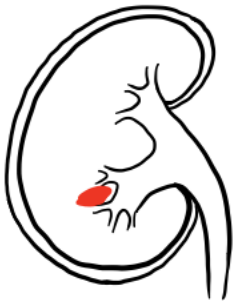
7. MRI

8. Cystoscopy, Ureteroscopy - Bladder lesions
'Golf hole' ureteric orifice

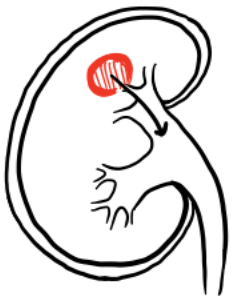
RENAL TUBERCULOSIS

- 80% GUTB occurs in Kidney
- Always SECONDARY TB
- Progressive & destructive

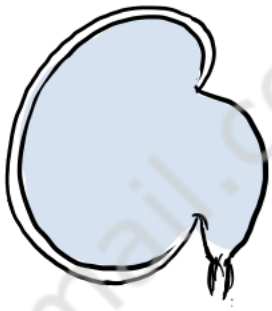
PATTERNS [Taken from Bailey & Love 26 E; Also see the image plates on pg 1359; 218]
Not there in current edition!



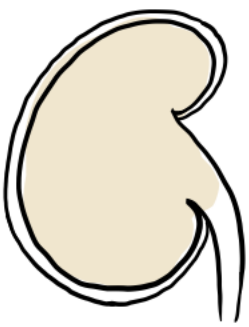
1. TUBERCULOUS PAPILLARY ULCER - coalesced tubercles on a renal pyramid ulcerate & discharge pus & bacilli into calyces
- uneven caliectasis



2. CAVERNOUS FORM
- A cavitating lesion which 'BURSTS LIKE A BOMBSHELL'



3. HYDRONEPHROSIS (RARE)
Due to TB stricture



4. PYONEPHROSIS
- secondary infection of Hydronephrosis (E. Coli) likely to supervene

5. PERINEPHRIC ABSCESS

6. PSEUDOCALCULI

7. CASEOUS KIDNEY (DIVIDED BY FIBROUS SEPTAE)

Putty Kidney → Calcifies → Cement Kidney → AMORPHOUS DYSTROPHIC CALCIFICATION

8. MILIARY TB KIDNEY

9. AUTONEPHRECTOMY (33 % of GUTB pts)

1) Caseocavernous type - viable tissue is replaced by granulomas & cavities filled i inflammatory exudate
2) Fibrotic: severe scarring / calcification → shrunken Kidney

ESRD - 7 %
Risk of SCC

URETER

- Infection via descent from kidneys
- Bacilli, Infected calculi } pass in urine along ureters → granulomas from along walls

↓

Inflammation

↓

Scarring

↓

Strictures

- (m/c in distal end at the VUJ)
- pan-ureteral → beaded / corkscrew ureter

Urinary obstruction resulting from strictures - important cause for renal failure in GUTB

EPIDIDYMIS, VAS, TESTES, SCROTUM

- Epididymis - 2nd m/c site of hematogenous GUTB after kidney
  - 10-55% GUTB cases
  - B/L in 34%

Granulomas → hardening → spread to vas

↓

classically thickened beaded spermatic cord d/t nodular scarring

Testis - Granulomas
Hydrocele (5%)

PROSTATE & SEMINAL VESICLES → TB → Infertility

Hematogenous / urinary contamination

20-50% GUTB

Peripheral lesions ; urethral sparing

urethral involvement

chronic prostatitis refractory to ABx

BLADDER

Shrunken, fibrotic bladder ∴ diminished capacity usually as a consequence of tuberculous cystitis's → **THIMBLE BLADDER**

TUBERCULOUS CYSTITIS

- usually 2° to renal TB
- Descending infection usually begins near the ureteric orifices and spreads along lymphatics to other areas
- Bacilli implant in urothelium → patchy cystitis
  - granulomas
  - ↓ coalesce
  - Ulcerations
- Dome of the bladder >>> trigone & neck

↓ chronicity, >ly

chronic inflammation
Mucosal scarring
Bladder contracture

↓

Urinary frequency, urgency
Pain & Dysuria
(when bladder capacity shrinks to <100ml)

↓

Severely contracted thimble bladder typically has CAPACITY <20ml

℞
- Augmentation cystoplasty – when bladder capacity is <100ml
  Augmentation ∴ Ileum, Caecum, Sigmoid colon, stomach
- Orthotopic bladder substitution

Management of GUTB

- ATT is mainstay
- Surgery is primarily for
  - establishing diagnosis
  - Adjunct to Abx in advanced cases

- ATT - 6m (Cat I) → duration prolonged if clinically indicated
- Corticosteroids - Healing process ↓ new fibrosis
  ↓
  worsens urinary obstruction & bladder contraction
  → Rx — use is anecdotal
  Not much evidence!

SURGICAL THERAPY

1) Procedures to relieve obstruction
   - to prevent / treat uremia & sepsis
   - Early ureteral stenting / PCN for TB ureteral strictures
     - limits loss of renal function

   Antegrade / Retrograde
   DJ stents

   If PCN is not followed by treating of the cause of obstruction, Tuberculous cutaneous fistula occurs

   - Open Surgical options - difficult - d/t fibrosis & poor vascularity
     pyeloplasty, ureteroplasty, Boari flap, psoas hitch

2) Unsalvageable Kidney -

   TOTAL NEPHRECTOMY - indications
   → Non functional Kidney
   → Recalcitrant / Recurrent TB despite optimum medical management
   → Non functional Kidney i medically resistant HTN

3) Thimble Bladder
   - Augmentation
   - Orthotopic Bladder Substitution

HEMATURIA

Presence of blood in urine

Significant : ≥3 RBC / hpf (Asymptomatic microhematuria)
→ of spun urinary sediment

Evaluation

① DEGREE
- GROSS → visible to naked eye
- MICROSCOPIC

GROSS = VH - Visible Hematuria
MICROSCOPIC = NVH - Non visible hematuria

chances of identifying significant pathology increases ↑ degree of hematuria

② TIMING (usually indicates site of origin)

INITIAL	TOTAL	TERMINAL
usually arises from urethra	- Bladder - Upper urinary tracts	Bladder neck or prostatic urethra ↓ occurs at end of micturition when bladder neck contracts to squeeze out last drop of urine

③ ASSOCIATION : PAIN

PAINFUL
- Inflammatory
  - cystitis
  - urethritis
  } irritative
- Obstruction
  - clot → ureteric colic → upper tract
    → Clot retention

PAINLESS ↓
most hematuria is painless

④ CLOTS - presence of clots = significant degree of bleeding
vermiform clots → upper tract bleed

MINIMUM INVESTIGATIONS → KUB USG, Cystoscopy

Fresh blood - lower tract bleed
Cola colored — Glomerular cause

50 %. Gross hematuria → identifiable cause

20 % Urological malignancy

12 %. bladder cancer

Mimics of Hematuria

Hemoglobinuria
Myoglobinuria
Beeturia
Menstruation - Endometriosis of urinary tract?
Drugs - Pyridium
Rifampin
Nitrofurantoin
Phenytoin

CAUSES OF HEMATURIA

Renal
1) Glomerular
   - Ig A nephropathy
   - Basement Membrane disease
   - Alport syndrome
2) Infections - Pyelonephritis
   - TB
3) Malignancy - RCC / TCC
4) Benign renal mass - Angiomyolipoma
5) PUJO
6) Renal vein thrombosis
7) AV malformation Kidney
8) Papillary necrosis - Analgesics, DM

Pelvis & Ureter
1) Malignancy - TCC
2) Stone
3) Stricture
4) Fibroepithelial polyp

Bladder
1) Malignancy
2) Cystitis
3) TB
4) Schistosomiasis
5) Radiation cystitis
6) Stone

Urethra
1) Urethritis
2) Stricture
3) Diverticulum
4) Trauma

Investigations

1) History & Physical examination
2) Urine analysis

Do not use
- first void after prolonged recumbency
- void after vigorous physical activity / intercourse
- ↓ osmolality urine (RBC lysis)

Urine dipstick - upto 1-2 RBC/hpf
False +ve in pigmenturia

Urine microscopy

Casts, dysmorphic RBCs → Glomerular/tubular hematuria

Intact red cells → Urologic cause

- WBCs ⇒ Cystitis / Infection → Culture

Urine biochemistry
> 2+ / >2-3g/d proteinuria → Glomerular casts

If UTI is believed to be cause of hematuria
→ repeat microscopy after 6 weeks of Abx

3) Urine cytology for malignant cells
↓ Urothelial cancers
↙
biomarkers - ~~NMP-22~~
Bladder tumor antigen

4) Imaging — USG - 1st line
↓
IVU / CT
↙
MR
→ Excretory phase
↓
↑ Sensitivity for collecting system lesions

5) Cystoscopy
Urethrocystoscopy → mandatory
→ only test for CIS bladder & small bladder lesions
/
Bloody efflux from ureteric orifice - helps lateralise the pathology

Allows biopsy - TURB / TURBT

Indications for Cystoscopy in hematuria

- Age >35y
- Male gender
- Smoking history
- Exposure to chemical dyes
- h/o radiation
- h/o chronic indwelling FB
- Gross hematuria
- Analgesic abuse
- Chronic irritative symptoms

Unidentified hematuria

Transient asymptomatic hematuria

↓

Annual urinalysis

↓

Gross hematuria → Repeat Full workup

ANURIA

Anuria- Complete absence of urinary output (for atleast 12 hrs)
[usually defined as Urine output of <100ml/day]

Oliguria- Urine output of <400ml/24hrs

Such urine volume is insufficient to excrete the daily osmolar load

CAUSES OF ANURIA

PRE-RENAL

- Severe systemic hypotension/shock
  [↓ intense renal vasoconstriction]
- Total renal artery or vein occlusion

℞- Fluid resuscitation

Interventional vascular procedure for renovascular disease

RENAL

- Cortical necrosis
- Acute Tubular necrosis
  - Drugs
  - Crush syndrome
  - Blood transfusion
  - Severe jaundice
- Rapidly progressive glomerulonephritis

(3) Phases (ATN)
Oliguria → Diuresis → Recovery

℞ Fluid & electrolyte management
℞ of cause

AKI - RRT
↓
Emergency Dialysis

POST-RENAL

B/L Total urinary tract obstruction
- Stone
- malignancy
- Iatrogenic
- Retroperitoneal fibrosis
- Bilharziasis
- Crystalluria

℞- Catheterise to r/o retention

USG - Dilated pelvicalyceal system
↓
- Stenting
- PCN
- Pyelostomy/Nephrostomy

℞ of cause

CYSTIC KIDNEY DISEASE

INHERITABLE

1) AR PCKD
2) AD PCKD
3) Juvenile Nephronophthisis
4) Medullary Cystic Disease

NON HERITABLE

1) Multicystic Dysplastic Kidney - cysts ↓ out identifiable (N) renal parenchyma
2) Medullary Sponge Kidney - precalyceal canalicular ectasia
3) Simple Cyst
4) Acquired renal cystic disease

MULTICYSTIC vs POLYCYSTIC

- Dysplastic Kidney resulting from aberrant renal development
- Renal units develop in a normal fashion ↓ NO DYSPLASIA
  Nephrons (+) throughout Kidney
  collecting system issues

AUTOSOMAL RECESSIVE / INFANTILE PCKD

- Relatively rapid, bilateral, symmetric enlargement of kidneys 2° to collecting duct cysts
- Seen in children - in utero, infancy, upto 20y
- a/i congenital hepatic fibrosis
- Mutations in PKHD1 on chromosome 6
  - very large kidneys ↑ Dilated collecting ducts → 20x (N)

- Hypertension
- Renal insufficiency
- Liver Disease

Rx - NO CURE
Manage hypertension, Heart failure, liver failure
Renal failure - Nephrectomy + Hemodialysis

ARPKD	ADPKD
• Chromosome 6 - PKHD1 (Fibrocystin)	• Chromosome 4 (PKD2), Chromosome 16 (PKD1)
• Perinatal, max ↓ in 20	• 4th & 5th decade
• Bl Symm Large Kidneys	• Large cystic kidneys - asymmetrical
• Collecting duct ectasia	• Microcysts + Macrocysts
• Hepatic Fibrosis	• Hepatic Cysts
• Other organs -	• Berry aneurysms, MVP, Colonic diverticula, arachnoid cysts liver, pancreatic, splenic & lung cysts

AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE

- m/c inheritable renal cystic disease
- 1 in 400-1000 live births
- Autosomal Dominant ; 100% penetrance
- 4th-5th decade presentation
- Associated ; cysts in Liver
  Pancreas
  Spleen
  Lungs
  Arachnoid
- Aneurysms in Circle of Willis
  Aorta
- MVP
- Colonic Diverticula

Pathogenesis

- PKD-1 & 2 normally generate Polycystin 1 & 2
- Abnormal gene products due to mutations

↓

Inhibition of cell proliferation ; Ciliary dysfunction → Cyst generation

The cysts originate as dilatations in the walls of intact tubules - initially filling ; fluid filtered at the glomerulus

↓

As cysts enlarge, they lose their connections ; parent nephrons

CLINICAL FEATURES

- Typically, signs / symptoms first occur b/w 30-50y

Microscopic & gross hematuria

Flank pain - mass effect, bleeding into cysts, UTI, stones
(30% ADPKD stones - Uric acid = oxalate)

Hypertension - Renin mediated, 2° to stretching of intrarenal vessels over cysts → distal ischemia

Renal insufficiency

- Extrarenal manifestations
  Cysts elsewhere
  & AH d/t Berry aneurysms
- Association ; Renal Cell Carcinoma

Evaluation

1) Family history - Atleast 3 generations

2) USG - cysts - ≥ 2 cysts - U/L or B/L

3) CT / MRI

TREATMENT

Directed towards : lessening complications
: delaying ESRD – V_2 antagonist TOLVAPTAN

→ Rx of Hypertension : ACE Is / ARBs - ACE I + ARB

→ Avoid nephrotoxic drugs : esp in Rx of colic

→ Cyst decompression - USG guided aspiration } symptomatic relief
Surgical deroofing }

→ Nephrectomy + Transplant – symptomatic pts i ESRD

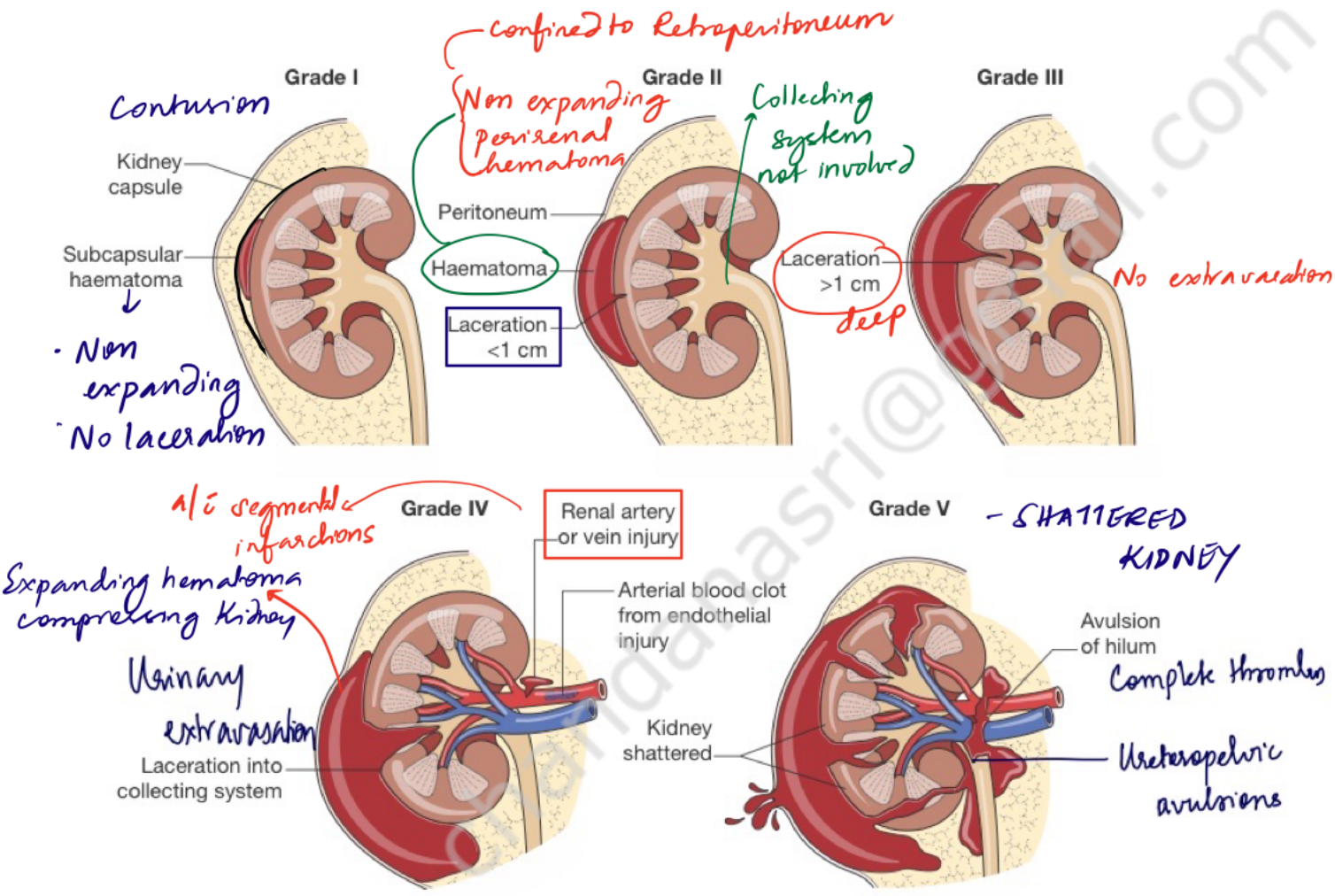
→ Management of UTIs – challenging d/t poor cyst penetration

use lipophilic antibiotics - Fluoroquinolones
TMP-SMX
chloramphenicol

→ SAH / aneurysms - manage accordingly

RENAL TRAUMA

2/t Blunt / penetrating abdominal trauma
Usually present as hematuria & shock
↓
may be absent



EVALUATION

Depends on mechanism of injury & hemodynamic stability
USG - not sensitive
CT - CECT
Standard IVP
One shot IVP - 10min after contrast
Renal angio → embolisation
MRI

Management - Any unstable pt
Gr ↓ even if stable
→ Surgery → Arrest bleed
Attempt Renal Salvage
Nephrectomy

URETER INJURY

Causes

Trauma - Hyperextension injury to the spine
Penetrating trauma

Iatrogenic → m/c
During abdominopelvic surgeries
- abdominal hysterectomy
- Colonic resections

can be minimized by preoperative ureteral stenting when ↑ risk of injury is anticipated
→ helps prevent injury
helps immediate identification of injury

B/L ligation → Anuria

Presentation

Swelling in loin/iliac fossa
↓ urine output

IVU - Extravasation of contrast

- Asymptomatic
- silent atrophy of kidney on affected side

Obstruction - HN

Urinary fistulas
- urine leaks from wound

GRADING -

I - Hematoma/Contusion ± devascularisation
II - Transection < 50%
III - ≥ 50% transection
IV - Complete transection ± <2cm devascularization
V - Avulsion ± >2cm devascularisation

Imaging - USG → HUN
Urinoma

IVP - Abrupt cutoff
Extravasation

MANAGEMENT

Recognised intra-op

- Patient is stable → Attempt to restore ureterovesical continuity
- Patient is unstable → Damage control surgery
  - Ligation of ureter & temporary percutaneous nephrostomy
  - Stent proximal ureter & exteriorize as cutaneous ureterostomy

Delayed presentation

1) Cystoscopy - attempt ureteral stenting
   - may work in cases of incomplete transection
2) Operative procedures
   a) Direct Ureteroureterostomy
      - Freshen, spatulate & anastomose over a stent
      - Must be tension free + Retroperitoneal
   b) Transureteroureterostomy
      - anastomose damaged ureter to contralateral ureter
   c) Interposition - ileal conduit to bridge the gap between severed ends
   d) Reimplantation
   e) Psoas hitch
   f) Boari flap
   g) Renal autotransplantation

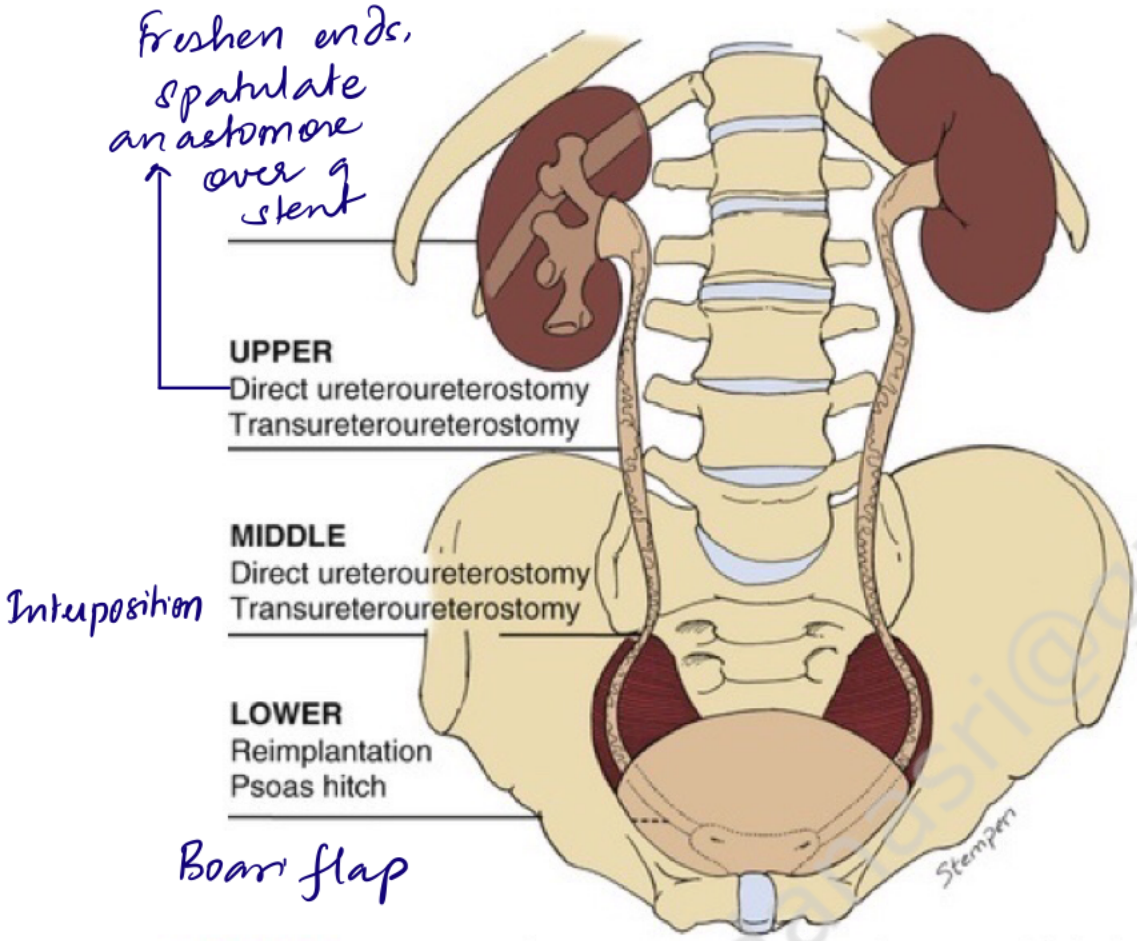
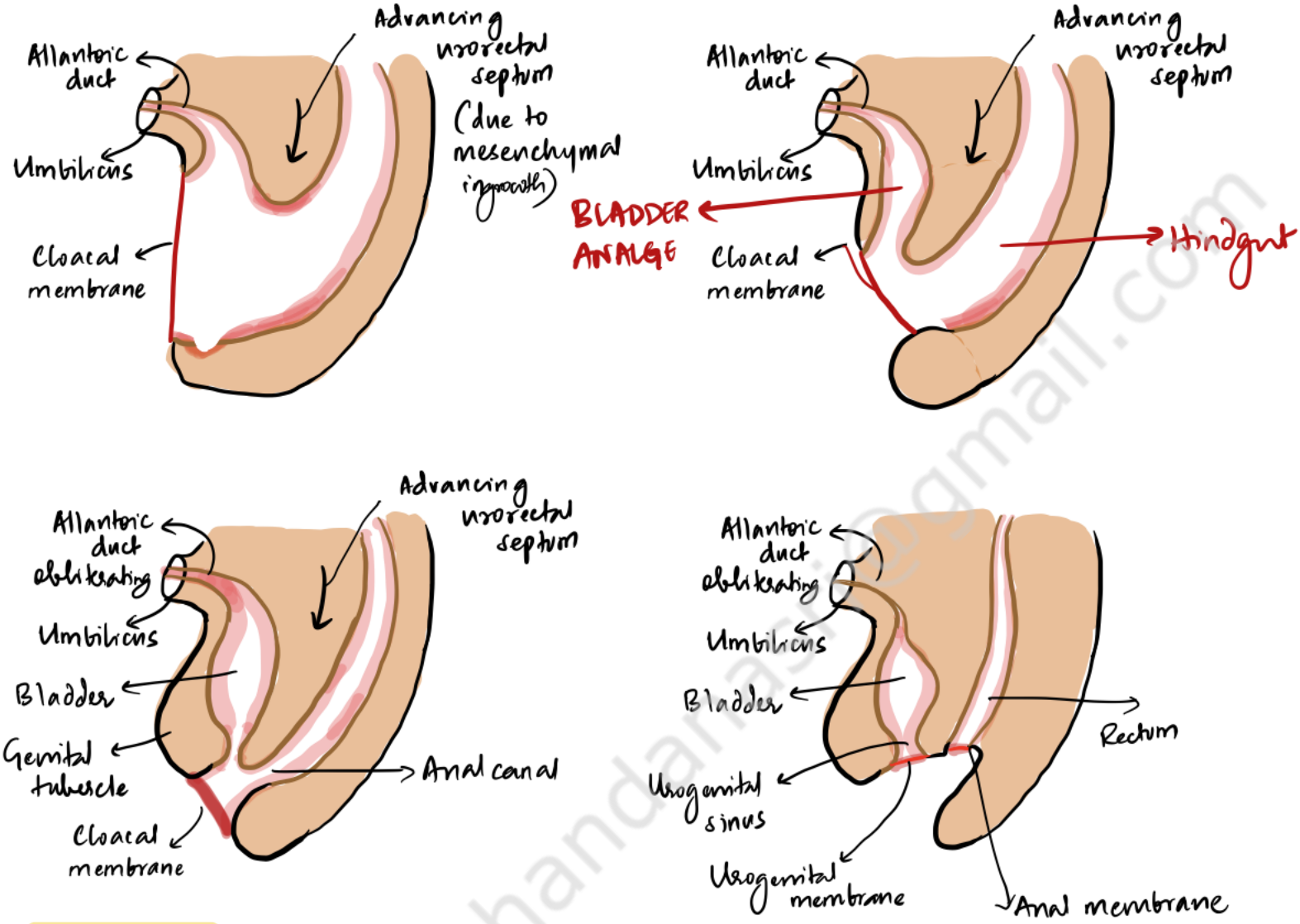


FIG. 90.17 Suggested management options for ureteral injuries at different levels.

