Voiding Dysfunction

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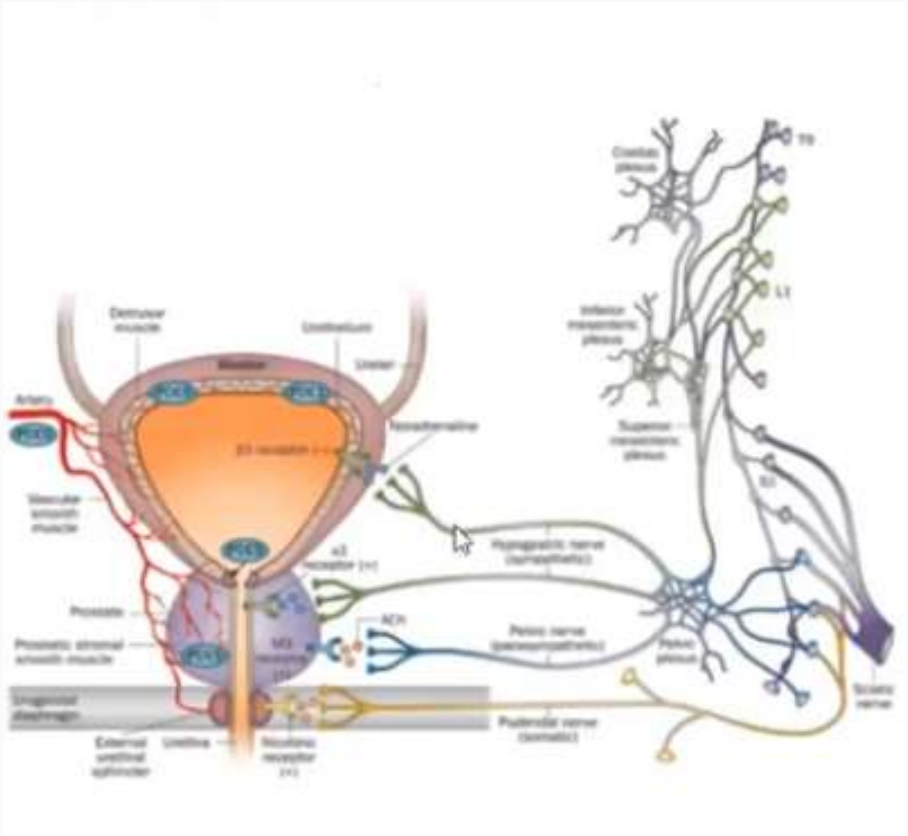
Introduction

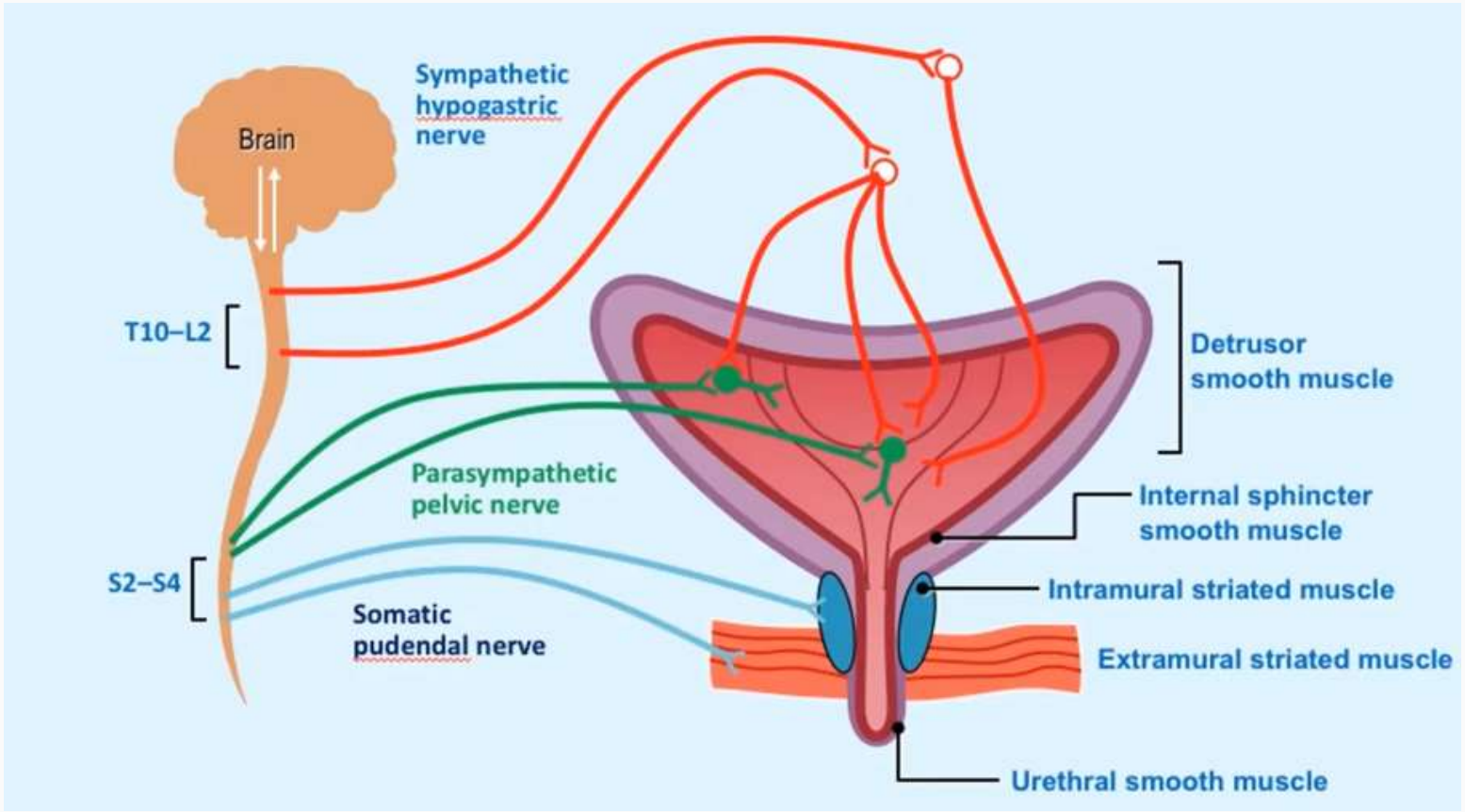
- Voiding dysfunction refers to any **abnormality in holding and emptying bladder**
- Accounts for 20% of pediatric urology visit
- Accounts for 4-32% of children with LUTS.
- Important to differentiate the cause
  - Organic vs functional (neurologic vs non-neurologic)
  - Functional -> Benign vs pathologic
- Early intervention prevents renal deterioration in those with high bladder pressure