PSOAS HITCH - bridging lower ureteral gap by hitching bladder apex to ipsilateral psoas muscle & psoas minor tendon

BOARI FLAP - fashioning a tube out of the bladder wall to bridge lower ureteral gap

Development of Bladder



EXSTROPHY

Abnormal overdevelopment of cloacal membrane during 4th wk of gestation

↓

Prevents mesenchymal tissue medial migration

↓

Prevents proper lower abdominal wall development

Bladder exstrophy (ectopia vesicae), cloacal exstrophy and epispadias are variants of the exstrophy-epispadias complex

In classical bladder exstrophy - defects in abdominal wall, bladder, genitalia, pelvis, rectum, anus

BLADDER EXSTROPHY

Abdominal Wall - The triangular defect caused by premature rupture of the abnormal cloacal membrane is occupied by the exstrophied bladder and posterior urethra

The fascial defect is limited inferiorly by intrasymphyseal band (neogenital diaphragm)

Upper end of fascial defect - umbilicus
- ↑ incidence of indirect inguinal hernias
(∵ ↓ obliquity of inguinal canal)

Anorectal Defects - Short broad perineum
Anteriorly displaced anus
(posterior limit of △ defect)
Imperforate anus
Rectal stenosis
Rectal prolapse

Male Genital Defect - Epispadias
Dorsal chordee
Shortened urethral groove

Female Genital Defect - Short vagina
Anteriorly displaced
Bifid Clitoris

Urinary Defects: Hamartomas
Neuromuscular dysfunction

Diagnosis

Prenatal - USG
- Absence of bladder filling
- Low set umbilicus
- Widening of pubic ramus
- Small genitalia
- Lower abdominal mass

Evaluation of the Newborn
- Size & quality of bladder template
- Extent of pubic diastasis
- Length & width of urethral plate
- Penile length
- Associated anomalies

Treatment

Bladder closure & reconstruction

Single procedure | **Staged reconstruction**

Components of repair:
- Primary bladder closure (± iliac osteotomy)
- Bladder neck reconstruction
- Repair of abdominal wall defect
- Penile reconstruction
  - Epispadias repair
- Ureter reimplantation

PRUNE BELLY SYNDROME

Eagle Barret S°
Triad S°
Abdominal Musculature S°

3 Major findings

1. Deficiency of abdominal musculature - (skin, s/c fat & single fibrous layer on peritoneum)
   ↓
   wrinkled like a prune
2. Bilateral Intra abdominal testis
3. Anomalous urinary tract
   - Hydronephrosis
   - Renal dysplasia
   - Dilated ureters
   - Enlarged bladder
   - Dilated prostatic urethra

Embryological bases

?. Early in-utero posterior urethral obstruction
- Primary defect in lateral plate mesoderm
  ↓ precursor of ureters, bladder, prostate, urethra, Gubernaculum
- Intrinsic defect of urinary tract
  ↳ Ureteral dilatation, Fetal ascites
- Yolk sac defect

Genitourinary Anomalies

Kidneys Dysplasia, Dilatation of Collecting System

Ureters Dilated, tortuous, redundant, Vesicoureteral reflux (75%)

Bladder - massively dilated, pseudodiverticulum at urachus, Wide bladder neck opening into dilated prostatic urethra

Prostate – Hypoplasia

B/L Intraabdominal testis overlying iliac vessels

Epididymis - poorly attached to testis (like in abdominal undescended testes)

Retrograde ejaculation d/t incompetent bladder neck

Urethral atresia
Patent urachus

Spectrum of Prune-Belly Syndrome

CATEGORY	CHARACTERISTICS
I	Renal dysplasia
	Oligohydramnios
	Pulmonary hypoplasia
	Potter features
	Urethral atresia
II	Full triad features
	Minimal or unilateral renal dysplasia
	No pulmonary hypoplasia
	May progress to renal failure
III	Incomplete or mild triad features
	Mild to moderate uropathy
	No renal dysplasia
	Stable renal function
	No pulmonary hypoplasia

Complete severe

Moderate

Mild

Initial Management

- Assess for associated anomalies
- Renal & Bladder USG
- Circumcision
- SPC in BOO

Surgical Reconstruction

- Upper urinary tract reconstruction
  - Ureteroplasty
  - Ureterocystoneostomy (VUR)
  - Pyeloplasty
- Lower urinary tract reconstruction
  - Reduction cystoplasty
  - Internal urethrotomy
  - Anterior urethral dilatation / reconstruction
  - Circumcision
- Orchidopexy - Transabdominal bilateral orchidopexy at 6 months of age
  - or
  - Fowler Stephen / Microvascular autotransplantation
  - Lap orchidopexy
- Abdominal wall reconstruction
  - for cosmesis
    - improved bladder emptying
    - effective cough
    - Improved defecation

BLADDER NEUROLOGY

Bladder Innervation

AUTONOMIC

PARASYMPATHETIC
- $S_{2,3,4}$
- Cholinergic
- Supply
  - Detrusor
  - Sphincter
- Stimulation causes
  Detrusor contraction
  Sphincter relaxation
  VOIDING

SYMPATHETIC
- $T_{10}, T_{11}, L_1, L_2, L_3$
- Noradrenergic
- Supply
  - Smooth muscle of bladder base
  - Internal sphincter
  - Proximal urethra

CONTINENCE

FILLING

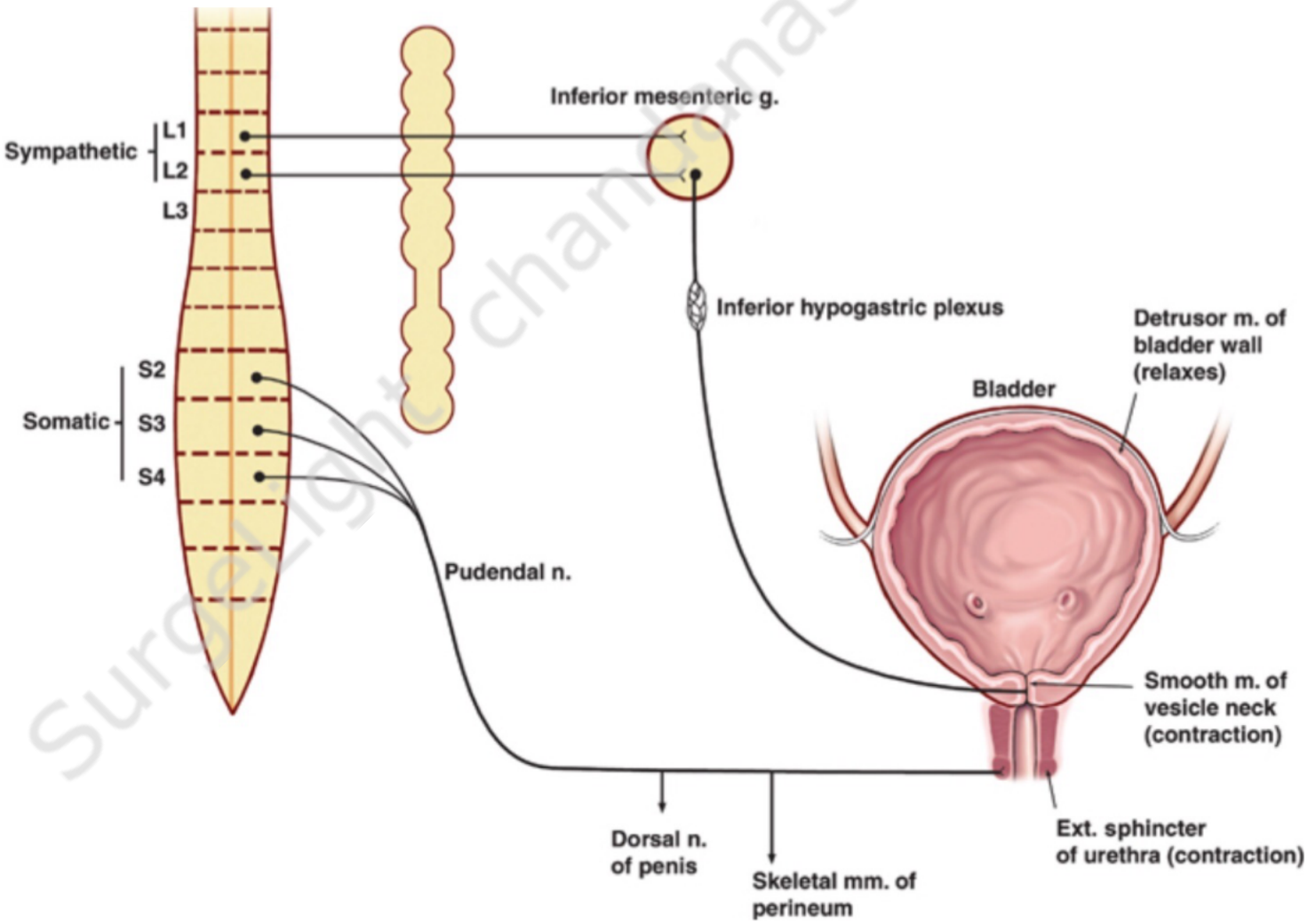
SOMATIC

Sensory afferents - Sensation of bladder fullness / distension

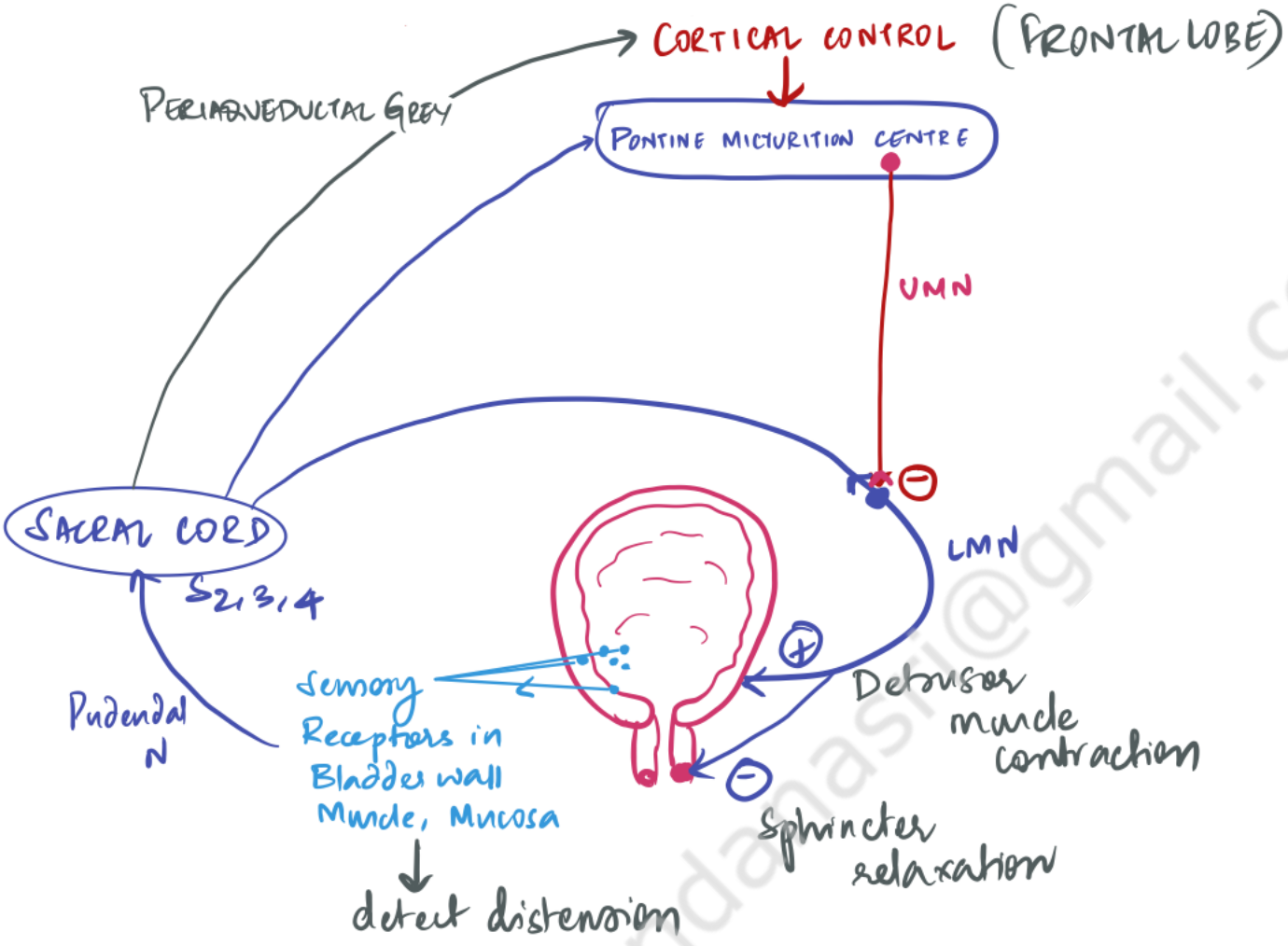
via inf hypogastric plexus to S_2, S_3, S_4

Motor efferents - External urethral sphincter

BLADDER INNERVATION



MICTURITION REFLEX



Voluntary control of micturition

(Cortical)

→ When micturition is desired — PMC inhibition is released

- Detrusor contraction ← Parasympathetic (+)
- Sphincter relaxation ← Sympathetic (−)

External sphincter (−)
Abdominal muscles contract

NEUROGENIC BLADDER

Bladder dysfunction secondary to a neurological cause affecting STORAGE / VOIDING / BOTH

Lapides classification - patient need not necessarily fit one category

- Sensory neurogenic bladder
- Motor paralytic / Motor neurogenic bladder
- Uninhibited neurogenic bladder
- Reflex neurogenic bladder
- Autonomous neurogenic bladder

} Atonic → Overdistension → chronic / Repeated → Flaccid, Large capacity bladder

① SENSORY NEUROGENIC BLADDER

- results from disease that selectively interrupts
  - sensory fibres between bladder & spinal cord
  - OR
  - afferent (ascending) tracts to the brain

eg: Diabetes mellitus
Tabes dorsalis
Pernicious anemia
Herpes zoster

- impaired sensation of bladder distension ⊕
- unless voiding is initiated on a timed basis, there will be varying degrees of bladder overdistension ± hypotonicity
  ↓
  decompensation → significant PVR

CYSTOMETRY - Large capacity bladder
Flat - High compliance
Low-pressure filling curve

② MOTOR NEUROGENIC BLADDER

- results from disease processes that destroy parasympathetic motor innervation of bladder

eg: Extensive pelvic surgery
trauma

Early symptoms - painful urinary retention
relative inability to initiate & maintain Ⓝ micturition

CYSTOMETRY - Easily filling Ⓝ, No voluntary bladder contraction
Chronic overdistension & decompensation - Large capacity bladder, low pressure filling curve, ↑ residual urine

③ UNINHIBITED NEUROGENIC BLADDER

- results from injury / disease of CORTICOREGULATORY TRACT.

(Sacral spinal cord is the micturition reflex centre.
Corticoregulatory tract normally exerts an inhibitory effect on micturition reflex)

Corticoregulatory tract → INJURY → Overfacilitated micturition reflex

Causes: eg: CVA
Brain / Spinal cord tumor
Parkinson's Disease
Demyelinating Disease

Voiding dysfunction - Frequency
Urgency
Urge incontinence

URODYNAMICS - (N) sensation
- Involuntary contraction at low filling volumes

RESIDUAL URINE CHARACTERISTICALLY LOW
(unless there is associated outlet obstruction < anatomical / functional)

Pt can initiate a bladder contraction voluntarily but sufficient urine storage is not allowed to occur before in contraction is stimulated

④ REFLEX NEUROGENIC BLADDER

results from COMPLETE INTERRUPTION of sensory & motor pathways between SACRAL SPINAL CORD & BRAINSTEM

- POST SPINAL SHOCK CONDITION
eg: Traumatic spinal cord injury
Transverse Myelitis
Extensive demyelination of suprasacral spinal cord

No bladder sensation
No ability to initiate voluntary bladder contraction

(COMPLETE UPPER MOTOR NEURON LESION)
Bors Comarr System

Bladder basically empties 'Reflexively' (Micturition Reflex)

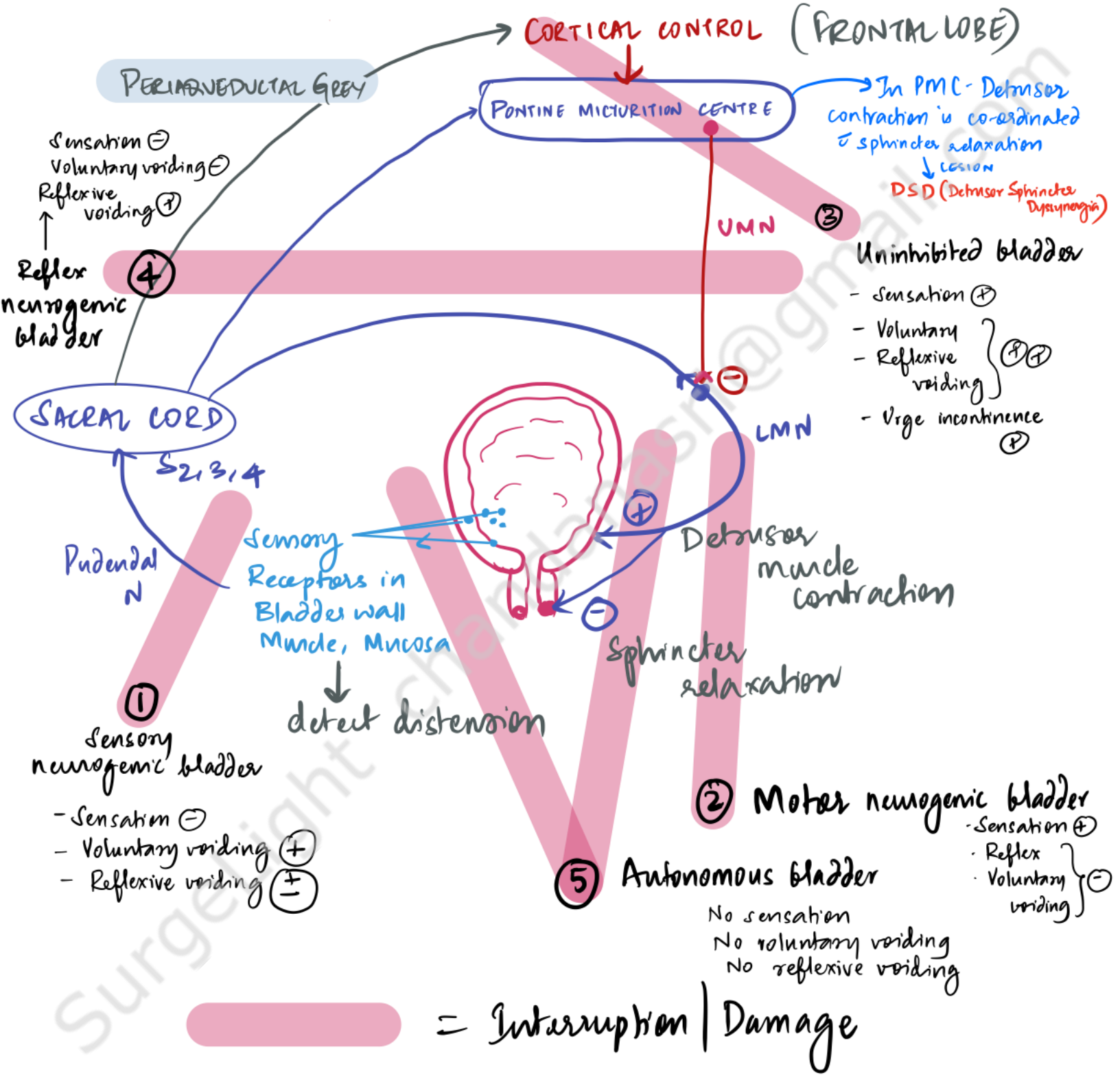
⑤ AUTONOMOUS NEUROGENIC BLADDER

Complete motor & sensory separation of bladder from sacral spinal cord due to diseases that destroy sacral cord / sacral roots / pelvic nerves

No ability to initiate micturition
No bladder sensation
No bladder reflex activity

[COMPLETE LMN lesion]
Bors-Comarr

LOCATION OF LESIONS



Evaluation of Neurogenic Bladder

1) Neurological evaluation - sensory, motor, reflex

2) Laboratory

Urinalysis
Urine C & S
RFT

3) Imaging

- Post void residue
  - → to determine if there is a significant voiding disorder
  - to determine interval of CIC
- Assesment of renal function (differential)

4) **Urodynamic studies** → most objective way of determining type

Uroflowmetry

Cystometrogram
Electromyogram

(N) Bladder capacity - 300-600 ml

- BLADDER IS FILLED
  - Volume
  - Compliance
  - Sensation
  - Presence of uninhibited bladder activity

  } Assessed

- Bladder pressures monitored during filling & emptying
- LPP - Leak point pressure - max detrusor pressure before urine leaks
- Simultaneous sphincter electromyography to detect DSD (Detrusor Sphincter Dyssynergia)

MANAGEMENT

① Nonpharmacological

- Bladder retraining & fluid schedule

Aims 1) To achieve / maintain continence
2) Prevent development of high pressure detrusor that can lead to upper tract damage
3) Minimize UTI
4) Prevent overdistension (which eventually leads to poor compliance)

- Fluid schedule allows predictable bladder filling
- ~1800cc/d total - Q6h CIC - 400ml drained/setting

Indwelling catheter - fluid intake can be generous

Manual evacuation practices

① Crede technique - manual pressure over suprapubic region to ↑ Vesical Pressure
② Tapping over suprapubic area to cause reflex contraction
③ Valsalva - ↑ IAP → ↑ IVP

② Pharmacological

→ TCAs - to reduce detrusor tone (anti M_3) in hyperactive bladder (uninhibited/ reflexive)
(α adrenergic) to ↑ sphincter tone
Eg: IMIPRAMINE

→ Anticholinergics
OXYBUTYNIN
TOLTERODINE
SOLIFENACIN
DARIFENACIN
TROSPIUM

→ CHOLINERGIC AGONISTS - Urecholine
in LMN bladder - to promote detrusor contraction

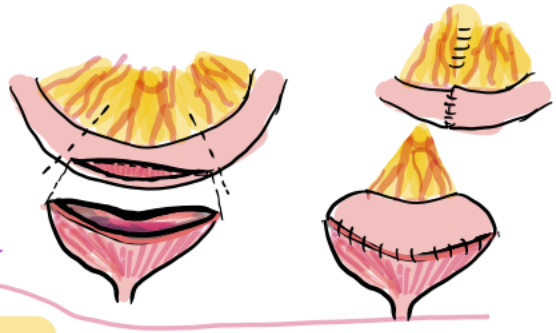
→ α_2 adrenergic agonists - CLONIDINE TIZANIDINE
↳ Presynaptic inhibition of Norepinephrine → Sphincter relaxation

→ α_1 adrenergic antagonists - Tamsulosin, Doxazosin, Silodosin
↳ Post synaptic blockade of NE activity → Sphincter relaxation

→ Benzodiazepines
→ GABA-B Agonists - Baclofen
} → Spinal & Supraspinal action to ↓ Sphincter tone

→ Botulinum Toxin → Detrusor injection → to treat detrusor overactivity

(3) SURGICAL INTERVENTIONS



(A) Procedures to enhance Bladder Storage

- Neuromodulation for Detrusor overactivity
- Bladder augmentation - Clam enterocystoplasty

(B) PROCEDURES TO CONTROL BLADDER EMPTYING

- Urinary Diversion
  - in pts ↑ PVRV who cannot perform CIC of urethra
  - Do a continent abdominal stoma that permits CIC
    - APPENDICOVESICOSTOMY
- Sphincterotomy
- Urethral stents / Balloon dilatation

(C) TO RESTRICT EMPTYING

Artificial sphincter
Sling procedures

URINARY INCONTINENCE

Definition - Symptomatic complaint of involuntary loss of urine

Physiology of Urinary Continence

- Complex interplay of neural and structural mechanisms

- Neural - Parasympathetic suppression
  Sympathetic activation
  } Promotes detrusor relaxation

  - creation of a low pressure reservoir maintained during the entirety of FILLING PHASE

- Anatomic -
  - Intraperitoneal position of bladder dome permits expansion
  - Multilayered mucosa — expansion ↓ filling
    collapse ↓ emptying

- Urethral continence mechanisms

MEN -

→ Internal sphincter

α - adrenergic activation of bladder neck & prostatic smooth muscle

→ External sphincter
- Rhabdosphincter
- Levator muscular elements

→ Anterior fixation by pubourethral ligaments

→ Posteriorly - perineal body

WOMEN

→ External sphincter - circular striated muscle in mid urethra - Pudendal nerve
longitudinal striated muscle - vagina & perineal membrane

→ Urethra - Adherent mucosa ; spongy submucosa favors apposition

→ Pelvic support

TYPES

1. **STRESS INCONTINENCE** - involuntary loss of urine i physical exertion or other activities that cause a rise in intra-abdominal pressure

INVOLUNTARY LEAKAGE OF URINE ON VALSALVA / COUGH

Urodynamic stress incontince = involuntary urine leakage during filling cystometry due to ↑ IAP in the absence of detrusor contraction

In women, SUI - occurs d/t LOSS OF URETHRAL SUPPORT
INTRINSIC SPHINCTERIC DEFICIENCY

CAUSES
Weak sphincter
Vesicourethral fistula / Ectopic ureter
Epispadias

2. **URGE INCONTINENCE** - involuntary urine loss a/i urgency

urodynamically - leakage associated with sudden urgency during bladder filling

3. MIXED UI - Stress + Urge

4. POSTURAL UI

5. NOCTURNAL ENURESIS

6. CONTINUOUS UI

7. INSENSIBLE UI

- OVERACTIVE BLADDER SYNDROME - Urinary urgency, usually a/c frequency & nocturia
  - ↓ SYNDROME BASED ON 'CLINICAL SYMPTOMS'
  - i/i out UUI in the absence of UTI / other obvious pathology
- DETRUSOR OVERACTIVITY - Urodynamic observation
  - → Involuntary detrusor contractions during filling phase
  - spontaneous / provoked
- BLADDER PAIN SYNDROME - c/o suprapubic pain related to bladder filling
- Overflow Incontinence - d/t chronic / Neglected Retention

Risk factors for UI

♀

1) Advancing age
2) Pregnancy & Postpartum
3) Vaginal delivery, High BW, Forceps/ Vacuum, prolonged labour
4) Multiparity
5) Race: Caucasian > Af-Am, Asian
6) Hormonal therapy - Estrogen (Oral)
7) Obesity
8) Smoking
9) Diet - Caffiene, Carbonated bev, artificial sweeteners
10) Comorbidities - Diabetes, Depression

♂

1) UUI >> SUI in men
2) SUI in men
   h/o pelvic surgery
   - Radical Prostatectomy
3) Advancing age

Pelvic Organ Prolapse & Incontinence

- > 40% ♀ c SUI
  20% ♀ c OAB
  } Anterior vaginal wall prolapse
- Occult SUI - only observed after reduction of prolapse
  → has to be addressed during prolapse surgery

Evaluation

- URODYNAMIC STUDIES - to diff between
  - Overactive Bladder / Detrusor overactivity
  - Genuine stress incontinence
  - Chronic Urinary Retention - overflow incontinence
  - Bladder Outflow Obstruction
  - Neurogenic bladder

  → Cystometry
  Flowmetry

MANAGEMENT

- Conservative – Lifestyle changes
  - Pelvic floor exercises
  - Biofeedback
  - Bladder training
  - Incontinence devices
  - Indwelling catheters
  - CIC

- Pharmacotherapy
  (Ref. section on Neurogenic bladder)

  Duloxetine for GSI

- Surgeries

  GSI – Transvaginal tape
  Open Colposuspension

  Storage disorders
  - Bladder augmentation – Enterocystoplasty
  - Urinary diversions (for end stage incontinence)

STUFF TO READ

1) Bailey & Love 27E – Bladder chapter – Decent description of Urinary incontinence

NOTE: Study Neurogenic bladder & Continence together – Complementary mechanisms & management

2) Definitions in Campbell-Walsh 12E – No nonsense approach

BLADDER CALCULI

PRIMARY

- Forms in **sterile urine**
- Usually originates in the KIDNEY
  - Historically a/i nutritional deficiency
  - ↓ reaches the bladder & enlarges

Calcium Oxalate stones
- Rough, spiculated
- Brownish-greyish
- Though Ca Oxalate is white, stones are colored d/t pigment incorporation

Uric Acid stones
- Smooth stones

Cystiene stones
- Hard, radio-opaque stones d/t ↑ Sulphur content

SECONDARY

- Forms in **infected urine**
- Originates in the BLADDER d/t stasis (Neurogenic Bladder / Diverticulae)
- Infection by urease-splitting organisms (Proteus-mirabilis)

↓

STRUVITE STONES

(Magnesium, Ammonium, Calcium Phosphat

Dirty white color

m/c presenting symptom - Terminal hematuria
LUTS

Causes for 2° bladder stones
- Foreign bodies
- Significant PVRV - BOO - stricture, BPH, neurogenic bladder
  urinary diversions

Rx -

Cystolithotapaxy : mechanical breakage of stone
Cystolithotripsy - fragmenting stone i energy source
Cystolithotomy - intact removal of stone

} transurethral or suprapubic or Open surgery

BLADDER OUTLET OBSTRUCTION

Urodynamic Concept ← BOO

- low flow rate ⊕
- high voiding pressures

∵ Symptoms are non-specific

Causes

1) BPH
2) Bladder neck stenosis
3) Bladder neck hypertrophy
4) Prostate cancer
5) Urethral strictures
6) Functional obstruction d/t neuropathic conditions

- **Flow rate** (for voided volumes of ~200ml)
  - >15 ml/s (N)
  - 10-15 ml/s - equivocal
  - <10 ml/s - Low

- **Voiding Pressure**
  - <60 cm H_2O (N)
  - 60-80 cm H_2O equivocal
  - >80 cm H_2O → high

Consequences

- Bladder decompensation - Detrusor contraction becomes progressively less efficient
  - RESIDUAL URINE
- Detrusor overactivity - ↓ functional capacity of bladder (Impaired filling)

Complications

1) Acute Urinary Retention
2) Chronic Retention
   (Overflow incontinence / enuresis) + (Upper tract damage)
3) Infections, Calculi, hematuria

NOTE: Bailey & Love 27 Ed (Prostate chapter) - BEST!

THIMBLE BLADDER

Shrunken, fibrotic bladder ∴ diminished capacity usually as a consequence of tuberculous cystitis

TUBERCULOUS CYSTITIS

- usually 2° to renal TB
- Descending infection usually begins near the ureteric orifices and spreads along lymphatics to other areas
- Bacilli implant in urothelium → patchy cystitis
  ↓
  granulomas
  ↓ coalesce
  Ulcerations
- Dome of the bladder >>> trigone & neck
  ↓ chronicity, >ly
  chronic inflammation
  Mucosal scarring
  Bladder contracture
  ↓
  Urinary frequency, urgency
  Pain & Dysuria
  (when bladder capacity shrinks to <100ml)
  ↓
  Severely contracted thimble bladder typically has CAPACITY <20ml

℞
- Augmentation cystoplasty – when bladder capacity is <100ml
  Augmentation ∴ Ileum, Caecum, Sigmoid colon, stomach
- Orthotopic bladder substitution

VESICO URETERIC REFLUX

Definition - Retrograde flow of urine from the bladder to the upper urinary tract

- Risk of upper tract scarring

Epidemiology

1) M : F — 3 : 1 (0–6 m)
   — 1 : 1 (21–24 m)

2) More common in younger children

   The younger a child c UTI, greater the likelihood of discovering reflux

3) Prevalence higher in siblings
   - Multigenetic

Embryological Basis

- Position & integrity of Ureterovesical junction influences risk of VUR
- The metanephric duct [primitive ureter] is generally drawn into the Urogenital sinus
- If the ureteric bud is drawn in too soon, over rotation draws it high and lateral in the bladder wall

↓

Inadequate incorporation

↓

Insufficient intramural length in the bladder wall

↓

Reflux

Antireflux mechanisms

1) Ureter has active antegrade peristaltic activity
2) Anatomic design of VUJ - intramural ureter remains passively compressed by bladder wall during bladder filling preventing the entry of urine into ureter

Etiology

Primary

Fundamental deficiency in the VUJ antireflux mechanism

Remaining factors (Bladder, ureter) — non contributory

- Inadequate intramural ureter length

↓

Rx - Non-refluxing ureteral reimplantation
- Long tunnel >5cm
- Reduction of ureteral diameter - tapering plication

(5:1 - Length : diameter)

Secondary

Due to overwhelmed (N) antireflux mechanism of VUJ due to sustained/repeated ↑ in intravesical pressure / Bladder dysfunction

May also have anatomically abnormal VUJ

- Raised bladder pressure

→ Mechanical blockage
PUVs, strictures, mass

→ Functional obstruction
Neurogenic - BSD
Non neurogenic

Rx - Early initiating of
- Clean Intermittent Catheterization
- Anticholinergics
- Close follow-up
- Rx of cause

Complications: Though reflux per-se is not a general cause of UTI, it facilitates PYELONEPHRITIS

Reflux associated renal scarring, dysplasia

GRADING OF VUR

1 - Into non-dilated ureter
2 - Into non-dilated ureter, pelvis & calyces
3 - Mild dilation of ureter, pelvis, calyces ± mild blunting
4 - Moderate ureteral tortuosity, dilated pelvis, calyces
5 - Gross dilation & tortuosity + Loss of papillary impressions

Diagnosis & Evaluation

- Micturating / Voiding Cystourethrogram (MCU/VCUG)
- Nuclear cystograms
- Upper tract assessment – IVP, USG, MAG3
- Urine C&S

Associated Anomalies

1) PUJO
2) Ureteral duplication / Ectopic ureter
3) Bladder diverticula
4) Renal anomalies
5) Megaureter

Pregnancy may be associated ↑VUR

Management

- low grade (I & II) - most cases spontaneously resolve
  Grade III - resolves ~ 50%.
- Management involves preservation of renal function
  ← prevention of UTI
  prevention of Renal scarring
  sterile reflux is unlikely to cause significant renal damage
  ↓
  Basis for antibiotic prophylaxis in VUS
- Sx - Ureteral Reimplantation (1°), Rx of cause (2°)
  i/c

BLADDER INJURIES

Etiology

- Trauma - Decelerating RTAs
  Falls
  Crush injuries
  Assault - Blows to lower abdomen
  m/c a/i Pelvic fracture (85-95%)
- Iatrogenic - during pelvic - Ob/Gyn surgeries

TYPES

EXTRAPERITONEAL

- most commonly associated with pelvic fractures and posterior urethral injuries

INTRAPERITONEAL

- Penetrating / Blunt injuries at the dome of the bladder by direct blow to a FULL BLADDER

CLINICAL FEATURES

- GROSS HEMATURIA
- Suprapubic pain, tenderness
- Free peritoneal fluid on imaging, Abdominal distension / Ileus
- Inability to void / ↓ urine output
- Clots in urine
- Enlarged scrotum & ecchymosis (extravasation)

INVESTIGATIONS - Routine imaging

- Retrograde Cystography

Dense, flame shaped collection of contrast media in pelvis = EXTRAPERITONEAL RUPTURE

Contrast material outlines loops of bowel = INTRAPERITONEAL RUPTURE

Rx - Extraperitoneal bladder injury - in the absence of other complications - stable pt

↓

CONSERVATIVE MANAGEMENT & Catheter drainage

↓

Remove catheter after Cystography - 1 & 2

OPERATE IF
Open Pelvic #
Bladder neck injury
Genital / Rectal injury

- Intraperitoneal injuries - always operate

ACUTE URINARY RETENTION

- Sudden painful inability to void urine voluntarily

Spontaneous AUR → consequence of natural history of progressive BPH

Risk factors:
- Older age
- Severe LUTS
- ↑ PVRV
- Large Prostate volume
- ↑ PSA

Precipitated AUR
- Surgical procedures ō general or locoregional anaesthesia
- UTI
- Bladder overdistension
- Anticholinergics
- Sympathomimetics

DYNAMIC COMPONENT - ↑ sympathone - Bladder neck hypertonia → AUR

Management

Initial management - immediate bladder decompression by catheterisation

α_1 blockers + 5α reductase inhibitors → TWOC → Failure → Surgery

- Large volume drained at cath
- Severe LUTS
- Advanced age

Bladder Cancer

Epidemiology

1) Male > Female - 3:1

2) Although disease is more common in males, females are more likely to be diagnosed ī advanced disease

3) Risk factors

- Smoking -30-40% → Tobacco smoke is full of aromatic amines
- Aromatic amines - Aniline dye
  2-naphthylamine
  4-aminobiphenyl } → hydroxylation → DNA adduction & damage
  Benzidine
- Genetics
  - NAT-2 - N-acetyl transferase-2
    GSTM-1 Glutathione S-Transferase M-1
    → Important role in metabolism of aromatic amines
- Lynch Syndrome
  - ↑ risk of urothelial cancer
    MSH_2
- BMI - ↑ BMI - ↑ risk
- Occupation - Tobacco workers
  Dye workers
  Chimney sweeps
- Medical Conditions - Neurogenic Bladder
  Indwelling catheters
  Bladder calculi
  Recurrent UTIs
  Congenital Bladder anomalies
- Schistosomiasis
- ? Pioglitazone
- Radiotherapy
- Chemotherapy - Cyclophosphamide
- Environmental - Arsenic

PRESENTATION

- Painless gross hematuria - 85% of new diagnosed bladder cancer
- Microscopic hematuria - 100%
- Irritative voiding symptoms - "Malignant Cystitis"
  - mc CIS

DETECTION

- CYSTOSCOPY - Gold std
  - Indications
    - All adults i gross hematuria
      - ≥35y i AMH
  - White light Cystoscopy
    - HAL - Hexaminolevulinate - Blue light
    - Narrow band imaging
- URINE CYTOLOGY
  - Doubtful sensitivity
  - High specificity
  - → Urine based biomarkers
    - NMP-22 , Immunocyt (CEA)
  - → FISH - UroVysion
    - ↓
    - Aneuploidy of Chr 3, 7, 17 in urothelial cells
- BLADDER TUMOR ANTIGEN
  - Assay for Basement membrane antigens
    - Human complement factor H related protein
    - Complement factor H
- Cx Bladder - cell based urine assay

BENIGN BLADDER TUMORS

1) Epithelial Metaplasia of urothelium
   - ↓
   - Trigone
     - Squamous
     - Glandular
2) Papilloma & Inverted Papilloma
3) Nephrogenic adenoma
4) Leukoplakia
5) Cystitis Cystica & Cystica Glandularis

Precursor Malignant Lesions

- Urothelial hyperplasia
  - Flat
  - Papillary
- Reactive atypia
- AUS
- Urothelial dysplasia
- Low-grade intraurothelial neoplasia

STAGING

Back

Urinary Bladder: Urothelial Carcinomas

T Stage - Clinical / Pathological

cTX
Primary tumor cannot be assessed

cT0
No evidence of primary tumor

cTa
Non-invasive papillary carcinoma

cTis
Urothelial carcinoma in situ: "flat tumor"

cT1
Tumor invades lamina propria (subepithelial connective tissue)
- 1a - superficial
- 1b - deep

cT2
Tumor invades muscularis propria
- pT2a – microscopic
- pT2b – macroscopic

cT3
Tumor invades perivesical soft tissue
- pT3a – microscopic
- pT3b – macroscopic

cT4
Extravesical tumor directly invades any of the following: prostatic stroma, seminal vesicles, uterus, vagina, pelvic wall, abdominal wall

cT4a
Extravesical tumor invades directly into prostatic stroma, seminal vesicles, uterus, vagina

cT4b
Extravesical tumor invades pelvic wall, abdominal wall

→ Non muscle invasive
→ Muscle Invasive
→ Disease Beyond bladder
→ Invading adj structures

N Stage - Clinical

cNX
Lymph nodes cannot be assessed

cN0
No lymph node metastasis

cN1
Single regional lymph node metastasis in the true pelvis (perivesical, obturator, internal and external iliac, or sacral lymph node)

cN2
Multiple regional lymph node metastasis in the true pelvis (perivesical, obturator, internal and external iliac, or sacral lymph node metastasis)

cN3
Lymph node metastasis to the common iliac lymph nodes

M0
No distant metastasis

M1
Distant metastasis

M1a
Distant metastasis limited to lymph nodes beyond the common iliac

M1b
Non-lymph node distant metastasis

Oa → Ta N0 M0
Ois → Tis N0 M0
I → T1 N0 M0
II → T2 N0 M0
III
- IIIa – T3 N0 M0 , T1,2,3,4a N1 M0
- IIIb – T1,2,3,4a N2,3 M0

IV
- IVA — T4b N0 M0 , Any T/N, M1a
- IVB — Any T, Any N, M1b

Non Muscle Invasive Bladder Cancer

Low risk	Intermediate risk	High risk
Low grade papillary (Ta) <3cm	Multiple / recurrent >3cm Low grade Ta	High grade CIS, Ta of any size

---

- 90 % cases of Ca bladder have prostatic urethral cancer

Histological variants of Urothelial Carcinoma

1) Micropapillary variant
2) Sarcomatoid variant
3) Plasmacytoid variant
4) Nested variant
5) Urothelial carcinoma + divergent differentiation

Non Urothelial Bladder Malignancies

1) Small cell - poorly differentiated neuro-endocrine
2) Squamous cell - schistosoma
   chronic cath
3) Adenocarcinoma - Bladder exstrophy
   Secondaries
   Urachus

MANAGEMENT OF NON-MUSCLE INVASIVE CA BLADDER (Ta, Tis, T1)

- Urothelial malignancies which have not invaded detrusor

At presentation - 70-80% NMIBC

- Ta 60-70%
- 10% CIS
- 20-30% T_1

Risk of progression:
- Ta G3 — 15-40%
- T_1 G3 — 30-50%
- CIS — >50%

ENDOSCOPIC MANAGEMENT

- TURBT is the initial treatment for visible lesions
  - → Avoid overdistension
    - → Detrusor thinning
      - → Perforation
        - → Intraperitoneal → Lap/open repair
        - → Extraperitoneal → leave cath in situ x 2 wks

- Complete Resection ± 2cm margin
- Shave bare to look for bladder invasion

Diverticular:
- low grade - resection
- high grade - partial / Radical cystectomy

↓

Repeat TURBT after 2-6 wks
in pts ± high grade disease
± no obvious muscle invasion on first TURBT

- INTRAVESICAL Rx
  - to prevent early recurrences
    (d/t tumor cell implantation immediately after TURBT)

Mitomycin-C, Epirubicin } single dose within 6hrs → Induction therapy

IMMUNOTHERAPY
- i BCG - robust local immune response
  - 2-4 weeks after TURBT
  - 50ml - retained in Bladder x 2hrs
- Interferons

Refractory high grade Disease
- Repeat BCG
- Photodynamic therapy
  - Cystectomy

Muscle Invasive ← Restricted to dome, adenoCa → Partial cystectomy

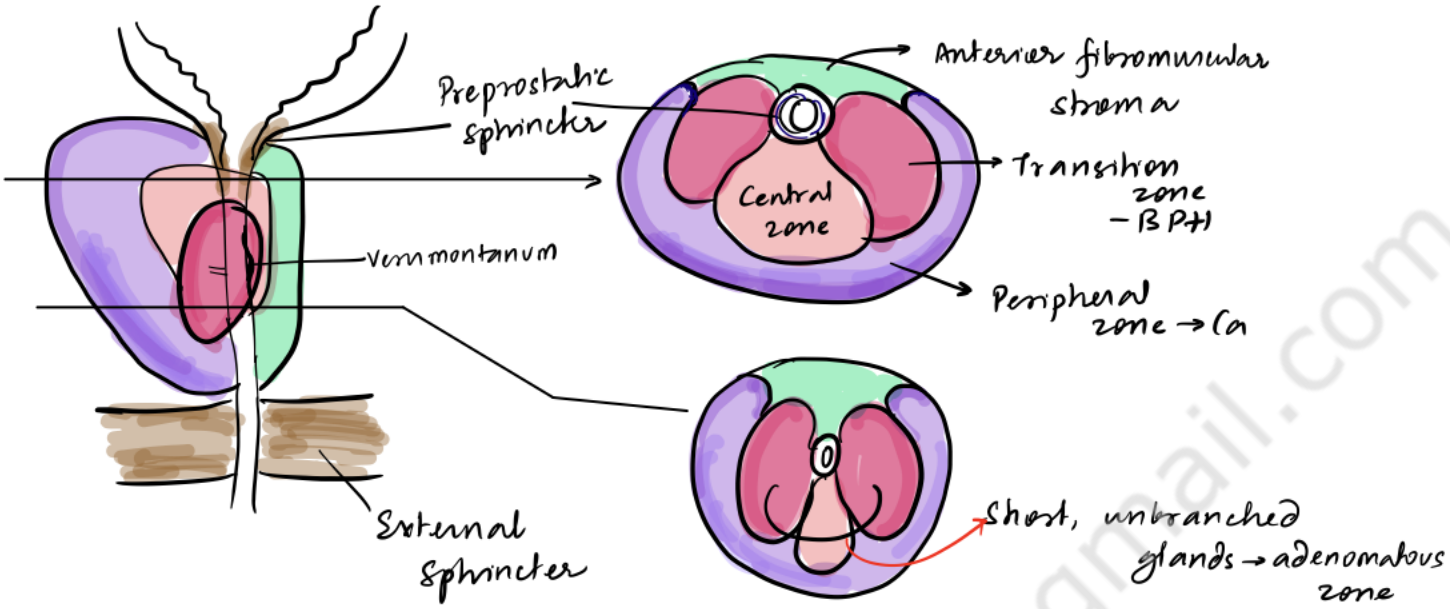
Gold
Radical Cystectomy ± BPLND

Urethra spared
Orthotopic neobladder

Ileal conduit

BENIGN PROSTATIC HYPERPLASIA

ANATOMY - McNeal zones

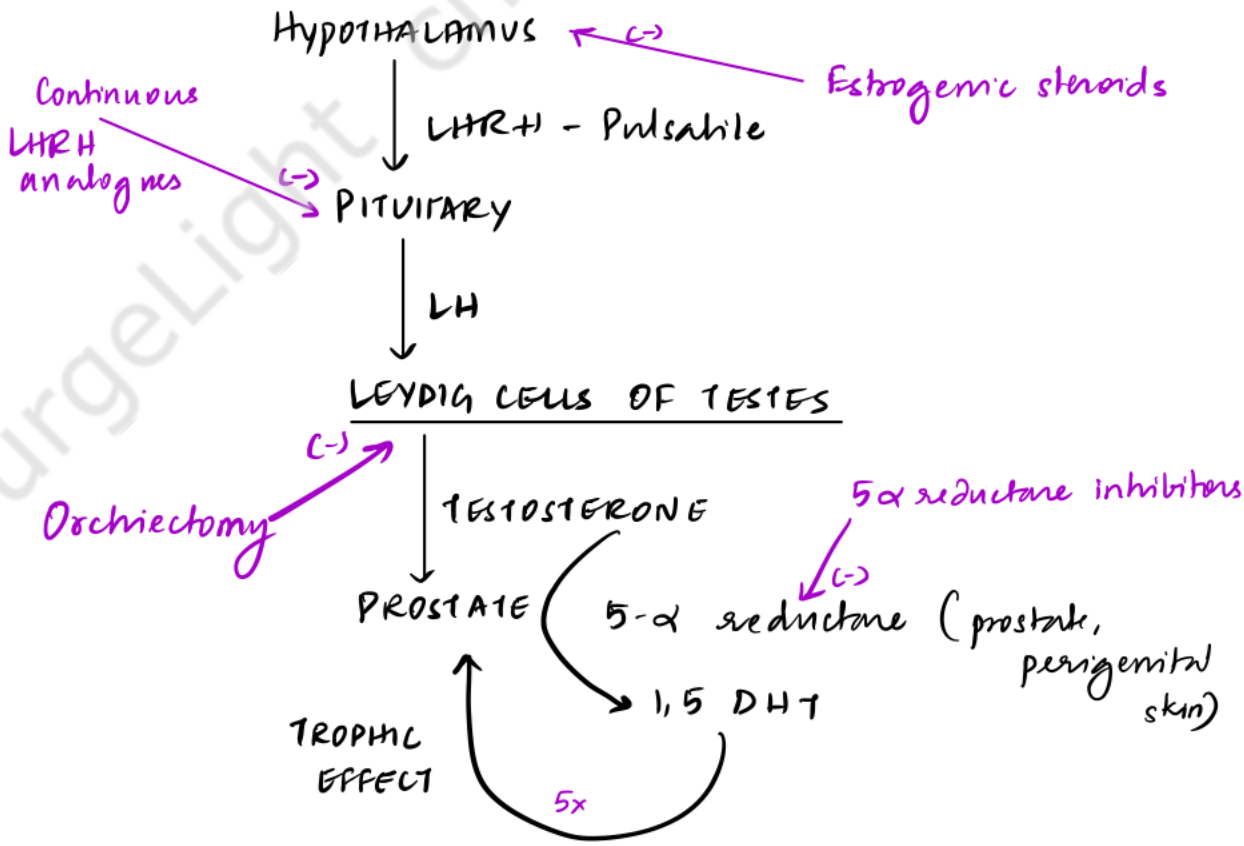


ARTERIAL SUPPLY - Inferior vesical artery → Prostatic artery
- Urethral A
- Capsular A

VENOUS DRAINAGE - Prostatic plexus → communicates c Batson's plexus

LYMPHATIC DRAINAGE - Internal iliac nodes

PHYSIOLOGY

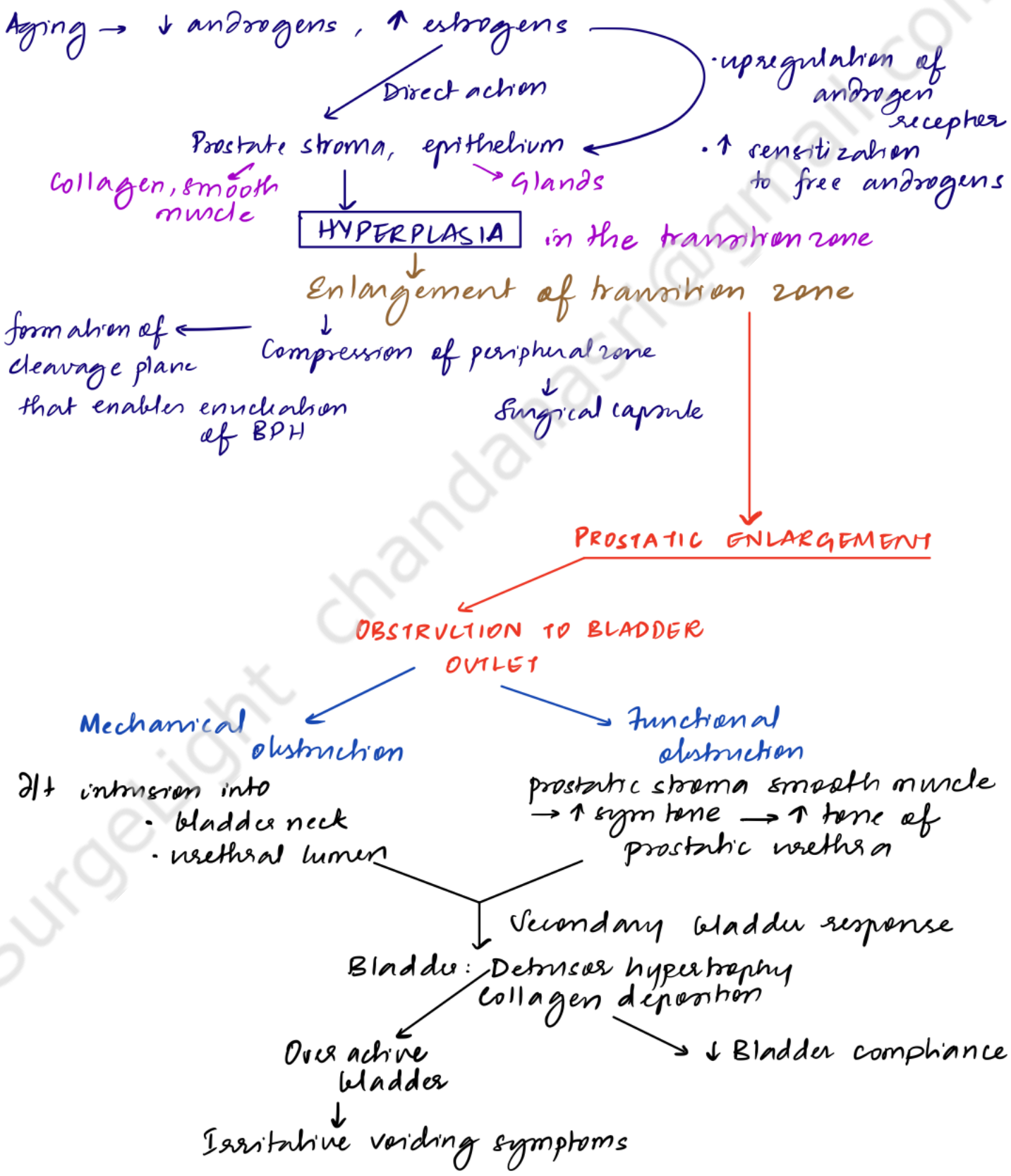


EPIDEMIOLOGY

Older age - Prevalence 50% in 51-60 y
>90% in >80y

ETIOPATHOGENESIS

Multifactorial, under endocrinal control



PRESENTATION

① BLADDER SYMPTOMS

- OBSTRUCTIVE
  - Hesitancy
  - Reduced stream
  - Straining
  - Incomplete voiding
  - Post void dribbling
  - Double voiding
- IRRITATIVE
  - Frequency
  - Urgency
  - Nocturia

IPSS (International Prostate Symptom Score) – 7 parameters scored 0–5

1) Incomplete voiding
2) Frequency
3) Intermittency / Hesitancy
4) Urgency
5) Weak stream
6) Straining
7) Nocturia
8) Quality of life 0–6

Total – 0–7 mild
8–19 moderate
20–35 severe

② SIGNS

DRE – Prostatomegaly – size
consistency, induration
tenderness
(r/o prostate Ca

③ LAB

Urinalysis – infection, hematuria r/o

RFT – Obstructive uropathy → warrants upper tract imaging

PSA

④ Imaging – USG – Prostate volume
PVRV
Upper tract

⑤ Additional – Cystoscopy
Uroflowmetry
Urodynamic studies
} Not routinely advised

Ddx – Ca Prostate
Bladder neck contracture
Urethral Stricture
Bladder calculus
| UTI
Neurogenic bladder
Ca Bladder

MANAGEMENT

1) Watchful waiting - mild symptoms

2) MEDICAL THERAPY

Phytotherapy

α_1 blockers - Tamsulosin → 14 d
Terazosin
Prazosin
Doxazosin } 7-10 d

5 α reductase inhibitors - Finasteride
Dutasteride

3) SURGICAL INTERVENTION

Indications - Urinary retention refractory to medical management & attempt at catheter removal → PVR > 200ml
- Recurrent UTIs
- Bladder stones
- Recurrent Gross hematuria
- Renal insufficiency
- Large bladder

APPROACHES

ENDOUROLOGICAL

1) TURP

2) TVIP - For posterior commissure hypertrophy resulting in bladder neck elevation
2 incision in 5 & 7 o'clock
- Just distal to ureteric orifice upto verumontanum

3) LASER — TRANSURETHRAL VAPORISATION (TUVP) Nd: YAG
Holmium Laser Enucleation of Prostate (HOLEP)

4) Transurethral microwave thermotherapy

OPEN SURGICAL

- for very large glands (>100g)
- concomitant bladder diverticulum
very large bladder stone

APPROACHES

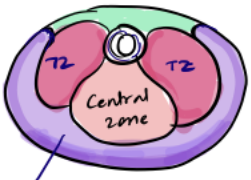
1) SUPRAPUBIC / TRANSVESICAL
when bladder stone / diverticulum needs Rx
- Bladder opened - finger in urethra
- enucleation — Freyer - SPC
Harris - lateral stiches for prostatic A

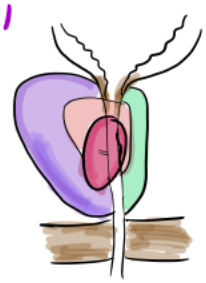
2) RETROPUBIC / MILLIN'S PROSTATECTOMY
Anterior prostatic capsule incised
- Plane - enucleation
+ Bladder neck wedge removed

3) PERINEAL APPROACH
(Young's perineal prostatectomy)

CARCINOMA PROSTATE

- m/c malignancy in Men > 65y
- Younger men – +ve family history → BRCA 2 > 1
- Risk factors - Obesity
  Smoking ±





Chemoprevention :
5-α reductase inhibitors
↓
controversial

PATHOLOGY

Carcinoma originates in PERIPHERAL ZONE (60-70%) ; 10-20% - transition zone, 5-10% central zone

- >95% - adenocarcinomas
- 5% - heterogenous - stromal
  ectopic
  epithelial

Multifocal

Mode of spread - strongly influenced by tumor grade

Local spread - Seminal vesicles
Bladder neck & trigone
Ureter

Distal sphincter

Rectum → rare (2/t Denonvilliers fascia)

↑ grade - Perineural invasion
↓
Lymphatic spread - Lymphangiogenesis
↓
Iliac nodes
Obturator nodes
Retroperitoneal nodes

Hematogenous
→ Bone - m/c - Osteoblastic lesions
Pelvic bones
lower lumbar vertebrae
Liver
Lung
Brain

PRESENTATION

1. Early prostate cancer : generally asymptomatic
   Detected incidentally - DRE
   ↑ PSA
   TURP for BPH (rarely)
2. Symptoms - BOO - LUTS
   Terminal hematuria
   Upper tract obstruction features
3. Due to mets - Back pain, Bony pain, FND - Radiculopathy / Myelopathy

Examination

1) DRE - Prostatomegaly
   Asymmetrical induration / nodularity - stony hard
   Lateral sulci - seminal vesicles - palpable
2) Inguinal nodes
3) Bone & spine - tenderness
   Neurological deficits

EVALUATION

- Blood routine - CBC
  Urinalysis - UTI
  RFT - Obstructive uropathy
  LFT - ALP - bone
  ↓ Calcium
  CxR
- USG - TAS / TRUS , Endorectal MRI
- PSA
- Biopsy - TRUS guided TRU-CUT
  → Gleason score : Sum of 2 scores → Each 1-5
  Score of most common histology
  Score of 2nd m/c histology

1 - Small uniform glands
2 - More stroma between glands
3 - Distinctly infiltrative margins
4 - Irregular masses of glands
5 - Anaplastic - occasional glands

Range 2-10

- CT / MRI - Pelvic lymphnodes
- Skeletal imaging - Bone scan (PSA > 10ng/mL

STAGING

(T)

T_x - cannot be assessed

T_0 - No e/o tumor

T_{is} - PIN

T_1 - Normal DRE

- T_{1a} - ≤ 5% tissue i cancer
- T_{1b} - > 5% tissue i Cancer
- T_{1c} - ↓ detected by ↑ PSA

T_{1a} & T_{1b}: in resection for benign disease

T_2 - tumor palpable by DRE / visible on imaging

- CONFINED TO PROSTATE
  - T_{2a} - < 1/2 lobe
  - T_{2b} - > 1/2 lobe
  - T_{2c} - both lobes

T_3 - Extraprostatic extension not involving other organs

- T_{3a} - U/L / B/L
- T_{3b} - seminal vesicles involved

T_4 - invades other structures

(N)

N_0 - no regional LN mets

N_1 - Regional LN mets

- Pelvic
- Hypogastric
- Obturator
- Iliac
- Sacral

(M)

M_0 - No distant mets

M_1 - Distant mets

Grading (based on Gleason score)

I	≤ 6
II	3 + 4 = 7
III	4 + 3 = 7
IV	8
V	9, 10

Stage grouping ↓ incorporates - PSA, Grade

N_1 = 4A, M_1 = 4B

MANAGEMENT

① RISK STRATIFICATION (for clinically localized disease)

A. Risk Groups
- low – PSA ≤10, Gleason ≤6, T_1, T_{2a}
- intermediate PSA – 10-20, Gleason 7, T_{2b}
- High – PSA >20, Gleason 8-10, T_{2c}, T_{3a}

B. Look up tables, nomograms

② TREATMENT OF LOCALISED DISEASE

1) Active surveillance – for early, low to intermediate risk prostate cancer in men & <10y life expectancy
↓
Serial – PSA
DRE
Follow-up TRUS guided biopsy
↳ Subclinical progression → INTERVENE

2) Radical Prostatectomy
/
Nows, RARP
– In pts & Life expectancy >10y & resectable, clinically localized prostate cancer

Complete removal of PROSTATE, seminal vesicles, ampullae of vas deferens
↓
division of bladder neck to remove specimen
↓
Reanastomosis of vesicourethral junction
Care taken to preserve the neurovascular bundle supplying cavernosal erectile bodies (Nerve sparing approach)
+ BPLND – Obturator, Iliac, Sacral nodes

3) RT + Adjuvant ADT (Androgen deprivation therapy) ± Docetaxel
EBRT / Brachy – Radioactive seeds
if high risk pt has ↓ life expectancy & poor surgical risk

③ TREATMENT OF ADVANCED DISEASE

- **SURGERY**
  - TURP to relieve BOO
  - Orchiectomy - as ADT in patients who are non compliant (B/L simple)

    require emergency blockade for cord compression

- **ADT** - GnRH agonists
  - Leuprolide, Goserelin, Triptorelin } AE - flare phenomenon
  - GnRH antagonists - DEGARELIX
  - Antiandrogens — Flutamide, Bicalutamide, Enzalutamide
  - Progestins - Megestrol acetate
  - ABIRATERONE - Blocks tumor androgen synthesis, CYP17 lyase inhibitor
  - Corticosteroids
  - Other drugs ↓ antiandrogen property - Ketoconazole
- **For Bone mets**
  - Zolendronate
  - Denosumab
  - Radiopharmaceuticals - Sr 89, Ra 223
- **Cytotoxic chemotherapy** - Mitoxantrone, Docetaxel, Cabazitaxel
- Vaccine therapy - Sipuleucel-T - castration resistant Ca prostate ± out visceral mets
- RT —
  - for cord compression
  - for isolated bony mets pain not responding to ADT
  - for pelvic pain SO, gross hematuria
  - Retroperitoneal nodes causing back pain / edema in scrotum / limbs

URINARY DIVERSIONS

Definition: Any procedure performed to reroute the flow of urine to prevent or treat obstruction

Goals of Urinary Diversion:

1) Non refluxing
2) Low pressure
} Safe Upper tract
3) Continent

Components:

- A reservoir in which urine is stored at low pressure
- A conduit to conduct urine
- A continence mechanism

TYPES

TEMPORARY

- Indwelling catheters
  - Per-urethral
  - Suprapubic
- Ureteric stents
- Nephrostomy

PERMANENT

EXTERNAL DIVERSION

CONTINENT

Cutaneous

NON-CONTINENT

- Conduits
- Cutaneous ureterostomy

INTERNAL DIVERSION

- ORTHOTOPIC BLADDER SUBSTITUTION
- DIVERSION TO GIT
  - Sigmoid colon
  - Rectum

Selection of Method depends on:

- Age & performance status
- Nature of disease
- Bowel condition
- Patient Preference

(A) CONTINENT CUTANEOUS URINARY DIVERSION

Components

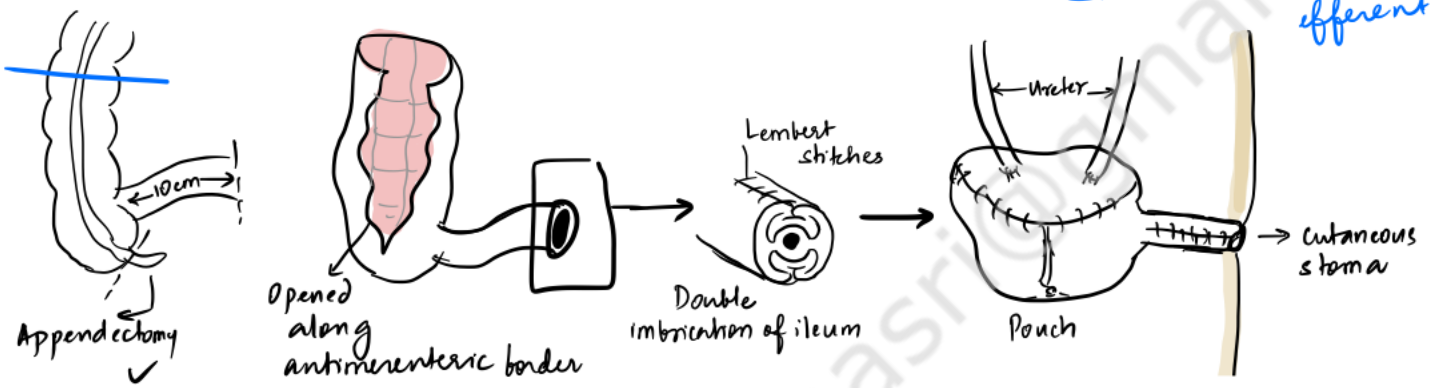
- Reservoir – Good capacity
  – Low-pressure storage
  – Minimal metabolic consequences
- Catheterisable efferent limb
- Continence mechanism
- Non-refluxing mechanism → tunneling ureters (Submucosal tunnel ~4-5cm)

Prerequisites

- Pt. intelligent/ motivated/ able to do CIC
- (N) renal & hepatic function
- Bowel healthy

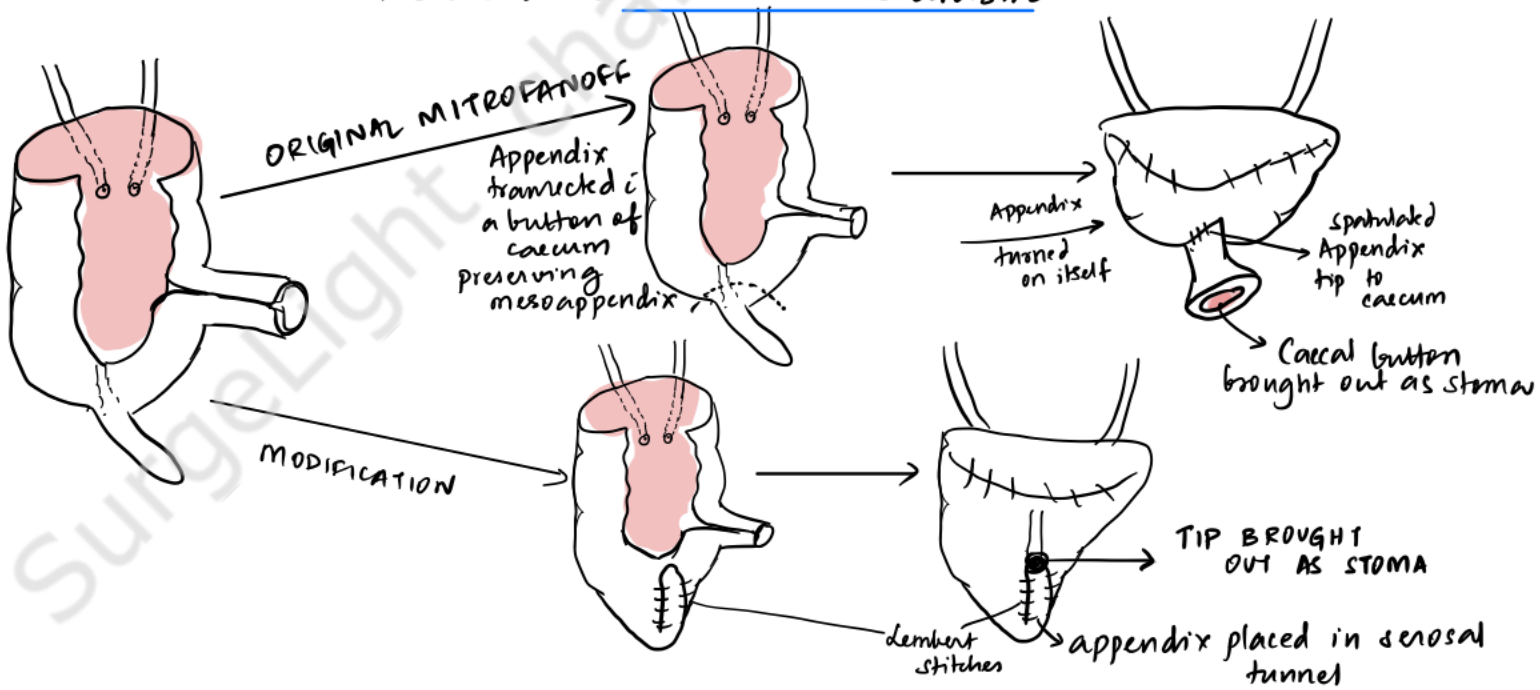
1) INDIANA POUCH → (R) Colon reservoir ī imbricated ileum

↳ continent catheterisable efferent limb

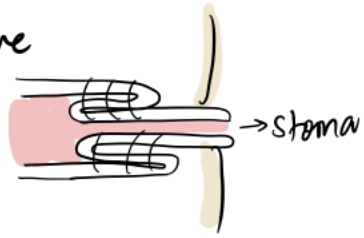


2) FLORIDA & MIAMI POUCH – similar but uses caecum, asc. colon, ½rd - ½ Tr. colon

3) PENN POUCH → Caecal pouch ī MITROFANOFF principle where appendix serves as continence mechanism



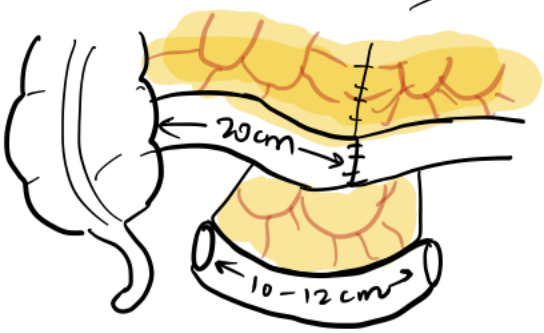
4) MAINZ POUCH → Caecal pouch ī nipple valve (ī intussuscepted ileal valve)



(B) NON-CONTINENT CUTANEOUS DIVERSIONS

1) Ileal Conduit

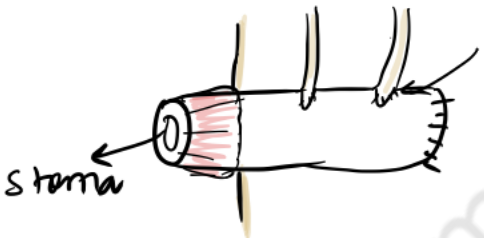
- 10-12 cm of ileum, ~20cm proximal to ILJ
- short, straight, kink free conduit



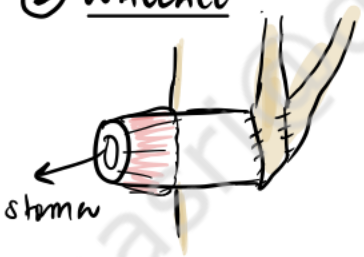
- Continuity of small bowel and mesentery established
- Ureteno-enteric anastomosis done over a stent
- Distal end of ileal segment fashioned as end ileostomy

URETER IMPLANTATION METHODS

(1) BRICKER NESBITT

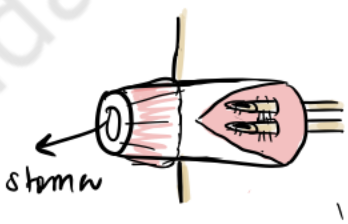


(2) WALLACE



Both ureters spatulated
- laid adjacent
- sewn together
- sewn to bowel

(3) LE-DUC



A spatulated length of ureter is introduced into the conduit via a vent and sutured to mucosa & bowel layers

(4) TUNNELED METHOD

Ureter is placed in a tunnel within the bowel wall

2) COLONIC CONDUIT – TRANVERSE COLON, ILEOCAECAL

Sigmoid colon is not used if hypogastric arteries have been ligated/ rectum left in situ

3) JEJUNAL CONDUIT

- very poorly tolerated - ↑ metabolic issues - Almost never done

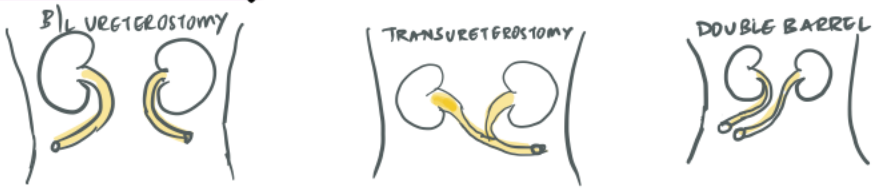
4) Ileal Vesicostomy

- Spatulated Ileum + Cystotomy → fashioned into stoma - done in neurogenic bladder

5) Gastric Conduit

6) Cutaneous ureterostomy

- end of ureter is brought out as stoma



⑥ INTERNAL DIVERSIONS

① ORTHOTOPIC BLADDER

- Relies on the rhabdosphincter for continence
  ∵ Pts must have adequate external sphincter function
- Voiding by ↑ IAP + Relaxing pelvic floor muscles - Crede's maneuver
  - Prerequisites
    - eGFR > 40 mL/min - Good renal function
    - Intact functional external Sphincter
    - Adequate available bowel
    - Willingness to perform CIC if needed

BLADDER RESERVOIR FEATURES

- Adequate volume (≈ 500ml) to allow for reasonable voiding intervals
- Maintenance of low pressure after filling
- BOWEL SEGMENT - COMPLETELY DETUBULARISED & RECONSTRUCTED INTO SPHERICAL SHAPE
  - Detubularised Ileum / Ileocolon
- Antireflux mechanism to conserve upper tract

- Ileal reservoir - 60-75 cm of terminal Ileum

Hautmann-W
Studer
Camey-II
Kock
T-pouch
Padua Pouch
} pouches

- Colon & Ileocolic pouches

Orthotopic Mainz pouch
Right-colon pouch
Sigmoid pouch

② URETEROSIGMOIDOSTOMY - oldest form ~ 1852

Urine is diverted by anastomosing ureters into the SIGMOID COLON

PREREQUISITE : ANAL SPHINCTER MUST BE COMPETENT

(Pt. must prove ability to hold ~200ml liquid in rectum)

Disadvantage

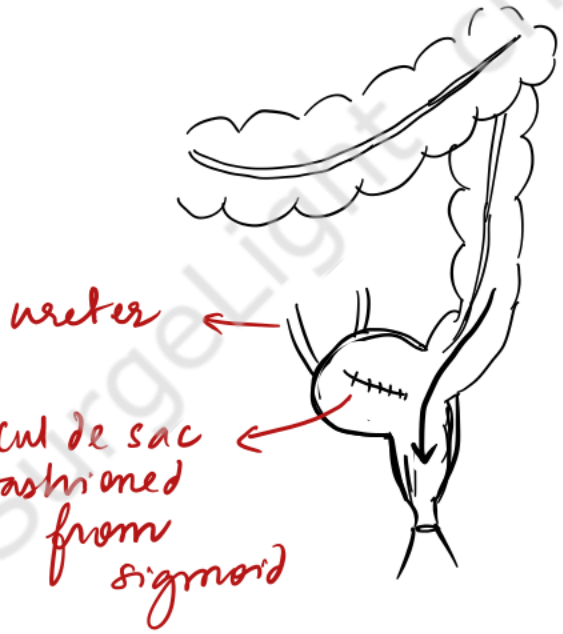
Renal tract is continuously exposed to infection from feces

↓

Minimised by constructing an ANTIREFLUX MECHANISM

Eg: Mainz II Cul-de-Sac Ureterosigmoidostomy

- Low pressure reservoir in sigmoid in which ureters are implanted
- Bowel content takes a more direct route to rectum



MAINZ II CUL-DE SAC URETEROSIGMOIDOSTOMY

COMPLICATIONS OF URINARY DIVERSIONS

① METABOLIC COMPLICATIONS

a) Electrolyte abnormalities

Type depends on the segment of bowel used & Renal Reserve

- Stomach - Hypochloremic metabolic alkalosis
  - ↑ Aldosterone
- Jejunum - Hyponatremia, Hyperkalemia, metabolic acidosis
  - ↑ Renin angiotensin
- Ileum, Colon - Hyperchloremic metabolic acidosis ± Hypokalemia
  - Hypocalcemia

→ Hyperammonemia → coma in pts ± poor hepatic reserve

b) Altered sensorium

d/t
- Mg deficiency
- Ammonia metabolism abnormalities
- Electrolyte disturbances

c) Abnormal drug absorption

d) Osteomalacia / Renal rickets - d/t Acidosis
Vit D resistance

e) Impact on Growth & Development

② INFECTION

↑ Bacteruria, Bacteremia & sepsis

③ STONES

Calcium, Magnesium, Ammonium phosphate
esp in pts ± hyperchloremic metabolic acidosis + INFECTION

④ INTESTINAL MOTILITY, SHORT BOWEL & NUTRITION ISSUES

Vitamin B_{12} malabsorption
Malabsorption of Bile salts → Poor EHC → Fat malabsorption
Malabsorption of Ca^{2+} & Folic acid

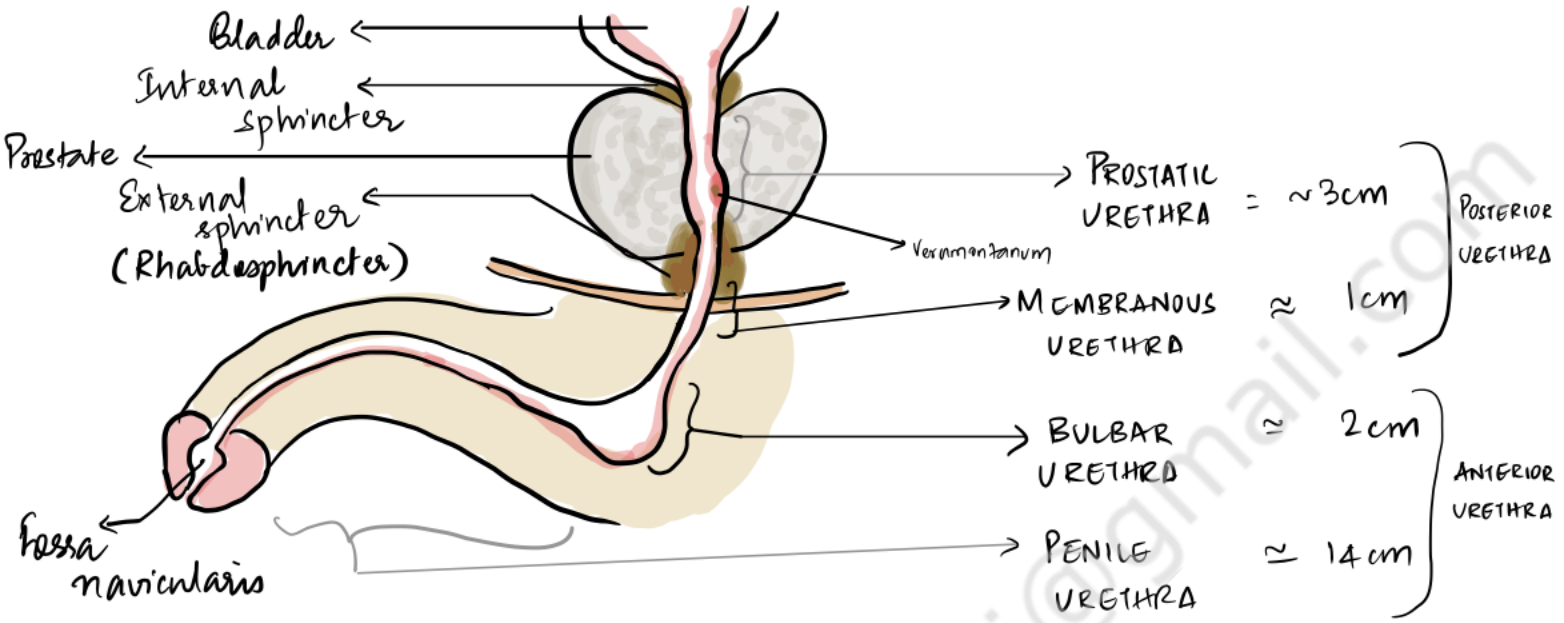
⑤ CANCER -

Adenocarcinoma, polyps, sarcoma, TCC } in ureterosigmoidostomy, colon conduits, Bladder augmentations, Rectal bladder

⑥ STOMAL COMPLICATIONS

- Necrosis, Prolapse, Parastomal hernia, pouching problems
Stenosis / stricture

Anatomy of the Urethra (Male) ≃ 20cm



The summit of the verumontanum bears a pit called utriculus masculinis which marks the proximal extent of external urethral sphincter

The anterior urethra is invested by corpus spongiosum

Vascularity of corpus spongiosum is based on common penile A (Terminal branch of internal pudendal A)

Fossa navicularis is lined by stratified squamous epithelium

Bulbar urethra is covered by midline fusion of ischiocavernosus
→ invested by bulbospongiosus of corpus spongiosum

** At bulbar urethra, there is transition to urothelium

Membranous urethra - traverses perineal pouch
surrounded by external sphincter
unattached to any fixed structures

URETHRAL STRICTURE

Definition: Fixed anatomic narrowing of the urethra

Anterior
↓
True urethral stricture
↓
Involves the urethra surrounded by corpus spongiosum

Posterior
↓
more correctly described as 'Posterior urethral injury' or 'Posterior urethral stenosis'

- an obliterative process in the posterior urethra that has resulted in fibrosis & is generally the effect of distraction in the area (trauma, radical prostatectomy)

PFUDD – Pelvic # Urethral Distraction Defect

Etiology: Any process that injures the urethral epithelium or the underlying corpus spongiosum to the point that healing results in a scar

IATROGENIC
Due to urethral instrumentation
- TURP, TURBT, Cystoscopy
- urethral dilatation
- Perioperative catheterisation

↓
Mechanism
- Injury
- Pressure necrosis
- Inflammation
- Infection

TRAUMATIC
Blunt/penetrating trauma
- Straddle
- Deceleration

Corpus spongiosum crushed against pubic rami
↓
BULBAR URETHRA

INFLAMMATORY
- previously d/t Gonorrhea
- Lichen sclerosus
↓
meatal stenosis

→ Bulbar urethra

IDIOPATHIC
↓
in children
↓
Idiopathic urethro-sarhagia
- Congenital

Presentation
- Obstructive voiding Symptoms, Urinary retention - forking
- UTI - prostatitis, epididymitis

Evaluation – Location, Length, Depth, density

Investigations

- Urine routine
- RGU/ Ascending urethrogram
- Urodynamic studies
- Endoscopic examination
- USG

Management

- **Dilatation** – for patients with epithelial strictures with no spongiofibrosis

  The goal is to stretch the scar without producing more scarring!

  - Multiple sittings
  - Bougies / Urethral Balloon dilating catheters

- **Internal Urethrotomy**

  Opening the stricture by incising it transurethrally (VIU)

  - akin to releasing a scar contracture to widen the lumen
  - The resultant larger luminal calibre has to be maintained after healing
  - suitable for strictures of Bulbar urethra <1.5 cm length (short segment shallow strictures)
    - not a/i dense/deep spongiofibrosis

- **LASERs** – CO_2, Ar / KTP / Nd:YAG, Holmium YAG
- **Urethral stents** – after internal urethrotomy / dilation
- **Open reconstruction** – Anastomotic urethroplasty – <1.5-2cm
  - Graft Urethroplasty / Augmented

  success depends on mobilising corpus spongiosum
- **Perineal urethrostomy**

URETHRAL INJURIES

In the setting of trauma (Pelvic trauma) urethral injuries commonly involve
- BULBAR URETHRA
- MEMBRANOUS URETHRA

~10% associated ī Pelvic fractures
- Bulbar urethral injuries
  ~ usually straddle injuries
- Distraction injuries are unique to membranous urethra

RUPTURE OF BULBAR / ANTERIOR URETHRA

CLINICAL FEATURES
- Clinical triad - Perineal Hematoma
  Urethral Hemorrhage
  Bladder distension / Retention of urine
- Subcutaneous extravasation of urine

Rupture may be complete / incomplete (Circumference)
Total / partial (Depth)

Management
Bleeding arrest - pressure on perineum, drain perineal hematoma
Urine should not be passed - extravasation may occur
Lone, gentle attempt at catheterisation - Successful → retain cath x ≥ 2wks
if not, **B**ladder should be emptied by SPC
Antibiotics
Repair later after evaluation

RUPTURE OF MEMBRANOUS URETHRA
- Complete transection
- Incomplete transection
- Associated Bladder injury

- Usually associated ī Pelvic fractures
- Usually associated with extraperitoneal rupture of bladder

Clinical features
- Shock, bleeding etc.
- Vermooten sign - Floating prostate
  complete rupture of urethra ī disruption of puboprostatic ligament

EXTRAVASATION OF URINE

- Collection of urine in the tissues following rupture of urethra / bladder
- Type depends on location of injury

SUPERFICIAL EXTRAVASATION

d/t bulbar urethral (anterior urethral) injury

Urine first collects in **superficial perineal pouch**

SUPERFICIAL PERINEAL POUCH

- is bounded by
  - Colles fascia **below**
  - inferior fascia of urogenital diaphragm **above**
  - fusion of colles fascia & inferior fascia **posteriorly**
  - attachment of the fascia to ischiopubic rami **laterally**

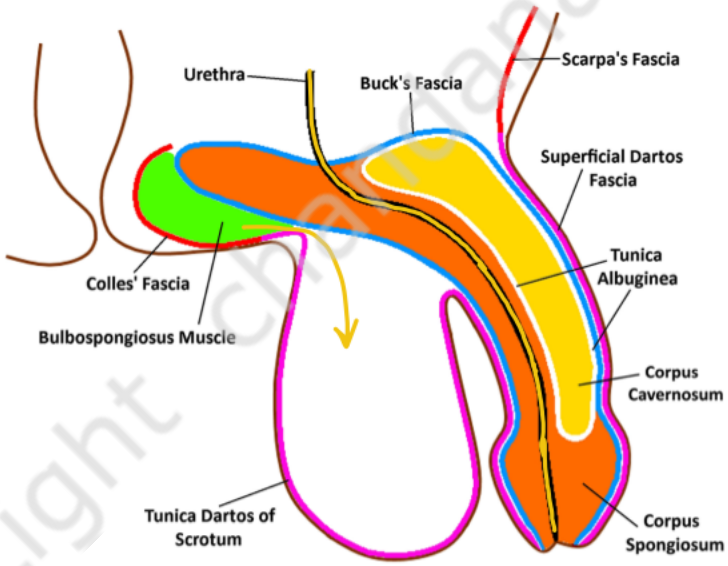
Anteriorly - open

↓

Urine tracks anteriorly into scrotum, penis, anterior abdominal wall and upper thigh underneath **SCARPA'S FASCIA**

↓

Tracks into thigh upto where scarpa's fascia fuses c fascia lata at **HOLDEN'S LINE**



DEEP EXTRAVASATION

d/t membranous urethral injury, extraperitoneal rupture of bladder

Urine collects in the **retropubic space of Retzius**

↓

tracks into **extraperitoneal space** behind **fascia transversalis**

↓

May track into **retroperitoneum**

Management - Resuscitate
SPC

- **Aligning catheter** (∵ usually a strip of epithelium is intact)
  - ↳ Placed by railroading
    or
    By Flexible endoscopy
- Aligning catheters - aid subsequent reconstruction
  - may even leave the pt ć an endoscopically manageable stenosis

→ Incomplete Rupture

Mitchell

SPC → malecot
↓ 6 wks
urethrogram

Blandy

Single attempt to pass Cath per urethrally
fails ↓
SPC
↓
OT - flexible scopy railroading

open endoscopic-foley after dil

Investigations

1. RGU - (Asc. Urethrogram)

McCALLUM GRADING

I - POSTERIOR URETHRA ELONGATED BUT INTACT

II - PROSTATE PLUCKED OFF - EXTRAVASATION ABOVE SPHINCTER

III - TOTAL DISRUPTION - EXTRAVASATION ABOVE + BELOW SPHINCTER

2. MRI
3. Endoscopy

Definitive repair after 3-6 months
- Anastomotic urethroplasty
- Graft urethroplasty

Post operative Mgt: Soft silicone cath × 2 wks

Posterior Urethral Valves

Congenital symmetrical valves in posterior urethra under verumontanum

(Does not obstruct ingress of catheter but obstructs outflow of urine)

- m/c/c of bladder outlet obstruction in male infants
- Antenatally + → insult to bladder & kidneys → long term issues

Etiology

? Hypertrophic urethral mucosal folds
? Cloacal remnants
? Congenital Obstructing Posterior Urethral membrane
? Genetic basis

Antenatal damage

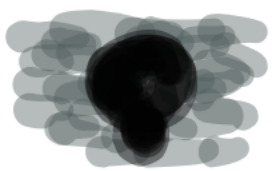
Lung - Pulm hypoplasia (2/t oligohydramnios)

Kidney - Obstructive uropathy
Dysplasia
Tubular injury

Bladder - Hypercontractility
Poor sensation
Low compliance
Eventually myogenic

Ureters - Poor contractility

VUR



Imaging

- Antenatal) - Keyhole sign
  Postnatal) Dilated bladder + Posterior urethra) on USG
- VCU - definitive
  Thickened bladder
  Trabeculations
  Diverticuli
  } Mimics Neurogenic bladder
  High grade VUR
  Grossly dilated posterior urethra
  Abrupt urethral funneling

Ddx

- Neurogenic bladder
- Marion's disease → intraureteric bar → BOO

- Radionuclide renal scan (DMAG3) → for assessing (differential) renal function
- MRI (fetal ?)
- Renal function tests

Management

ANTENATAL

~50% detected antenatally

- Severity of obstruction can be assessed by
  - Volume of amniotic fluid (Oligohydramnios)
  - Degree of renal dysplasia (IV obstructive insult)
  - Fetal urinary markers

- VESICOAMNIOTIC SHUNTING (Fetal Surgery)
  - may help

POSTNATAL

- Valve ablation - cystoscopic
- Vesicostomy
  - ↳ if urethra cannot accomodate scope
- Upper tract diversion
- Circumcision - to ↓ risk of UTI (∵ ↑ VUR in PUV)
- Nephroureterectomy ∵ severe VURD

EPISPADIAS

Bladder exstrophy
Cloacal exstrophy
Epispadias
} Components of EEC

EEC - Epispadias Exstrophy complex

→ Defect in the dorsal wall of urethra

→ Normal urethra is replaced by a broad mucosal strip lining the dorsum of the penis extending towards the bladder with potential incompetence of the sphincter mechanism

Varying degrees of Dorsal Chordee

→ Displaced meatus may be found on
- Glans
- Penile shaft
→ - Penopubic region
↓
subsymphyseal epispadias

Surgical management

Goals
- achievement of urinary continence
- preservation of upper tract
- Reconstruction of cosmetically acceptable genitalia

HYPOSPADIAS

Classical triad of Hypospadias

1) Proximal ventral urethral meatus
2) Ventral penile curvature
3) Dorsally hooded foreskin

Embryological basis of Hypospadias

- Arrest in intrauterine penile development
- Normal Development → tubularisation of urethral plate

Endodermal penile urethral plate

↑ Ingrowth

Complete fusion

Later, glandular urethral lining undergoes dedifferentiation into str. sq. epi

↓

New theory

Old → Glans - ingrowth

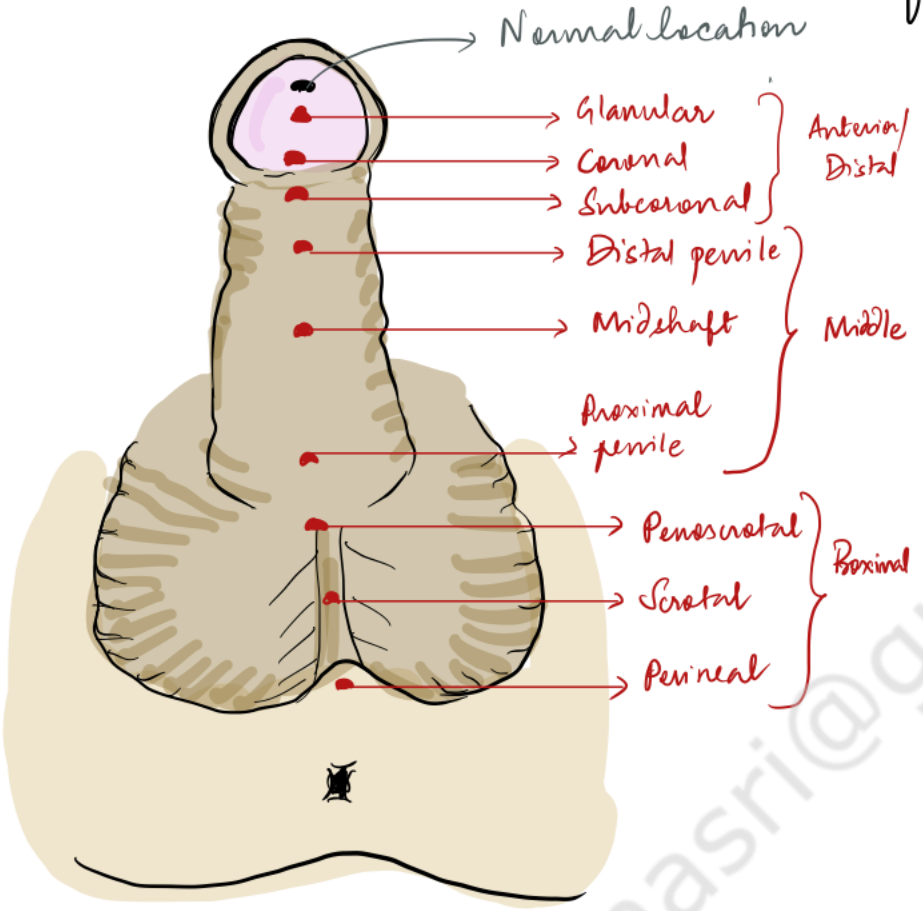
↓

Later fusion

→ This occurs during 8-16 wks of IU life and is ANDROGEN DEPENDENT (Dihydrotestosterone)

- Preputial development depends on urethral development
- Disproportion in dorsal & ventral growth

CLASSIFICATION → based on location of meatus



GMS score - Glans, Meatus, Shaft curvature score

G

1. Good size — Healthy glans & urethral plate - deeply grooved
2. Adequate size glans; UP - grooved
3. Small glans; fibrosed UP - flat
4. Very small glans; Indistinct UP - narrow & flat

M

1. Glanular
2. Coronal
3. Mid / Distal penile
4. Boxinal penile / Penoscrotal

S

1. No chordee
2. chordee < 30°
3. > 30° - 60°
4. > 60°

Associated abnormalities
Penile torsion
Penoscrotal webbing
↑10% → Cryptorchidism
↓
suspect DSD – Disorder of Sexual Diff

- Preoperative Androgen stimulation

DHT
hCG
testosterone } in prepubertal boys

→ testosterone cypionate IM & 2 weeks before (5 weeks)

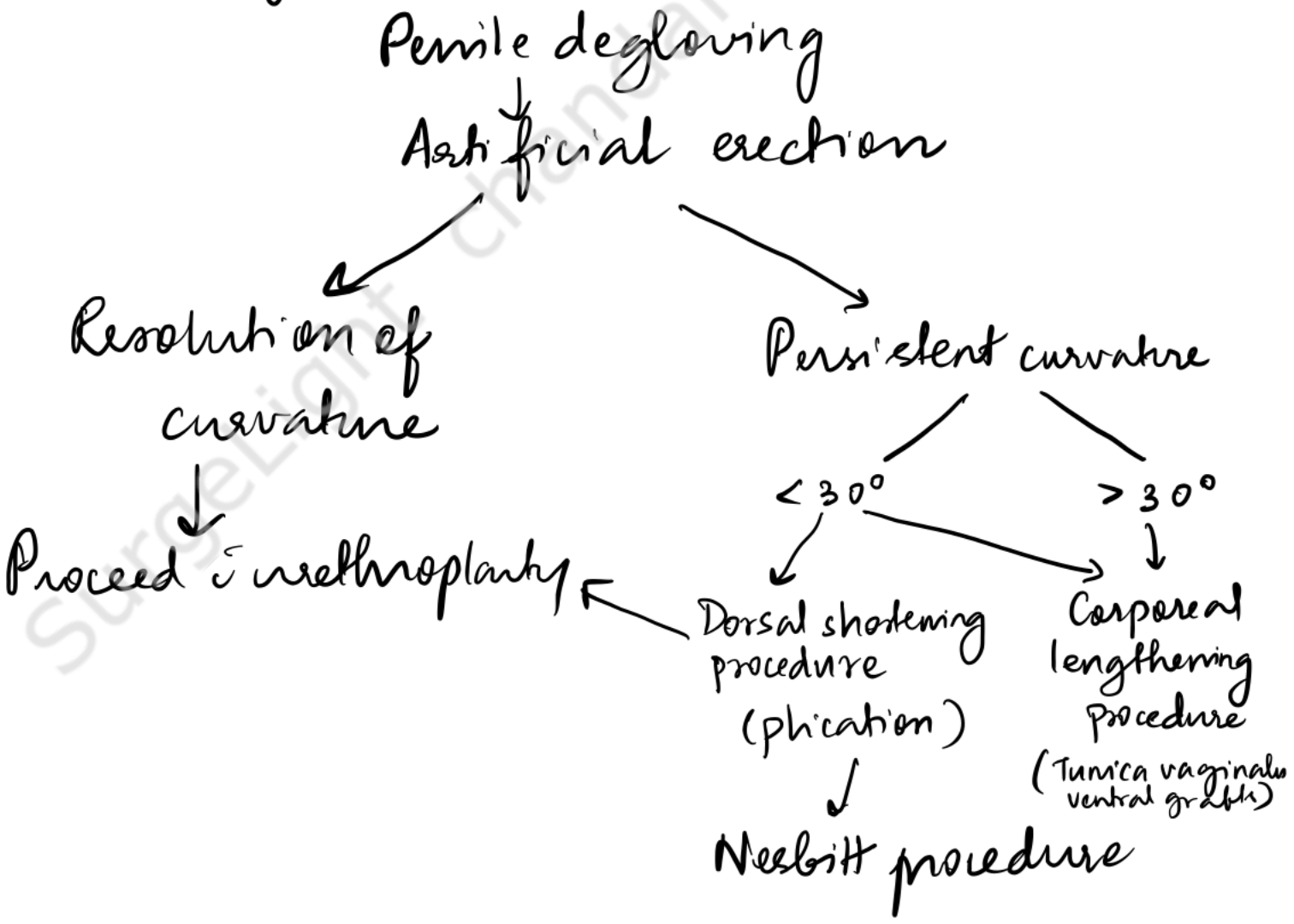
Rx – Surgery

Aims of repair
- Correction of chordee
- Reconstruction of good & uniform caliber urethra upto tip of glans
- Restoration of meatus at tip of glans
- Normally configured glans & frenulum
- Skin cover to ventral repair & excision of redundant dorsal skin

Choosing the repair depends on

- Meatus size & location
- Glans size
- Width of urethral plate - groove depth
- Chordee
- Prepuce
- Penile torsion
- Scrotal transposition & width

- Dealing : Penile curvature



SURGICAL APPROACHES

Steps

1) Penile degloving
2) Assessment of ventral chordee by inducing artificial erection
3) Correction of chordee
4) Urethroplasty
5) Meatoplasty
6) Glans plasty
7) Preputioplasty

GLANDULAR → enough to mobilise urethra & advance meatus

1) Inverted Y technique
2) MAGPI (Meatal advancement & glanuloplasty) - Duckett
3) Y-V modified Mathieu

Distal Penile → Urethroplasty needed
- TIP
  - Heirsch Duplay
  - Snodgrass

Proximal
- Lateral based flap
- Onlay Island flap
- 2-stage repair

Complications of Hypospadias repairs

Urethroplasty complications

- Fistula – Urethrocutaneous
- Glans dehiscence
- Meatal stenosis
- Urethral stricture
- Urethral diverticulum
- Recurrent chordee

Skin complications

- Penile tethering
- Penile torsion
- Preputial fistula
- Preputial dehiscence
- Post pubertal phimosis
- Lichen sclerosus

UNDESCENDED TESTES

EMBRYOLOGY

- TESTICULAR DEVELOPMENT
- TESTICULAR DESCENT

- Absence of testis in the scrotum of a male individual

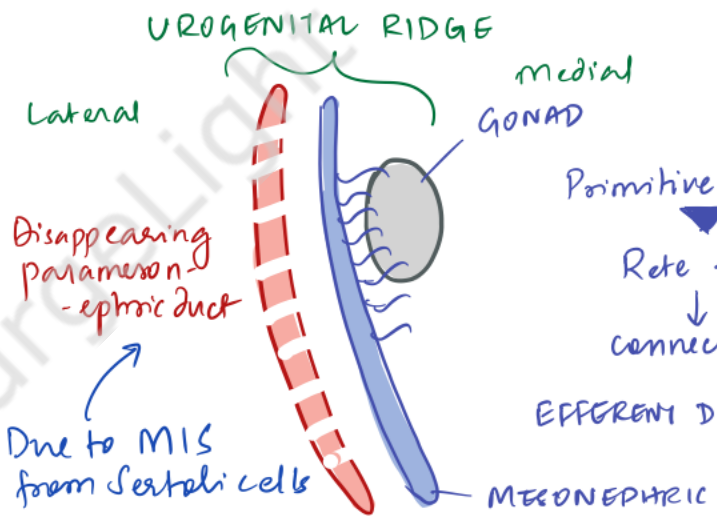
If testicular arrest occurs outside the normal line of descent → ECTOPIC TESTIS

TESTICULAR DEVELOPMENT

- Primordial germ cells arise in the yolk sac (3rd week of Gestation)
  ↓
  Migrate along the dorsal mesentery
  ↓
  Reach the gonadal ridges in the lower thoracic & upper lumbar region

- Surface epithelial cells from genital ridge (6th week of Gestation)
  ↓
  Invade the mesenchyme of gonadal ridge
  ↓
  PRIMITIVE SEX CORDS
  ↓
  INDIFFERENT GONAD
  ← SRY Gene products ← Y chromosome
  ↓
  TESTES

In the absence of SRY Gene product, the indifferent gonad becomes OVARY



Primitive sex cords → canalisation → SEMINIFEROUS TUBULES

Primitive sex cords → Rete testes → connect ī mesonephric tubules → EFFERENT DUCTULES

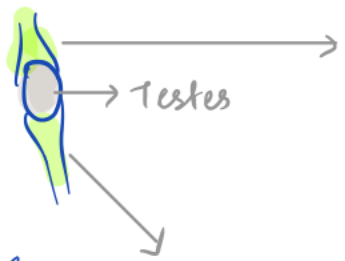
Some epithelial cells differentiate into Sertoli cells → AMH/MIS

LEYDIG cells arise from coelomic epithelium perivascular cells near gonad–mesonephric border

FETAL LEYDIG CELLS → TESTOSTERONE SYNTHESIS by 6-7 wks, peaks at 14-17 wks

TESTICULAR DESCENT

- Before gonadal differentiation, the testes lie near the developing kidneys
- Loosely held in place by (2) ligamentous structures



GUBERNACULUM - mucofibrous structure attached to the testis & scrotum
- guides the descent of testis into scrotum

The distal end is attached to the fascia between abdominal muscles initially & then descends to scrotum along with PROCESSUS VAGINALIS

Phases of Descent

1) Transabdominal phase: 8 - 28 weeks

Testes descends from retroperitoneum to deep inguinal ring

Due to
- regression of cranial ligament due to androgens
- thickening of gubernaculum due to Insulin-like factor 3 (Leydig cells)

2) Inguinoscrotal phase: 28 - 35 weeks

- under androgenic control
- due to CGRP (Calcitonin Gene Related Peptide) from Genitofemoral nerve
- Aided by transmission of raised intra-abdominal pressure via processus vaginalis
- SHORTENING & TRACTION OF GUBERNACULUM

TESTICULAR DESCENT - Timeline

1) 2ND MONTH - LUMBAR REGION
2) 3RD MONTH - ILIAC FOSSA
3) TILL 7TH MONTH - DEEP INGUINAL RING
4) IN 7TH MONTH - Travels to Inguinal canal
5) 8th month - Superficial ring
6) 9th month / After birth - Scrotum

Incidence (of Undescended testis)

- Preterm babies - 30%.
- Term babies - 4%.
- At 1 y of age - 1%.

> Post natal descent of testes beyond 3 months - RARE

UDTs
- 2/3rd ≤ → palpable in inguinal region
- Rest - impalpable

Associated anomalies

1) Patent Processus Vaginalis → Indirect Inguinal hernias
2) Epididymal anomalies
3) Hypospadias
4) Urinary tract abnormalities

✓ Congenital Cryptorchidism - extrascrotal testis at birth
✓ Acquired - cryptorchid testis documented as scrotal in a previous examination

> **RETRACTILE TESTES**
> Scrotal testes that retract easily out of the scrotum but can be manually replaced in a stable scrotal position & remain there atleast temporarily

Based on location

1) Lumbar testis
2) Iliac testis - just deep to deep inguinal ring
3) Inguinal testis - in the inguinal canal
4) At the superficial inguinal ring
5) Scrotal testis - upper part of the scrotum

ETIOLOGY

① Hormonal defects - of HPG axis - Sertoli/Leydig cell dysfunction
② Genetic susceptibility
③ Environmental risk factors - Maternal smoking
Organic pollutants

④ SYNDROMIC CRYPTORCHIDISM
- Androgen Biosynthetic Defects
- Androgen insensitivity
- Leydig cell agenesis
- Gonadotrophin deficiency disorders
- Persistent Mullerian Duct Syndrome
- Klinefelter Syndrome
- Prune belly Syndrome

ECTOPIC TESTIS - deviates from the normal path of descent

RARE → otherwise normal (whereas undescended testis is often underdeveloped)

PATHOGENESIS — Lockwood Theory

▶ Gubernaculum testis has 5 tails
- SCROTAL - major
- PUBIC - attached to pubic tubercle
- PERINEAL - attached to perineum
- INGUINAL - attached to front of inguinal canal
- FEMORAL - attached to saphenous opening

Scrotal tail is strongest & other tails usually disappear

If any one of the 4 accessory tails become stronger, the testis is drawn towards the attachment of that tail & becomes ectopic

POSITIONS OF ECTOPIC TESTIS
- Superficial Inguinal pouch - m/c - lateral to superficial ring between EOA & Scarpa's fascia
- Pubopenile - in front of pubis at root of scrotum
- Perineal - in superficial perineal pouch - in front of anus - one side of midline
- Crural / Femoral - near fossa ovalis
- Contralateral scrotal

UDT		Ectopic Testis
• Arrest of descent		• Deviation in path of descent
• Underdeveloped testes		• Normal testes
• Underdeveloped scrotum	EMPTY SCROTUM	• Normal scrotum
• Short spermatic cord		• Long spermatic cord
• a/c indirect inguinal hernia		• Not associated

Rx - ORCHIDOPEXY

CLINICAL FEATURES

1) (R) side 50% , (L) - 30% , B/L - 20%

2) Gliding test - Roll fingers of one hand from inguinal canal to scrotum while the other hand at the root of scrotum attempts to grasp the testis

3) Check for
- Testicular position
- Palpability
- Mobility
- Size

{ Positions - supine, upright cross legged, standing

Associated findings –
- Hernia
- Hydrocele
- Hypospadias
- Hemiscrotal development

PATHOLOGY

- Arrested development of spermatogonia & progressive loss in the cryptorchid testis
- Cryptorchidism is associated with primary & secondary effects on testicular development

Retractile vs UDT - Inj: hCG helps in descent of retractile testis
—true UDT will not descend

Anorchia vs B/L Cryptorchidism

Baseline levels: FSH, LH, Testosterone

↑↑ ⇒ Anorchia ← ↓

Inj: HCG 2000 IU IM × 3d

↑ Testosterone ⇒ Presence of functional testis

RADIOLOGICAL

USG – MRI , Diagnostic lap

Complications

- **T**ORSION
- **E**PIDIDYMOORCHITIS
- **S**TRANGULATION OF HERNIA
- **T**RAUMA
- **I**NFERTILITY – B/L UDT – Infertility 50%
- **S**EMINOMA (Tumor) → Risk of malignancy is
  - TGCT risk 2-5 x ↑ in boys ± cryptorchidism
  - Contralateral normally descended testis also has risk
  - Risk is maximum in intraabdominal testis
  - M/C Malignancy in UDT = Seminoma

SURGICAL MANAGEMENT

Surgery should be considered once there is failure of spontaneous descent

GOALS

Surgical correction of Cryptorchidism is indicated to

- Optimize testicular function
- Reduce & / or facilitate diagnosis of testicular malignancy
- Provide cosmetic benefits
- Prevent complications such as clinical hernia / torsion

TIMING

6-12 months (corrected gestational age)

Rationale –

Spontaneous descent unlikely beyond 6m
Testicular growth is restored after early orchidopexy (9m vs 3y)
Orchidopexy for abdominal testes easier in young infants

HORMONAL THERAPY

- Hormonal therapy to stimulate testicular descent is **not** currently recommended for boys ō Cryptorchidism

SURGERY

ORCHIOPEXY

ORCHIECTOMY is a treatment option for pubertal & postpubertal boys, especially if testis is intraabdominal & difficult to mobilise

∴ poor spermatogenesis & hypotrophy are usually present
→ risk of carcinoma in situ & torsion exist

APPROACH

For Palpable testis - Open orchiopexy
For Impalpable testis - Laparoscopic Approach

ORCHIOPEXY FOR PALPABLE TESTES

- Inguinal approach - standard
  - Testis position is determined & recorded
  - Spermatic cord isolated & testis is dissected distally to its Gubernacular attachment
    ↓
    Gubernaculum is transected distal to the sac

CORD LENGTHENING

- Processus vaginalis dissected from cord completely
- Incision of internal spermatic & transversalis fascia at deep ring
- Release of all fascial bands
- Division of retroperitoneal attachments

- PRENTISS MANEUVER - posterior wall of the inguinal canal medial to the inferior epigastric vessels is opened. Testis is pulled through the space medial to epigastric vessels (shortens the course of testicular vessels and vas deferens) — ADDS 1 cm

Inferior epigastrics can also be ligated & divided

If testis cannot be pulled down to the scrotum despite doing all the above cord lengthening manevuers,

STAGED ORCHIDOPEXY

STAGE-1: initial mobilisation & fixing the testis at the lowest (most distal) site possible

STAGE-2: second procedure after ≥6 months to bring the testis down to the scrotum

FOWLER-STEPHENS PROCEDURE

Testicular artery is divided on the assumption that testis will retain adequate blood supply from Ar to vas and cremasteric vascular anastomosis

HIGH LIGATION OF TESTICULAR VESSELS

ONE STAGE

Prior recognition of the need to divide testicular artery, so that dissection that compromises the artery to vas / cremasteric supply can be avoided

TWO STAGE (Lap)

Stage 1: Testicular artery ligated early to allow development of collaterals

Stage 2: Subsequent orchiopexy 6-12 months later.

MICROVASCULAR ANASTOMOSIS

OF TESTICULAR VESSELS TO INFERIOR EPIGASTRIC VESSELS

LAPAROSCOPIC ORCHIOPEXY FOR IMPALPABLE TESTES

Laparoscopy

① BLIND ENDING VESSELS & VAS
↓
Absent testis
↓
No further intervention

② ATROPHIC INTRA-ABDOMINAL TESTIS
↓
Orchiectomy

③ TESTIS AMENABLE TO ADEQUATE MOBILISATION
↓
Orchiopexy

④ TESTIS NOT AMENABLE TO ADEQUATE MOBILISATION
↓
2-STAGE FOWLER STEPHENS PROCEDURE

⑤ VAS & VESSELS SEEN EXITING VIA DEEP RING
↓
Inguinal exploration

Koff's - Low ligation of Testicular vessels

Shehata - Fixing intra-abdominal testes close to opposite deep ring & then bringing it down to scrotum in a second procedure

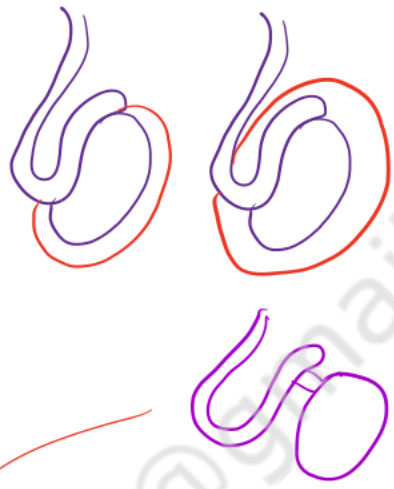
TECHNIQUES OF ORCHIOPEXY

- External anchorage - passing stitch through tunica albuginea & anchoring it to thigh - tie over gauze - keep stitch x 3wks
- Keetley Torek - Testis placed in s/c pouch in thigh - 2nd stage - placed in scrotum
- Omberdanne - placing the UDT in the opposite hemiscrotum by incising median septum
- Denis Browne - Purse-string catgut suture at neck of scrotum
- Dartos pouch

TORSION TESTIS

- Condition whereby the testis twists in a manner that compromises its blood supply
- Surgical emergency

PREDISPOSING FACTORS



1) High investment of tunica vaginalis
   ↓
   Testis hangs within the tunica like a clapper in a bell (B/L)
2) Inversion of testis - lies transversely or upside down
3) Separation of the epididymis from the body of the testis
   ↓
   testis twists on the pedicle connecting it with the epididymis
4) Undescended testis

Abdominal muscle contraction → Cremasteric contraction
↓
d/t Spiral attachement of cremaster + improperly fixed testis
↓
TORSION

Twists ≥720° - rapid & profound ischemia

Chance of testicular salvage - 100% at 6 hr
20% at ≥24 h

Spontaneous untwisting → recurrent episodes → Intermittent testicular pain in adolescents

FEATURES

- m/c in 10-25y
- Sudden onset of pain - usually follows an episode of exertion/intercourse
- a/i nausea
- cremasteric Reflex lost

PREHN SIGN — Elevate testis → Pain ↓ — ED
→ Pain ↑ → Torsion

ANGEL SIGN - torsion testis lies in a slightly higher position

USG

Doppler ultrasound

Exploration ⇒ transverse scrotal incision

↓

untwist cord

↙ Viable

↓

Orchiopexy

↓

3 non-absorbable sutures from tunica albugenia to scrotal raphe

+

Orchiopexy of c/L testis

↘ Non viable

↓

Confirm by small incision in tunica albugenia

↓

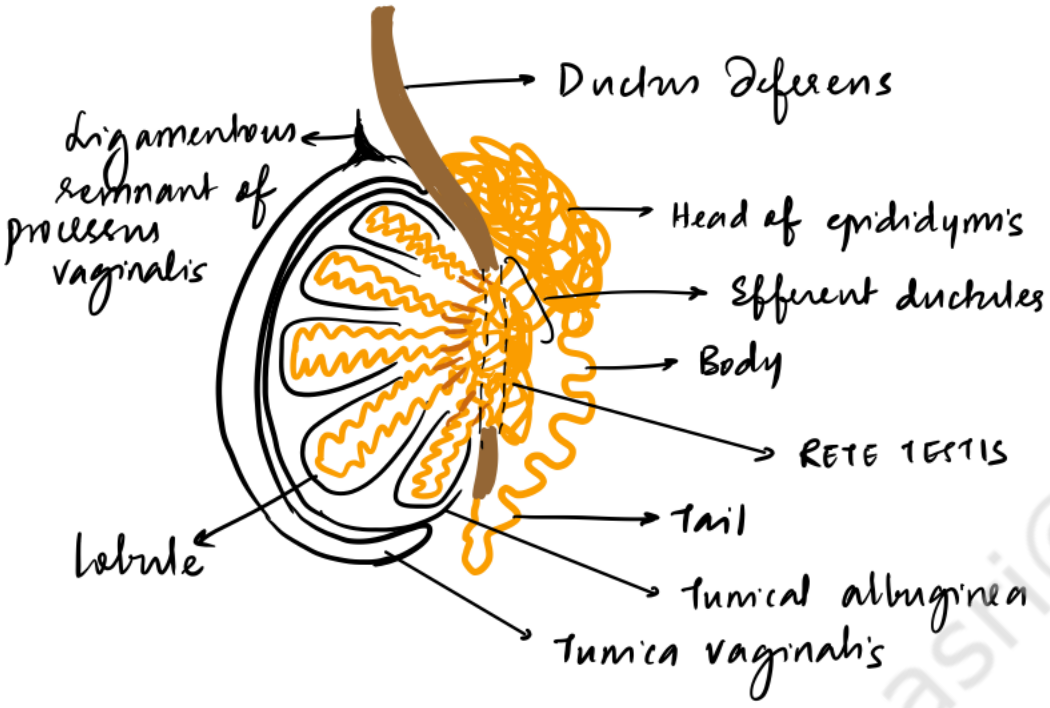
Orchiectomy

↓

Testicular prosthesis

TESTICULAR TUMORS

ANATOMY



200-300 lobules
↓
2-3 seminiferous tubules / lobule
↓
Straight tubules
↓
Rete testis
↓
Efferent ductules
↓
Epididymis
↓
Ductus deferens

Blood supply- testicular artery

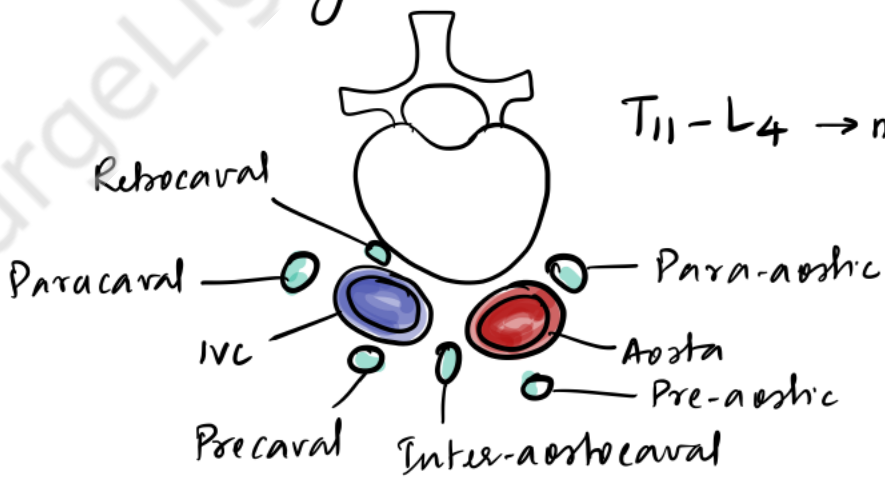
Collaterals- Cremasteric artery
Artery to vas

Venous drainage → pampiniform plexus → gonadal veins

(R) → IVC

(L) → (L) Renal vein

Lymphatic drainage- RETROPERITONEAL NODES



$T_{11} - L_4$ → more $L_1 - L_3$

Pelvic & Inguinal nodes are not regional nodes → involvement likely if h/o transscrotal Sx (+)

EPIDEMIOLOGY

- M/c malignancy in men aged 15-35y
- GCT (90-95% of all Testicular tumors) → 34y : median age at Dx
  - NSGCT → 3rd decade
  - Seminoma → 4th decade
- TRIMODAL → 2-4y, 20-40y, >50y
- >50y ⇒ Lymphoma likely → 50% (B|L) → LDH ↑

RISK FACTORS

1. Cryptorchidism – 7-10% of Cryptorchidism-tumors
   - max for intra-abd testis
   - ↑ risk of malignancy in contralateral testis
   - Prepubertal orchidopexy (<13y) → ↓ risk of malignancy
2. Klinefelter SO → brother - 8-10x, father - 2-4x
3. family, personal history
4. ITGCN – Intratubular germ cell neoplasia
   - NOT a precursor for Yolk sac tumor, teratoma, spermatocytic seminoma
   - isochromosome 12p, CKIT mutation
   - Mx – Orchiectomy / low dose RT (≥20Gy) / Observation
5. ? Trauma / Viral infection / Environmental estrogens

CLASSIFICATION

GERM CELL TUMORS

ITGCN

- Seminoma
  - Classical
  - Anaplastic
  - Spermatocytic
- NSGCTs
  - Embryonal ca
  - Yolk sac tumor
  - Polyembryoma
  - Trophoblastic tumors
  - Teratomas

SEX-CORD/STROMAL TUMORS

- Leydig cell
- Sertoli cell
- Granulosa cell
- Thecoma/fibroma
- Mixed

UNCLASSIFIED

Gonadoblastoma
Mixed GC-SC tumors

SEMINOMA

- m/c testicular tumor

TYPES

- CLASSICAL → m/c (85%), 4th decade
  - Homogenous; NO hemorrhage/necrosis
  - CD117, PLAP ⊕ CD30 ⊖
- ANAPLASTIC – 5-10%
  - → ≥3 mitoses/hpf, nuclear pleomorphism
- SPERMATOCYTIC – 5-10%
  - older pts – >65y, slow growing, no mets

→ TUMOR MARKERS – AFP, LDH → Ⓝ
hCG → Ⓝ, ± in 10% cases

EMBRYONAL CARCINOMA – 2nd m/c

* pleomorphism, mitoses, giant cells
* variegated – Areas of HEMORRHAGE & NECROSIS Ⓟ

Very aggressive – invade cord & epididymis

→ TOTIPOTENCY → can differentiate into other types of NSGCTs

AFP, βHCG Ⓟ

YOLK SAC TUMOR

- Pure form → KIDS
- Mixed form → ADULTS

AFP ↑, hCG Ⓝ

→ Schiller-Duval bodies → Glomerular pattern – mesodermal core & central capillary

CHORIOCARCINOMA

Rare, AGGRESSIVE

↑ hCG

Presents as disseminated disease
- LUNGS & BRAIN

Primary is usually small
- often no testicular enlargement

hemorrhage → in lung / brain
↓
FATAL

TERATOMA

contains derivates of 2/more germ layers ± varying degrees of differentiation

PURE FORM → KIDS

MIXED → Adults

AFP ± ↑

IMMATURE

MATURE

Mucinous cysts, heterogenous

CHEMORESISTANT

EXTRAGONADAL GCTs: Mediastinal | Retroperitoneal | Sacrococcygeal | CNS
- Pituitary
- Pineal

Mediastinal → truly 'ectopic'
m/c → SEMINOMA

Retroperitoneal → usually have testicular primary

SEX-CORD-STROMAL TUMORS

LEYDIG CELL TUMOR

m/c non germ cell tumor

Bimodal — 5-10y
25-35y

small, yellow, well circumscribed

REINKE CRYSTALS – cytoplasmic inclusions

SECRETE TESTOSTERONE

SERTOLI-CELL TUMOR

very rare

Bimodal — <1y
20-45y

gray-white, cystic components

Virilization, gynecomastia

GONADOBLASTOMA

very rare

Mixed germ cell / sex cord / stromal tumor

GONADAL DYSGENESIS → 80% phenotypic females
<30y

PRESENTATION

1) m/c presentation → Painless testicular mass
firm, non transilluminant scrotal mass
↓
cancer unless otherwise proven

2) Acute testicular pain → less common
↘ d/t intratumor hemorrhage / infarction
↓
NSGCT >> seminoma
↓
R/o epididymo-orchitis $\xrightarrow[2\text{-}4\ wks]{Abx}$ re-evaluate

3) Symptoms d/t LN mets
↳ RP nodes → Back pain → Psoas muscle
Nerve roots
↘ Radiculopathy
↓
IVC compression
↳ lower limb swelling
DVT
↓
Abdominal mass
↓
Supraclavicular nodes – neck mass

4) Distant mets:
Lungs – dyspnea, chest pain, coughs, hemoptysis
CNS – FND, seizures

5) Endocrine effects – Gynecomastia (d/c ↑ hCG
↓ Androgen
↑ Estrogen → Leydig cell tumors)
↓ Fertility
Virilization

EVALUATION

1) Scrotal USG - extension of clinical examination

5-10 MHz - high frequency transducer

B/L - 2% chance - 0.5% of all GCTs - B/L at ∂x

<10mm ✓

homogenous — Seminoma Heterogenous - NSGCTs

2) TUMOR MARKERS

ONCO FETAL SUBSTANCES

ALPHA FETO PROTEIN

(N) - <16 ng/mL

$t_{1/2}$ - 5-7∂

Elevated in -
- Embryonal CA
- Teratocarcinoma
- Yolk sac tumor
- Mixed tumors

NOT ELEVATED IN
- Pure seminoma
- Pure choriocarcinoma

β-HCG

(N) - < 5 IU/L

$t_{1/2}$ - 24-36 h

Elevated in

Choriocarcinoma	100%
Embryonal Ca	60%
Teratocarcinoma	55%
Yolk sac tumor	25%
Seminoma	~7%

CELLULAR ENZYMES

LDH

(Isoenzyme -1)

(N) - <333 IU/L

$t_{1/2}$ - variable

Metastatic seminoma (80%)

NSGCT metastatic (60%)

PLAP

$t_{1/2}$ - ≤ 24 hrs

↑ in ~50% of seminomas at presentation

In testicular cancer, tumor markers are measured
- at presentation → to confirm diagnosis
- 1 week after orchidectomy - for staging
- After completion of therapy at regular intervals for surveillance & followup

for germ cell tumors

3) RADICAL INGUINAL ORCHIECTOMY (RIO)

Suspected testicular neoplasm ⟶ RIO - initial dx & tx procedure of choice

Removal of tumor-bearing testicle + spermatic cord to the level of the INTERNAL INGUINAL RING

TRANS-SCROTAL ORCHIECTOMY / BIOPSY ⟶ CONTRAINDICATED

∵

- Alters lymphatics ↓ Inguinal / Pelvic LN mets ↓ M1
- leaves inguinal spermatic cord intact ↓ Locoregional recurrence

HPE
- type
- size & invasion
- Multifocality
- ITGCN±
- LVI

TESTIS SPARING SURGERY

↓

Not justified in a pt ☐ testicular tumor + contralateral (N) testis

May be considered in

1) • Bilateral testicular tumors in young
   • tumor in solitary testis ☐ suff androgen production
   → IFF → tumor <2-3cm (<30% testicular volume)
2) Suspected benign lesion <3cm
   Leydig / Sertoli cell tumor

☐/L TESTICULAR BIOPSY

In pts ☐ ↑ risk for ITGCN (testicular volume <12 ml, Cryptorchidism hx, suspicious USG lesion)

Open inguinal biopsy

CHEVASSU MANEUVER
- Inguinal approach
- Clamp testicular vessels ↓ Explore testis & biopsy (via incision on anterior convexity)

4) IMAGING FOR METASTASIS

Abdominopelvic CT – CECT - Oral + IV contrast
- RP nodes - size, number, location
- RP vascular anatomy anomalies - Retrocaval (R) nodes

CXR, Chest CT - lung mets, Mediastinal GCTs

Bone & Brain scan → if symptomatic
→ ++ for Choriocarcinoma / ↑ BhCG

STAGING

Clinical Staging

Cs I → Confined to testis

Pathological

- T_{is} - ITGN
- T_1 - limited to testis & epididymis, no LVI
- T_2 - T_1 + tunica vaginalis / LVI
- T_3 - Spermatic cord invasion ± LVI
- T_4 - Scrotum invasion ± LVI

Cs II → Regional (Retroperitoneal) nodal involvement

	Cs II A	II B	II C
	LN < 2cm	2-5 cm	> 5cm
Pathological ←	N_1	N_2	N_3

Cs III – Non regional nodal / Distant mets

Pathological

- M1a → Pulmonary / Non regional nodes
- M1b – other distant mets

Serum Marker staging

	S_1	S_2	S_3
AFD	< 1K ng/mL	1K-10K ng/mL	> 10K ng/mL
	+	(or)	(or)
hCG	< 5K IU/L	5K-50K IU/L	> 50K n lr
	+	(or)	(or)
LDH	< 1.5 × ULN	1.5-10 × ULN	> 10 × ULN

→ Based on **POST-RIO** serum tumor marker levels (NOT) levels at Dx

	SEMINOMA	NSGCT
Presentation	Early	late
Occult mets	↓	↑
Relapse	↓	↑
Tumor markers	−−/+	↑
Tumor marker level in mets	↔	↑↑
Chemosensitivity	↑↑↑	↓
Radiotherapy	✓	only in brain mets
Risk of teratoma at mets sites	↓↓↓	↑
Likelihood of requiring post-chemo Sx	↓	↑

MANAGEMENT (After R1O)

A. CS-I

Seminoma – OPTIONS

- Surveillance
- Primary RT – to retroperitoneum & ipsilateral pelvis
  20-30Gy / 10-15 daily fractions
- Primary chemotherapy
  Single agent – CARBOPLATIN

NSGCT

Surveillance – in very low risk tumors

High risk: Embryonal component, LVI
↓
1) RPLND – Primary RPLND
   ~full B/L template nerve sparing
   or
2) Primary chemo
   BEP x 1 – Bleomycin
   Etoposide
   Cisplatin

B. CS II A, II B

Seminoma	NSGCT
Dog-leg RT - 25-35 Gy First line chemotherapy BEP x 3 EP x 4	(A) 1° RPLND ± Adjuvant chemo OR (B) Induction chemo (BEP x3/x4) → ± Post chemo RPLND

C. CS II C, CS III, CS I(S) → in NSGCT

Seminoma	NSGCT
Chemo - EP x 4 BEP x 3	BEP x 4 or VIP in high risk pts Vinblastin, Ifosfamide, Cisplatin

RPLND

Standard RPLND - Pre aortic
Para-aortic
Aortocaval
Precaval
Paracaval
+
Common iliac nodes

Nerve sparing - L_1-L_4 - post ganglionic efferent sympathetic fibres → influence antegrade ejaculation

Avoided in Choriocarcinoma

Male Infertility

Infertility - inability of a sexually active couple to achieve spontaneous pregnancy with one year of unprotected intercourse

CAUSES OF MALE INFERTILITY

PRETESTICULAR (Hormonal)

- **Hypothalamic Causes**
  - Gonadotropin deficiency (Kallman S°)
  - Isolated LH deficiency - Testis enlarged
  - Isolated FSH deficiency
  - Idiopathic
  - Congenital S° - Prader willi, Bardet Biedl
- **Pituitary Causes**
  - Pituitary insufficiency (tumor, infarcts, radiation, inflammation, hemochromatosis)
  - Hyperprolactenemia
- **Exogenous / Endogenous Hormones**
  - Estrogens (↑ Estrogen : Testosterone ratio 10 : 1 → is disturbed)
    - Liver disease, testicular & adrenal tumors
  - Androgens - d/t suppression of HPT axis

CONGENITAL ADRENAL HYPERPLASIA

- Thyroid disorders: Both Hypo & Hyper

Issues i stimuli for spermatogenesis

TESTICULAR

- **Genetic Causes**
  - Y chromosome microdeletions
  - Klinefelter S°
  - Noonan S° (45 x / 46 x Y mosaic)
  - Myotonic Dystrophy
  - Vanishing testis S°
  - Sertoli cell only S°
  - Defective DNA mismatch repair
- **Gonadotoxins**
  - Radiation
  - Drugs
- **Systemic Disease**
  - Renal failure
  - Liver failure
  - Sickle Cell disease
  - Diabetes Mellitus
- **Defective androgen activity**
  - 5α reductase deficiency
  - Androgen Receptor Deficiency
- **Testicular injury**
  - Orchitis
  - Torsion
  - Trauma
- **Cryptorchidism**
- **Varicocele**
- **Idiopathic**

Issues i spermatogenesis

POST TESTICULAR

- **Reproductive Tract Obstruction**
  - Congenital blockages
    - Cystic Fibrosis
    - Young S° - ciliary dysmotility
    - Idiopathic Epididymal obstruction
    - ADPKD - Epididymal obstruction
    - Congenital Ejaculatory Duct obstruction
  - Acquired blockages
    - Vasectomy
    - Vas injury
    - Bacterial infections
  - Functional blockages
- **Disorders of Sperm Function / Motility**
  - Immotile cilia S° - Kartagener
  - IMMUNOLOGICAL - Anti sperm abs
  - Infections
- **Disorders of Coitus**
  - Impotence / ED
  - Hypospadias
  - Timing and frequency

Issues i sperm transport

APPROACH

A - HISTORY

Components of Infertility History

① FERTILITY HISTORY
- Previous Pregnancies (all partners)
- Previous infertility treatments
- Duration of Infertility
- Female evaluation - Female Fecundity ↓ ≥ 35y

② SEXUAL HISTORY
- Timing & frequency of intercourse - ideal → around ovulation, Q 2d (sperm resides in cervical mucus 1-2d)
- Erectile dysfunction
- Use of lubricants. - K-Y Jelly, lotions & saliva → ↓ sperm motility

③ DEVELOPMENTAL HISTORY
- Cryptorchidism — ↓ sperm production
- Childhood cancer/treatment
- Mumps orchitis
- Pubertal development - Kallmann - Delayed puberty

④ MEDICAL HISTORY
- Systemic Illnesses - T2DM, Cancer, Infection
- Genetic diseases - Klinefelter's, Cystic Fibrosis → Congenital absence of vas

⑤ SURGICAL HISTORY
- Orchiopexy → testicular atrophy
- Hernia surgery → vas deferens injury, testicular atrophy
- Traumal Torsion
- Pelvic / Retroperitoneal Surgery } Ejaculatory dysfunction
- TURP

⑥ FAMILY HISTORY

⑦ MEDICATIONS
- Testosterone
- Nitrofurantoin
- Cimetidine
- α-blockers
- Spironolactone
- Opioid analgesics
- Cytotoxic chemotherapy
- PDE 5 inhibitors

⑧ SOCIAL HISTORY: Smoking, alcohol, anabolic steroids (inhibition of Hypothalamic Pituitary Gonadal axis), recreational drugs - Gonadotoxic

⑨ OCCUPATIONAL HISTORY: Exposure to ionizing radiation, Chronic Heat exposure, Pesticides, aniline dyes, heavy metals. → ↓ sperm count

Childhood testicular radiation ≥ 7.5Gy

(B) PHYSICAL EXAMINATION

1) Secondary Sexual characters, obesity
   - Gynecomastia, ↓ Body Hairs } Androgen insufficiency

2) Scrotal examination
   - TESTIS – SIZE & CONSISTENCY – MALDESCENT, TUMOR
     - Firm – (N)
     - Soft – abnormal
   - Orchidometer for testicular volume

Hypogonadism –

EPIDIDYMIS – Induration, tenderness, cysts

VAS – for any congenital absence of vas deferens

VARICOCELE – a/c atrophy of testis

3) PENIS
   - Hypospadias, Chordee, Phimosis } Inadequate semen delivery

4) PROSTATE & SEMINAL VESICLES
   - Prostatitis, Ca Prostate
   - Enlarged seminal vesicles – Ejaculatory duct obstruction

(C) LABORATORY EVALUATION

1) Semen analysis – After 2-5 d of abstinence

SEMEN VOLUME	≥1.5 ml (N); ↓ in retrograde ejaculation → analysis of urine – centrifuge semen pellet for sperm count	
SPERM CONCENTRATION	≥ 15 million/ml	↓ in oligozoospermia
TOTAL NUMBER OF SPERMS	≥ 40 million/ejaculate	
% MOTILITY	≥ 40%	↓ in asthenozoospermia
% PROGRESSIVE MOTILITY	≥ 32%	
% NORMAL FORMS	≥ 4%	→ ↓ in teratozoospermia
% VITALITY	≥ 58%	→ ↓ in necrozoospermia

pH > 7.2

Leucocytes < 1×10^6/ML

Seminal fructose – ↓ in ejaculatory duct obstruction

Semen culture

- Sperm function assessment
  1) Sperm-mucus (cervical) interaction – Post coital test
  2) Acrosome reaction testing
  3) Sperm-penetration Assay
- Antisperm antibodies assay < direct – over sperm; indirect – in semen/serum
- Sperm DNA fragmentation assay
- Hypo-osmotic swelling test

2) Hormonal Assessment
- to evaluate hypothalamic - pituitary - gonadal axis

CONDITION \ HORMONE	TESTOSTERONE (240 - 950 ng/dl)	FSH (1 - 8 IU/L)	LH (1.3 - 13 IU/L)	PROLACTIN (2 - 15 ng/mL)
PRIMARY TESTICULAR FAILURE	↓	↑	↑	(N)
Central Cause ← HYPOGONADOTROPIC HYPOGONADISM	↓	↓	↓	(N)
HYPERPROLACTINEMIA	↓	↓	↓	↑
ANDROGEN RESISTANCE	↑	↑	↑	(N)

Poor secondary sexual characters, obesity → measure estrogen
ESTRADIOL - ↑
(N 12-40 pg/mL)

3) Genetic tests
1) Chromosomal studies - Klinefelter syndrome
2) CFTR mutation testing
3) Y-chromosome microdeletion analysis

(D) RADIOLOGICAL INVESTIGATIONS

1) Scrotal ultrasound
- TESTICULAR ASSESMENT
- VARICOCELE

2) TRUS - (low ejaculate)
Obstruction - dilated seminal vesicles (>1.5cm)
dilated ejaculatory ducts (>2.3mm)

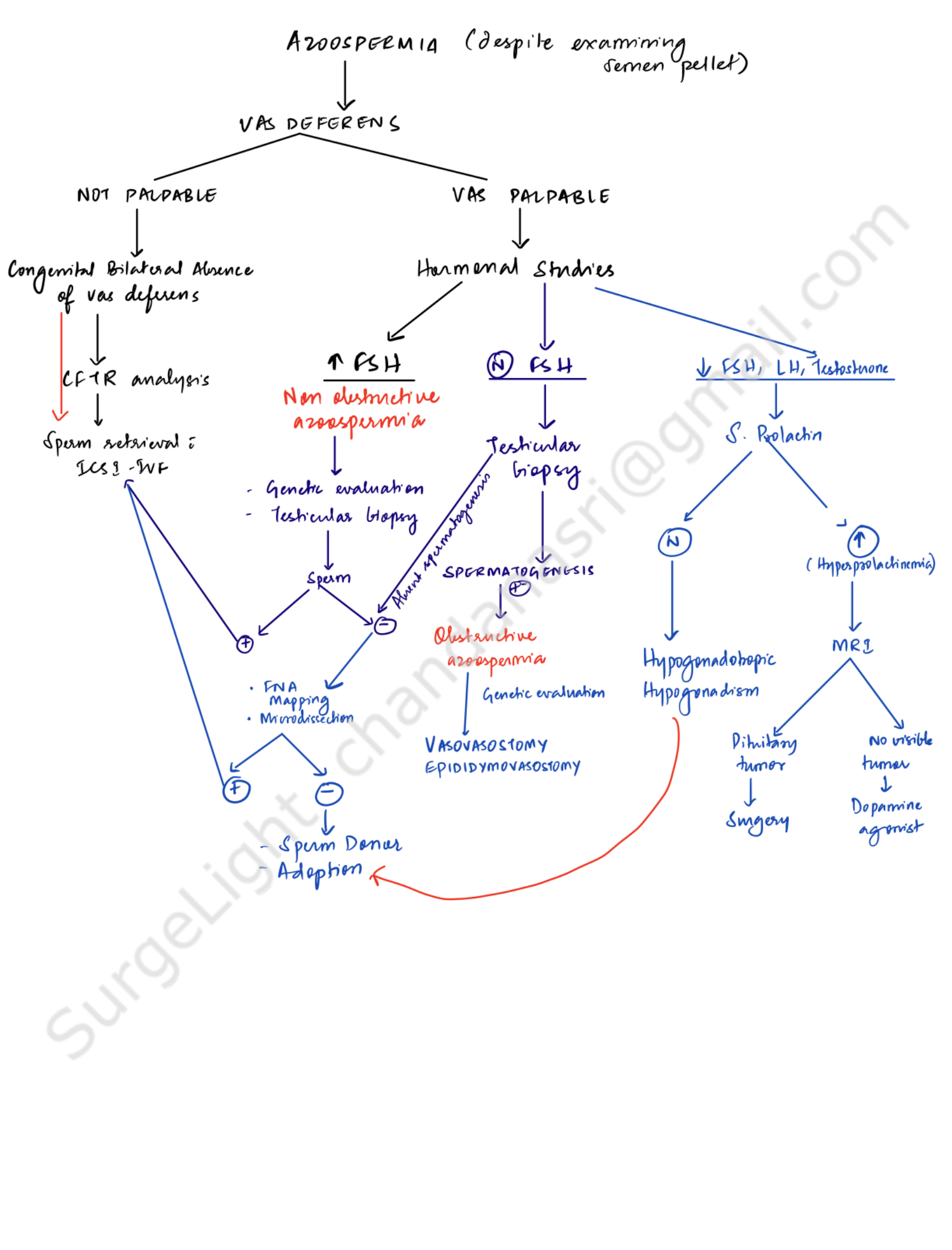
3) CT/MRI - evaluation of non-palpable testis
Retroperitoneal pathology - solitary (R) varicocele
cranial imaging for hyperprolactinemia - pituitary adenomas

4) Vasography - no longer done

(E) TESTES HISTOPATHOLOGY

Indications - Azoospermic men - to distinguish b/w OBSTRUCTIVE/NON-OBSTRUCTIVE AZOOSPERMIA

Multisite FNA of testis → Sperm Retrieval



TREATMENT OF MALE INFERTILITY

- COITAL COUNSELLING THERAPY
  - Timing - around ovulation
  - Frequency - alternate day
  - Avoiding lubricants
  - Avoiding gonadotoxins

- Rx of ED
- Antioxidants
- Steroids in Antisperm antibodies?

Rx of retrograde ejaculation - Imipramine, Pseudoephedrine, Ephedrine
EJACULATION ON FULL BLADDER, VIBRATORY PENILE STIMULATION

- CORRECTION OF HORMONAL DISORDERS

- Hyperprolactinemia - Surgery for pituitary adenoma
  Dopamine agonists
- Correct thyroid Dysfunction
- Congenital Adrenal Hyperplasia - Corticosteroids
- Idiopathic ↓ FSH, LH & low sperm count - Clomiphene Citrate (off label)
  blocks -ve feed back by endogenous estrogens
  ↑ GnRH, FSH, LH
- Testicular stimulation ± recombinant FSH, hCG, GnRH
- Stop any culprit drugs

SURGICAL TREATMENT

1) Varicocele treatment — Open
   Laparoscopic
   Radiologic
2) Vasectomy reversal / Vasovasostomy / Vasoepididymostomy
3) Ejaculatory duct Obstruction - unroofing of obstructing cyst by TURED
   ↓
   Transurethral resection of Ejaculatory duct
4) Orchidopexy

ASSISTED REPRODUCTIVE TECHNIQUES

1) Intrauterine Insemination
2) IVF & ICSI after sperm retrieval — Vasal aspiration
   Epididymal aspiration
   Testicular sperm extraction
3) Sperm/Testicular Cryopreservation in Cancer

VARICOCELE

Abnormal dilatation & tortuosity of internal spermatic veins within the PAMPINIFORM plexus of the spermatic cord

- common after adolescence
- risk of subfertility in adulthood

L > B/L > R

Causes

1) ↑ pressure in (L) renal vein [(L) testicular vein inserts into (L) Renal vein]
2) Collateral venous anastomoses
3) Valvular incompetence of (L) internal spermatic veins (test. vein) at its junction i (L) renal vein

↓

Reflux

PATHOGENESIS

Varicoceles impede testicular growth ⇒ Testicular hypotrophy / atrophy

↓

? By increasing scrotal temperature

Causes for predilection for (L) side

1. Left testicular vein drains into left renal vein at right angles.
   <(R) testicular veins drains directly into IVC>
2. Total length of the testicular vein → (L) > (R)

∴ (L) testicular vein drains at a higher level and left testis hangs at a lower level

3. In about 15% of cases, left testicular artery arches over left renal vein.
4. Loaded sigmoid colon may press on left testicular vein
5. Left suprarenal vein drains into (L) renal vein
   → circulating adrenaline may cause constriction of testicular vein at site of drainage.

⑥ Occasionally, left testicular vein may pass in between abdominal aorta and superior mesenteric artery (NUTCRACKER SYNDROME)

⑦ Incompetent valves are more common on left side

CLINICAL EVALUATION

Examine in supine & standing positions

Inspect for visible swelling

↓

palpate spermatic cord at rest & valsalva maneuver

'Bag of worms'

CLINICAL GRADES

Grade-0-	Non palpable (Subclinical)
Grade-1	Palpable only ε Valsalva
Grade-2	Easily palpable but not visible
Grade-3	Visible

Veins should decompress in supine position

↓

failure - esp on (R) side ⇒ evaluate for abdominal/pelvic mass
eg. RCC

Testis - examine for size & consistency

↓

Prader orchidometer

EVALUATION

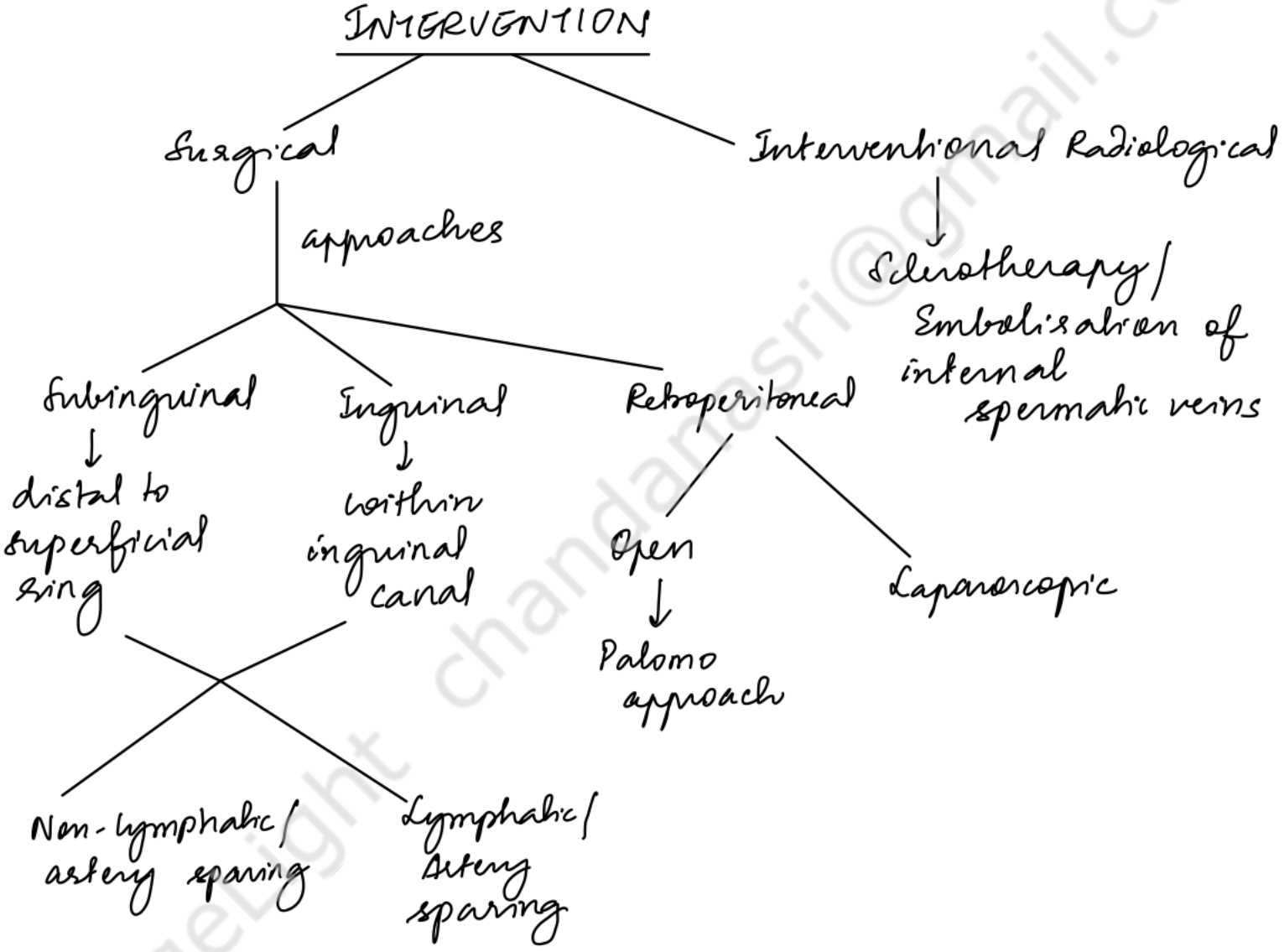
USG - Spermatic vein diameter >2mm
Retrograde blood flow

↓ Testicular volume

Semen analysis - to quantify/document testicular dysfunction

Rx - Indications for intervention

- Infertility – Abnormal semen analysis + varicocele
  Significant testicular atrophy (≥ 20%)
  Pain



VASECTOMY

Permanent method of male contraception

Pre-vasectomy measures

- Information about short term & long term contraceptive measures
- Counselling - Vasectomy is permanent
  Reversal is possible, but not assured

  Also, reversal of female sterilization has poorer results than reversal of male sterilization
- Age >22y, <60y
- Atleast 1 child older than 1y
- Sound mind
- Partner - informed
  Partner consent not mandatory
- Inform about risk of vasectomy failure
- Vasectomy doesn't interfere with the logistics of the sexual act - can have erections and ejaculate
- Barrier contraception to be used upto 8-12 weeks post procedure - until sperms in the tubes have been evacuated
- Still need barriers to prevent STD

TYPES

- Conventional vasectomy
- No scalpel vasectomy

RECANALISATION OF VAS DEFERENS

Indications

1) Vasectomy Regret
2) Obstructive azoospermia resulting from iatrogenic injuries such as hernia surgeries

Pre-operative evaluation

1) Testis - Small / soft (atrophic) testis ⇒ poor outcome
2) Epididymis - indurated, irregular epididymis
   ⇒ 2° epididymal obstruction
   ⇒ requires vasoepididymostomy
3) Sperm granuloma ⇒ good outcome
4) Varial gap - ↑ gap ⇒ extensive surgery

Lab investigations

1) Semen analysis ± centrifugation
2) Antisperm antibodies ⇒ poor prognosis
3) S. FSH ⇒ ↑ ⇒ impaired spermatogenesis - poor prognosis

Approaches: Scrotal / Inguinal

Technique - Periadventitial dissection while avoiding injury to vasal vessels

Large vas gap - mobilising vas from epididymal tunica

- Transverse cut of testicular end of vas
  - inspection for healthy, supple mucosa
  - milked and slide sent for examination
- Freshening of abdominal end of vas
- Vasovasostomy / vasoepididymostomy performed by microsurgical technique
  - mucosa - mucosa
  - tension-free
  - leak-proof
  - gentle handling
  - preserve vascularity

- Crossed vasovasostomy - U/L obstructive azoospermia ± contralateral atrophic testis ± (N) vas

Male sterilisation techniques that make recanalisation easier

1) Injected plug: Medical Grade Polyurethane
Medical Grade Silicone rubber
→ injected into vas
→ hardens & forms plug

2) Intra-vas devices

3) RISUG - Reversible Inhibition of Sperm under guidance
powdered styrene maleic anhydride
injected ↓ hardens into gel
plugs vas & also has spermicidal action
Reversal - Injection of Dimethyl sulfoxide flushes out the gel.

Other methods

Hormonal - Poor acceptance 2/t to systemic effects & effect on libido

Barrier - male condoms

CARCINOMA PENIS

Epidemiology

- ↑ in non-circumcising populations ; Rare among jews
- older men
- Poor prognosis- Age at dx >65
  LN ⊕

RISK FACTORS

1) Sexual habits- Multiple sexual partners
2) Phimosis
3) Balanoposthitis
4) Chronic penile inflammation
5) Lichen sclerosus - BXO
6) SMOKING & TOBACCO
7) HIV/ HPV infection → m/c → 16, 18, 31, 33, 35, 39, 45, 51, 52, 58, 59 → G6, G7 → RB, P53
8) Poor hygiene
9) Lack of Neonatal circumcision } Smegma
10) ? Penile trauma

PREMALIGNANT CONDITIONS

NON HPV-RELATED

- Cutaneous horn : Develops over a pre-existing lesion → which may be pre-malignant/ malignant - Rx - Excise ⊕ margin, examine base
  33% penile horns - a/w SCC
- PKMB - Pseudoepitheliomatous Keratotic Micaceous balanitis
  ↳ growth on glans : PLAQUE → VERRUCOUS → INVASIVE
- BXO - Balanitis Xerotica obliterans - genital lichen sclerosus
  whitish patch on prepuce / glans → meatus → fossa navicularis
  Rx - Clobetasol cream / Meatoplasty / excision

HPV RELATED

1) CONDYLOMA ACUMINATUM
   soft, papillomatous
   HPV- 6, 11, 42, 44
   Rx - Imiquimod
   Cidofovir gel
   5FU cream
2) BUSCHKE-LOWENSTEIN TUMOR - Giant Condyloma acuminatum
   Topical Podophyllin / 5FU
3) Bowenoid Papulosis

PENILE INTRAEPITHLIAL NEOPLASIA / CARCINOMA IN SITU

GLANS
Erythroplasia of Queyrat

SHAFT
Bowen's Disease

PRESENTATION → glans > prepuce > coronal sulcus > shaft

small lesion → spreads to glans, shaft, corpora → untreated → Penile auto-amputation

papillary/exophytic — Flat/ulcerative → tendency for earlier nodal mets

INDURATION (+)

Buck Fascia - temperary natural barrier → protects corpora

Penetration of BUCK'S FASCIA & tunica albuginea → Corporal invasion → vascular dissemination

LYMPHATIC SPREAD - Regional - Femoral & iliac nodes

Prepubial lymphatics + shaft lymphatics → Superficial nodes (sup. to fascia lata)

Glanular + Corporeal lymphatics → Superficial nodes (sup. to fascia lata)

↓

DEEP NODES → PELVIC NODES (External + Internal Iliac, Obturator)

NODAL DISEASE

↓

Skin necrosis, infection

- death d/t sepsis/ erosion into femoral vessels

Distant mets: Lung, Liver, Bone, Brain - 1-10 Y.

EVALUATION

- Biopsy - Depth of invasion, Vascular invasion, grade → Broders grade
  - SCC: PAPILLARY / BASALOID / CONDYLOMATOUS / VERRUCUOUS / SARCOMATOID
    - PAPILLARY → m/c
    - BASALOID → Aggressive
    - HPV +/-

Perineural invasion → strong predictor of LN mets

- Hypercalcemia (without osseous mets) - paraneoplastic syndrome
- Imaging
  - Penile USG, MRI (for lesions i suspected corpora invasion) + erection
  - Nodal basin
    - → USG → CT/MRI
    - Clinically detected mets - PET-CT

STAGING

T

T_0 - no e/o 1°

T_x - cannot be assessed

T_{is} - PIN

T_a - Non invasive localised SCC (Well diff Verrucous Ca)

T_1

- Glans → invades lamina propria
- Prepuce → invades dermis, lamina propria, Dartos fascia
- Shaft → invades connective tissue between epidermis & corpora

T_{1a}
No lymphovascular invasion
Not high grade (3)
Not sarcomatoid

T_{1b}
LVI
high grade
perineural invasion
Sarcomatoid

T_2 - invades corpus spongiosum ± urethral invasion

T_3 - invades corpus cavernosum (including tunica albuginea) ± urethral invasion

T_4 - invades adjacent structures
- SCROTUM
- PROSTATE
- PUBIC BONE

N

N_x
N_0

N_1 - U/L mobile inguinal node

N_2 - B/L mobile inguinal nodes

N_3 - U/L / B/L fixed nodes or Pelvic nodes

M

M_0

M_1 - Distant mets ⊕

Stage grouping

0_{is} - T_{is} N_0 M_0

0_a - T_a N_0 M_0

I - T_{1a} N_0 M_0

II
- IIA - T_{1b} N_0 M_0; T_2 N_0 M_0
- IIB T_3 N_0 M_0

III
- IIIA - T_{1-3} N_1 M_0
- IIIB - T_{1-3} N_2 M_0

IV - T_4 any N M_0
N_3 any T M_0
M_1 any T any N

Ddx - Chancre
Chancroid
Granuloma inguinale
Herpes, TB

MANAGEMENT

a) Primary tumor

→ **ORGAN PRESERVATION**

Suitable cases:
- Tis, Ta, T1
- Grade I & II
- No LN/distant mets

MARGINS

Traditionally - 2cm proximal surgical margin for PARTIAL PENECTOMY

Now → 5mm for Gr I & II
10mm for Gr III

→ Glans sensation, Penile length } Important considerations

Modalities

- **Topical Rx**
  - Imiquimod, 5 FU } Tis
- **Radiation**
  - EBRT
  - Brachytherapy
    - Interstitial
    - Surface Mold Ir-192
- **Laser ablation** CO_2/Nd:YAG
- **Limited excisions**
  - Mohs micrographic &
  - Circumcision
  - Limited excision of glans
  - Glans stripping/resurfacing → Cis
  - Glansectomy

→ **PENILE AMPUTATION**
- Partial
- Total - Total penectomy & perineal urethrostomy

When partial penectomy is done,
A PENILE STUMP OF ≥2.5cm should be preserved → if not feasible - prefer total penectomy

SIR PIERSEY GOLD PROCEDURE - Total penoscrotectomy + B/L Orchidectomy + Perineal urethrostomy

Young's - operation = Partial Penectomy + B/L ILND

MANAGEMENT OF NODAL DISEASE

Cabana sentinel node - above & medial to SFJ

1) Clinically node-negative disease

ILND / DSNB indicated if primary is high risk

- $\geq T_2$
- $\geq T_1$, c Grade 3
- Lymphovascular invasion
- >50% is poorly differentiated

DSNB +ve → ILND

≥ 4 nodes (one I/ both sides combined) → PLND B/L

≥ 2 nodes +ve / Extranodal extension → Consider PLND on that side

Bilateral ILNDs are performed as it is not possible to predict laterality of nodal involvement

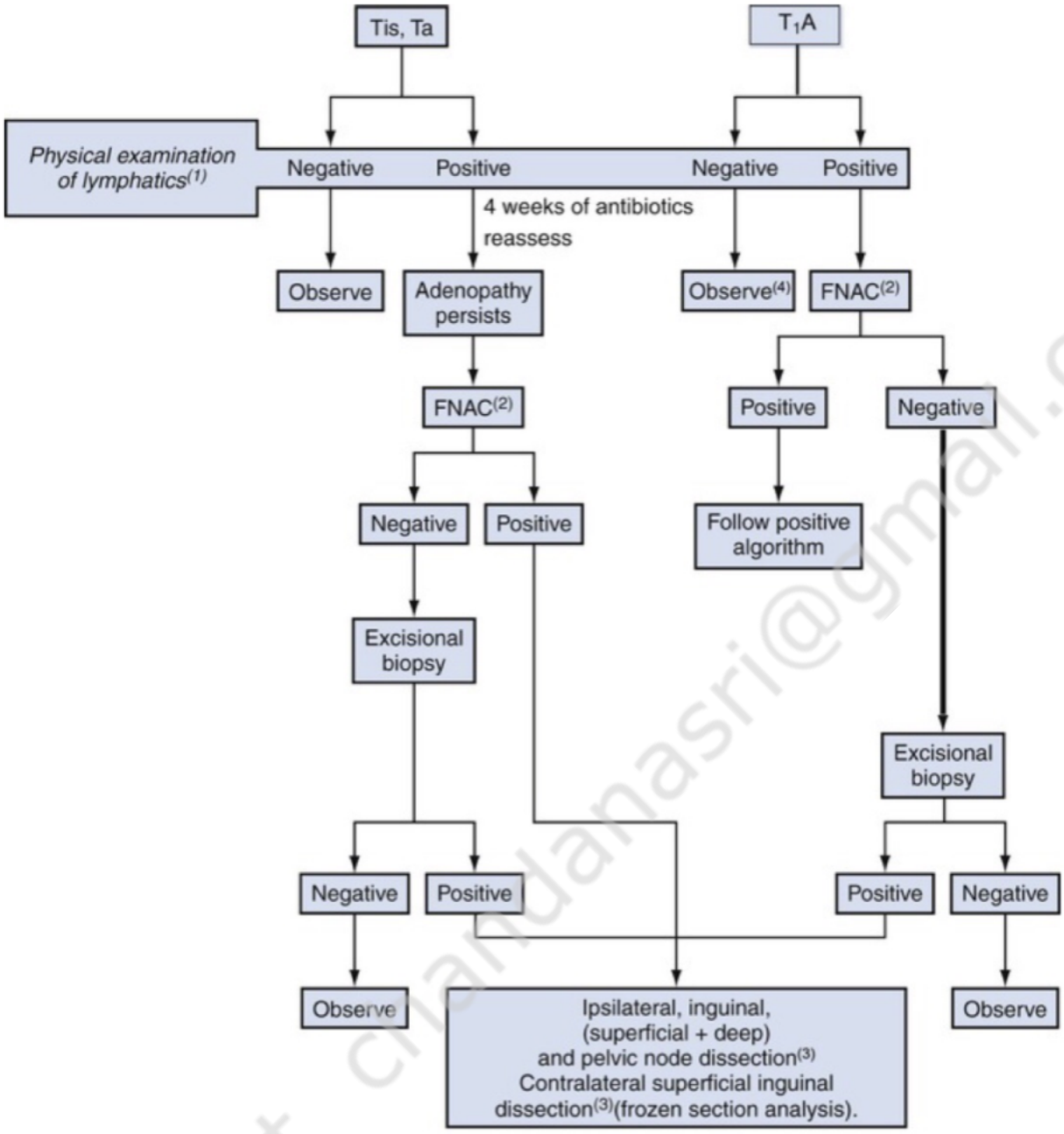
2) clinically node positive disease

B/L ILND ± PLND as per ILND findings

3) Delayed nodal presentation,

i.e., pt presenting c inguinal nodal neks $\geq$ 1y after treatment of primary

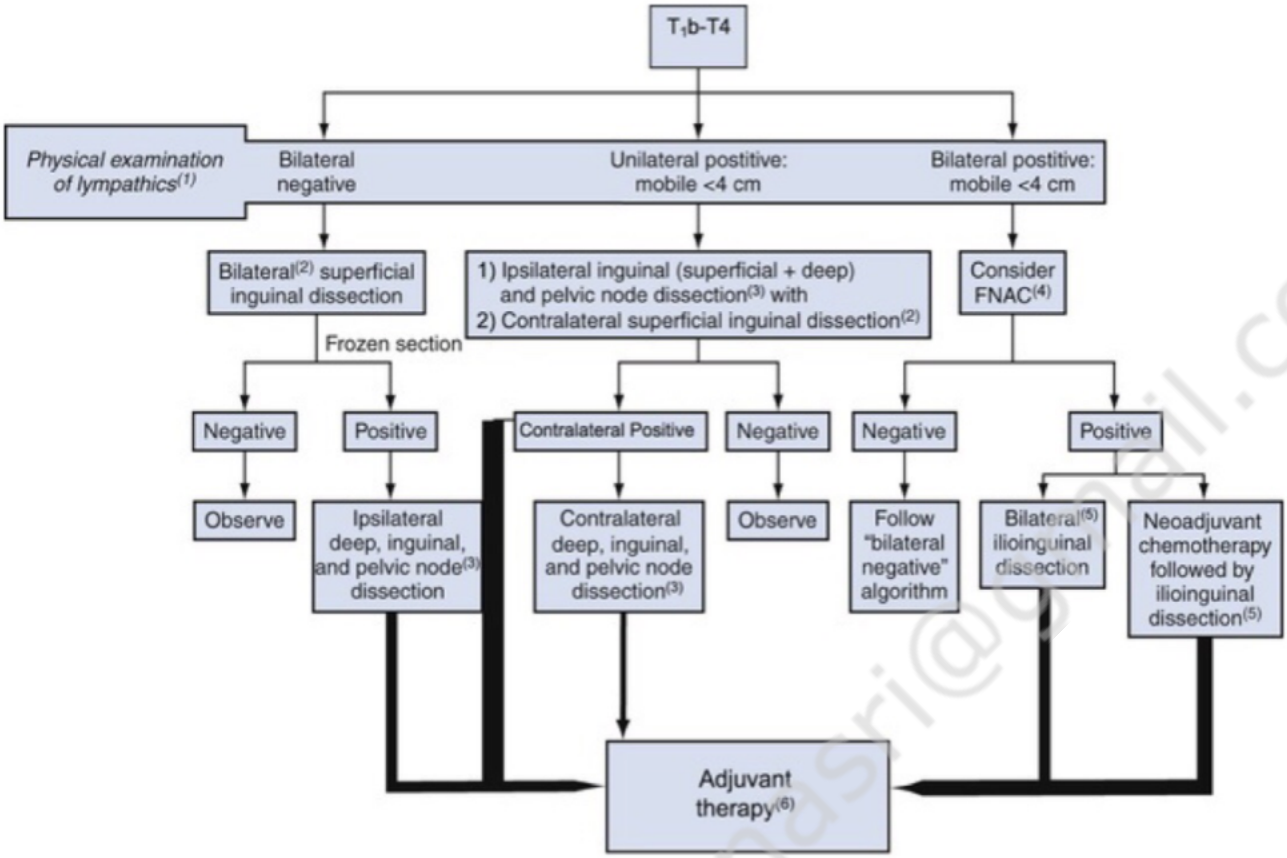
→ if nodes are unilateral, U/L ILND ± PLND will suffice (>3 m of surgery)



A

1) Includes physical examination and/or imaging studies.
2) Fine-needle aspiration cytology.
3) If 2 or more positive ipsilateral inguinal nodes or extranodal extension found.
4) Alternative DSNB at experienced centers, superficial dissection if noncompliant patient.

→ Observation ≤ 4 weeks Abx is done only in low risk tumors ≤ clinicoradiological nodes



1) Includes physical examination and/or imaging studies.
2) Complete modified dissection and dynamic sentinel node biopsy (DSNB, experienced centers) acceptable.
3) If >2 positive inguinal nodes or extranodal extension of cancer.
4) Fine-needle aspiration cytology.
5) Either approach is acceptable.
6) Consider if >2 positive lymph nodes, or bilateral metastases, extranodal extension of cancer or positive pelvic lymph nodes.

B

Even if B/L node negative - in ↑ risk cases,
minimum procedure - B/L superficial inguinal dissection
↓ Based on HPE
Deep, Pelvic ND

U/L +ve → Ipsilateral ILND + PLND
→ Contralateral ESLND $\xrightarrow[HPE]{}$ ± DILND + PLND

B/L +ve - FNAC - negative → B/L negative Algorithm

LOCALLY ADVANCED DISEASE

Tumor >4cm
+
Nodes >4cm
- Fixed nodes
- Pelvic nodes (+)

Surgically unresectable nodes

Circumcision + EBRT to 10

+

Induction chemo

Response → Surgery → Adjuvant Rx

① Radiotherapy

For Primary

Margins +ve after penectomy

For Nodal Basin

- Multiple +ve nodes
- ENE +

No response → Palliation → Chemoradiati

② Chemo – TIP regimen

Paclitaxel + Ifosfamide + Cisplatin

or

5FU + Cisplatin

INGUINAL BLOCK DISSECTION

STANDARD

Boundaries of standard - full template ILND
= DAESLER's QUADRILATERAL AREA

Superiorly - Inguinal ligament

Inferiorly - Apex of femoral △

Laterally - Medial border of Sartorius

Medially - Lateral border of Adductor Longus

→ GSV is divided

→ Sartorius is transposed to provide cover to the exposed femoral vessels

MODIFIED (CATALONA)

Aim - to decrease the morbidity a/i standard ILND

- shorter skin incision
- Limit the dissection field
  - Exclude area lateral to femoral artery
  - Exclude area caudal to fossa ovalis
  - PRESERVE GSV
  - eliminate the need to transpose sartorius

Therapeutic ILND
Nodal involvement detected on Sx
} → std ILND preferred

Complications

→ Injury to external iliacs / femorals → Hemorrhage

→ Injury to obturator nerve → impaired thigh adduction

→ Flaps - necrosis, SSI

→ Seroma

→ Lymphedema of limb

→ Deep vein thrombosis

Standard Inguinal Node Dissection: A 15–20-cm sub-inguinal incision, is performed, 2 cm below the inguinal ligament, from just beneath the anterior superior iliac crest medially to just beneath the pubic tubercle. Skin flaps are created, preserving the subcutaneous tissue superficial to Scarpa's fascia. The superior limit is just above the external oblique aponeurosis and the spermatic cord to the inferior border of the inguinal ligament. The lateral limit is the sartorius muscle, and the medial limit is the adductor longus muscle. The inferior extent of the dissection is the apex of the femoral triangle, where the femoral artery and vein are encountered. The saphenous vein is excised with the nodes, being ligated and divided below, at the apex of the femoral triangle and above, at the saphenofemoral junction. The lymph node tissue is then dissected off the fascia lata from an inferolateral to a superomedial direction. The deep inguinal nodes are removed from beneath the fascia lata, medial and lateral to the femoral vein, and extend superiorly to and below the inguinal ligament. The sartorius muscle is divided at its origin to the anterior iliac spine and is rotated to cover the femoral vessels to protect the femoral vessels from erosion. PLND is usually performed if the superficial or deep inguinal lymph nodes are positive for tumor.

PRIAPISM

Persistent penile erection – full / partial ≥4 hrs arising from the dysfunction of the mechanisms regulating penile rigidity & detumescence

ISCHEMIC / VENOGENIC PRIAPISM
(Penile compartment Syndrome)

Rigidity of corpora cavernosa ∵ LITTLE/NO CAVERNOSAL arterial inflow

arises due to VENOUS CONGESTION

Venous congestion / ↓ Venous outflow from corpora

↓

Compromised arterial inflow

↓

ISCHEMIA

↓

PAINFUL

Penile blood gas – ↓ O_2, ↑ pCO_2 acidosis

∂/t
- Drugs
  - α blockers, antipsychotics, antihypertensives
- INTRACAVERNOSAL INJECTIONS
- MALIGNANT INFILTRATION
- SICKLE CELL DISEASE
- TOXINS / VENOMS
- Hematological Dyscrasias

℞ – Decompression

↓

ASPIRATION

SHUNTS – DISTAL CAVERNOGLANULAR SHUNT

PROXIMAL CAVERNO-SPONGIAL SHUNT

NON-ISCHEMIC / ARTERIAL PRIAPISM

Rigidity of CORPORA due to UPREGULATED ARTERIAL FLOW

– fistula develops between

[CENTRAL PENILE ARTERY] & [SINUSOIDAL SPACE]

↓

Tumescence

↓

PAINLESS ERECTION

∂/t
- Trauma
- Iatrogenic – penile procedures

PENILE BLOOD GAS – ↑ pO_2, ↓ pCO_2

℞ – aimed at reducing arterial inflow

PROCEDURES

Selective arterial embolization

Selective arterial ligation

PEYRONIE'S DISEASE

- 'Induratio penis plastica'
- Wound healing disorder of tunica albuginea

INJURY to tunica albuginea

↓

EXUBERANT SCAR

↓

PLAQUE - inelastic
fails to undergo remodelling

↓

- PENILE DEFORMITY: Curvature
  Indentation
  Hinge effect
  Shortening

↓

ERECTILE DYSFUNCTION

NATURAL HISTORY - 2 PHASES

ACTIVE / ACUTE PHASE	→	CHRONIC / STABLE PHASE
- Painful erections - 'changing deformities' of the penis		- Stabilization of deformity - Disappearance of Painful erections

Does NOT spontaneously regress often

RISK FACTORS / ASSOCIATED CONDITIONS

1) Advanced age
2) T_2DM
3) Radical Prostatectomy
4) Hypogonadism
5) Collagen vascular disorders

Dupuytren's contracture

EVALUATION

1) Detailed history - presents ± ED

2) Penile examination - · Plaques (Palpate on stretch)
· Stretched flaccid penile length
· Induced erection → Measurement of penile deformity

3) INVESTIGATIONS

PENILE DUPLEX USG - Plaque calcification
Corporeal fibrosis
Erectile response

TREATMENT

NON-SURGICAL

Oral agents
1) Vitamin E
2) Tamoxifen
3) Colchicine
4) Carnitine
5) POTABA
6) Pentoxifylline

INTRALESIONAL
1) Verapamil
2) Nicardipine
3) INF α-2b
4) Clostridial collagenase

EXTERNAL FORCE APPLICATION
1) Electromotive Drug Administration
2) Extracorporeal shock wave Rx
3) Penile traction
4) Vacuum therapy
5) Radiotherapy

SURGICAL

Indications for Surgery
1) Stable deformity for ≥6 months
(Surgery should not be performed in the active phase)
2) Erectile Dysfunction
3) Failed conservative management

PRINCIPLES - Surgical correction of deformity ± Prosthesis
- TUNICAL SHORTENING
- TUNICAL LENGTHENING
- PLAQUE EXCISION/ INCISION
- GRAFTING

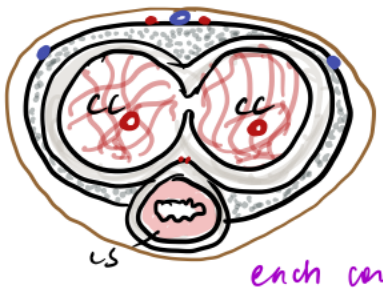
ERECTILE DYSFUNCTION

Mechanism of Penile erection

FUNCTIONAL ANATOMY

1) 3 cylindrical structures → which contain spongy vascular tissue with the capicity to expand & contain large volumes of blood

→ 2 Corpora cavernosa - with an incomplete septum in between
- extending from pubic rami to tip of penis
- Dorsal, invested by tunica albugenia - 2 layers circular & longitudinal
  - Fibrillar collgen (I > III)
  - Elastin - allows penis to expand



each corpus cavernosum - vascular sinusoids (centre > periphery)
separated by smooth muscle trabeculae

→ 1 Corpus spongiosum - encircles urethra
- distally continues as glans penis

} longitudinal layer of tunica albuginea 5 - 7 'o'clock

Terminal cavernous nerves are associated c smooth muscle of corpora

IN FLACCID STATE - blood slowly diffuses from centre to periphery
BLOOD GAS LEVELS = VENOUS BLOOD

DURING ERECTION - Rapid entry of arterial blood to sinusoids
BLOOD GAS LEVELS = ARTERIAL BLOOD

2) ARTERIES

Primary source - Paired Internal pudendal arteries (Branches of Internal Iliac A)

INTERNAL PUDENDAL A
→ Perineal branch
→ Common Penile A
- → Cavernous → Supplies corpora cavernosa via Helicine As
- → Dorsal → Glans
- → Bulbourethral (lies outside tunica albuginea) → Penile bulb & corpus spongiosum

Cavernous + Dorsal + Bulbourethral → form a ring near glans

3) Veins - venules from sinusoids → Subtunical plexus → Circumflex V. → DORSAL V (Saphenous V ← Superficial Dorsal V)
DORSAL V → PERIPROSTATIC PLEXUS

HEMODYNAMICS OF ERECTION
- Sinusoidal relaxation
- Arterial Dilatation
- Venous Compression

NEUROANATOMY & PHYSIOLOGY

1) PENILE INNERVATION

- AUTONOMIC
  - SYMPATHETIC
    - $T_{11} - L_2$
    - ↓ sympathetic ganglia
    - ↓ Inferior mesenteric & superior hypogastric plexus
    - → DETUMESCENCE
    - → Pelvic plexus
    - ↓ Cavernous nerves
    - ↓ Penis
  - PARASYMPATHETIC
    - $S_{2,3,4}$
    - ↓ Pelvic nerves
    - → Pelvic plexus
    - → ERECTION
- SOMATIC ($S_{2,3,4}$)
  - SENSORY > MOTOR
  - SENSORY
    - ↑ Dorsal penile nerve
    - Penis
  - MOTOR
    - ↓ Bulbocavernosus, Ischiocavernosus (modulates reflex)
    - → Rhythmic contraction
      - ↓ Ejection phase of Ejaculation
    - → Contraction
      - ↓ Rigid phase of erection

2) Supraspinal pathways

Several centres in Forebrain, Hypothalamus & Brainstem

3) Neurotransmitters

(+)	↔	(−)
• Dopamine	• Serotonin	• GABA
• Oxytocin		• Opioids
• NO		• Cannabinoids
• Melanocortin		• Prolactin

SMOOTH MUSCLES IN CORPORA CAVERNOSA ARE CONTRACTED IN BASAL/NORMAL STATE

- → Regulated by intracellular $[Ca^{2+}]$
- → Rho-Kinase pathway

NITRIC OXIDE (+) → cAMP, cGMP → reduce intracellular calcium

PHOSPHODIESTERASE -5 (−) → cAMP, cGMP

ERECTILE DYSFUNCTION

Persistent inability to attain / maintain a penile erection sufficient for satisfactory sexual intercourse

ETIOLOGY

ORGANIC

1) **Vasculogenic**
   - Arteriogenic - Atherosclerosis, trauma
   - Cavernosal - Degenerative, trauma
   - Mixed
2) **Neurogenic**
   Disease / Injury to
   - Brain
   - Spinal cord
   - Pudendal / Cavernosal nerves (PELVIC SURGERY / TRAUMA)

   May still have reflexogenic erections
3) **Anatomic** — Primary ED
   - Peyronie's disease
   - Micropenis
   - Cavernosal abnormalities
4) **Endocrinologic**
   - ↓ Testosterone
   - ↑ Prolactin
   - Thyroid illness
5) **Drug induced**
   - Antiandrogens
   - Antidepressants
   - Antihypertensives

PSYCHOGENIC

1) **Generalised**
   - → Primary
   - → Age-related
   - → Generalised inhibition
2) **Situational**
   - Partner related
   - Performance related
   - Adjustment related

ORGANIC	PSYCHOGENIC
Gradual Onset	Sudden Onset
Incremental progression	Complete Immediate Loss
Global Dysfunction	Situational Dysfunction
Waking erections - poor / ⊖	Waking erections ⊕

Evaluation

1) Detailed History & General evaluation

R/o Psychogenic ED
Drug history
Cardiovascular history
Metabolic - s/o T_2DM
Endocrinopathies

2) Specific

a) VASCULAR EVALUATION - arterial impairment / Venoocclusive dysfunction

1) Dynamic Infusion Cavernosometry / Cavernosography (DICC)
2) Intracavernous Injection ± Color doppler Duplex US
   (Injection → vasodilator)
3) Angiography

b) PSYCHOPHYSIOLOGIC EVALUATION

To differentiate psychogenic from organic ED

- NPTR - Monitoring of Nocturnal Penile tumescence & rigidity
  Ⓝ - 4-5 erectile episodes / night
- Audiovisual / Vibratory stimulation
- Neuroimaging - fMRI

c) NEUROLOGICAL EVALUATION

- Biothesiometry - sensory evaluation
- Bulbocavernosus reflex latency
- Dorsal nerve conduction velocity
- Heart rate variability, sympathetic skin response
- Corpus cavernosum EMG

d) Endocrine evaluation

- S. Testosterone
- S. Gonadotrophin < FSH, LH
- S. Prolactin (Hyperprolactinemia -> 40ng/ml)
- TFT

TREATMENT

1) Lifestyle modification
2) Medication change in drug-induced ED
3) Psychosexual therapy in psychogenic ED
   - Systematic anxiety reduction
   - Sensate focus
   - CBT
   - Interpersonal therapy
4) Hormonal therapy
   - Testosterone
     - IM - Inj: Testosterone enanthate / cypionate 200mg 2-3 weekly
     - S/c
     - Transdermal
     - Buccal
   - Bromocriptine for hyperprolactinemia
     - Rx of Pitutary adenomas

5) PHARMACOTHERAPY
   - PROMOTERS OF PROERECTILE MECHANISMS
   - INHIBITORS OF ANTIERECTILE MECHANISMS

- Oral therapy
  1) PDE-5 inhibitors

cGMP —PDE5 (⊖)→ GMP

- Sildenafil - 25, 50, 100mg
- Vardenafil
- Tadalafil
- Avanafil

ADEs: Headache, flushing, dyspepsia, can't be used c nitrates

  2) α- adrenoceptor antagonists

Phentolamine (⊖) → NE → α_1 receptor → cavernous smooth muscle contraction

  3) Dopaminergic agonists - Apomorphine
  4) Melanocortin agonists - Melanotan

} Central pathway

- Intracavernosal injection
  - ALPROSTADIL (PGE1)
  - PAPAVERINE (non specific PDE inhibitor)
  - PHENTOLAMINE (α_1 blocker)

} Pre-intercourse injection

- Intraurethral suppositories

ALPROSTADIL - MUSE (Medicated Urethral System for Erection)

- Transdermal / Topical - Gels & creams - Nitroglycerine, Alprostadil

6) DEVICE THERAPY

Vacuum Erection Device therapy - mechanically create negative pressure surrounding the penis → ENGORGES ∴ BLOOD

↓

VASCULAR EGRESS IS PREVENTED BY CONSTRICTION DEVICE AT BASE OF PENIS

↓

Intercourse

7) SURGERY

Indications:

1) Penile injury due to genital / pelvic trauma
2) Penile structural deformity d/t Peyronie's disease
3) Cavernosal fibrosis 2° to ischemic priapism / infection

PROCEDURES

PENILE PROSTHESIS

Semirigid Rods

Paired solid cylinders that fill each corpus cavernosum

- Malleable devices
- Positional devices

Inflatable devices

↓

can be filled with saline during sex & deflated later

- 2piece (Scrotal pump)
- 3piece (Reservoir)

PENILE REVASCULARISATION

ARTERIAL REVASC

↓

To improve arterial inflow to corpora cavernosa

↓

ANASTOMOSIS OF INFERIOR EPIGASTRIC ARTERY TO

- Corpora
- Dorsal artery
- Deep dorsal vein

VENOUS RECON

↓

To prevent pathological venous egress of blood from penis

↓

- Ligation / embolisation of dorsal / crural veins
- Crural plication
- Pericavernoplasty

PEYRONIE'S DISEASE

- 'Induratio penis plastica'
- Wound healing disorder of tunica albuginea

INJURY to tunica albuginea

↓

EXUBERANT SCAR

↓

PLAQUE - inelastic
fails to undergo remodelling

↓

- PENILE DEFORMITY: Curvature
  Indentation
  Hinge effect
  Shortening

↓

ERECTILE DYSFUNCTION

NATURAL HISTORY - 2 PHASES

ACTIVE / ACUTE PHASE	→	CHRONIC / STABLE PHASE
- Painful erections - 'changing deformities' of the penis		- Stabilization of deformity - Disappearance of Painful erections

Does NOT spontaneously regress often

RISK FACTORS / ASSOCIATED CONDITIONS

1) Advanced age
2) T_2DM
3) Radical Prostatectomy
4) Hypogonadism
5) Collagen vascular disorders

Dupuytren's contracture

EVALUATION

1) Detailed history - presents ± ED

2) Penile examination - · Plaques (Palpate on stretch)
· Stretched flaccid penile length
· Induced erection → Measurement of penile deformity

3) INVESTIGATIONS

PENILE DUPLEX USG - Plaque calcification
Corporeal fibrosis
Erectile response

TREATMENT

NON-SURGICAL

Oral agents
1) Vitamin E
2) Tamoxifen
3) Colchicine
4) Carnitine
5) POTABA
6) Pentoxifylline

INTRALESIONAL
1) Verapamil
2) Nicardipine
3) INF α-2b
4) Clostridial collagenase

EXTERNAL FORCE APPLICATION
1) Electromotive Drug Administration
2) Extracorporeal shock wave Rx
3) Penile traction
4) Vacuum therapy
5) Radiotherapy

SURGICAL

Indications for Surgery
1) Stable deformity for ≥6 months
(Surgery should not be performed in the active phase)
2) Erectile Dysfunction
3) Failed conservative management

PRINCIPLES - Surgical correction of deformity ± Prosthesis
- TUNICAL SHORTENING
- TUNICAL LENGTHENING
- PLAQUE EXCISION/ INCISION
- GRAFTING