OUTLINE

1. Basics
2. Functional voiding disorders
3. Neurogenic bladder



Basics



Spinal innervation and CNS control - Sympathetic (spinal control) promote urine storage. Bladder fullness initiates parasympathetic (sacral control) to result in voiding leaving <5ml residual. The consciously controlled extrenal sphincter relies on sacral reflex arc for coordination in infants. Micturition centers on pons and cerebral cortex modulate autonomic .

Maturation of voiding

- Maturation Sequence is linked to bowel control
  1. Night time fecal continence
  2. Day time fecal continence
  3. Day time urine continence
  4. Night time urine continence
- Maturation with age
  - Infancy - void 20x/d, purely reflexive
  - 18mo - 2 yr – under some cortical control
  - 3 years - void 10x/d, full cortical control
  - 4 years - attain day and night continence

Toilet training

1. Increased bladder capacity allowing longer interval b/n voiding
    - Infant bladder capacity = 38 + 2.5 × Age (months)
    - Older child capacity = [Age (years) + 2] × 30
2. Recognition by brain (socially unacceptable situations)
3. Resist urge to void by voluntary contraction until detrusor contraction passes
    - **This process may become dysfunctional
4. Full control of spinal micturition reflex (initiate detrusor contraction)

History

- **Age at presentation**
  - school age,
  - Tethering (infancy, age 6)
- **Toilet training** (when, easy/difficult)
- **Constipation**
- **Neurologic** (red flags)

- **Storage symptoms**
  - Frequency ≥8/day (low if ≤3/day)
  - Incontinence (continuous, intermittent)
  - Urgency
- **Voiding symptoms**
  - Hesitancy
  - weak stream
  - Straining
  - Intermittency
  - Dysuria
- **Other symptoms**
  - Holding maneuvers
  - Retention/ incomplete emptying
  - Post micturition dribble

Patterns of abnormal voiding

- **Urinary frequency** - Small bladder (overactive).
    - also have urgency and accidents.
- **Infrequent voiding** - Large bladder (underactive)
    - no warning until very urgent need to void, may have accidents.
- **Stuttering stream** - indicate Detrusor Sphincter Dyssynergia (DSD)

Incontinence

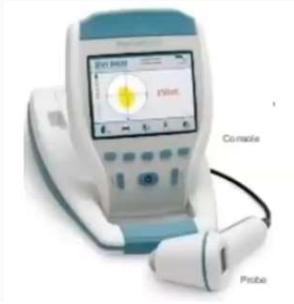
- **Enuresis** – considered normal in <5yr
  - Developmental - 15% wet bed after 5yr, resolve 15%/year, 99% resolve by 15 yr
  - Genetic - 80% if both parents affected, 44% if one parent),
  - Psychological stress – secondary nocturnal enuresis (after dry for 6mo)
  - ADH – some children may under secrete ADH at night
- **Daytime incontinence** – proper evaluation to sort out causes
- **Continuous incontinence** – high probability of pathology

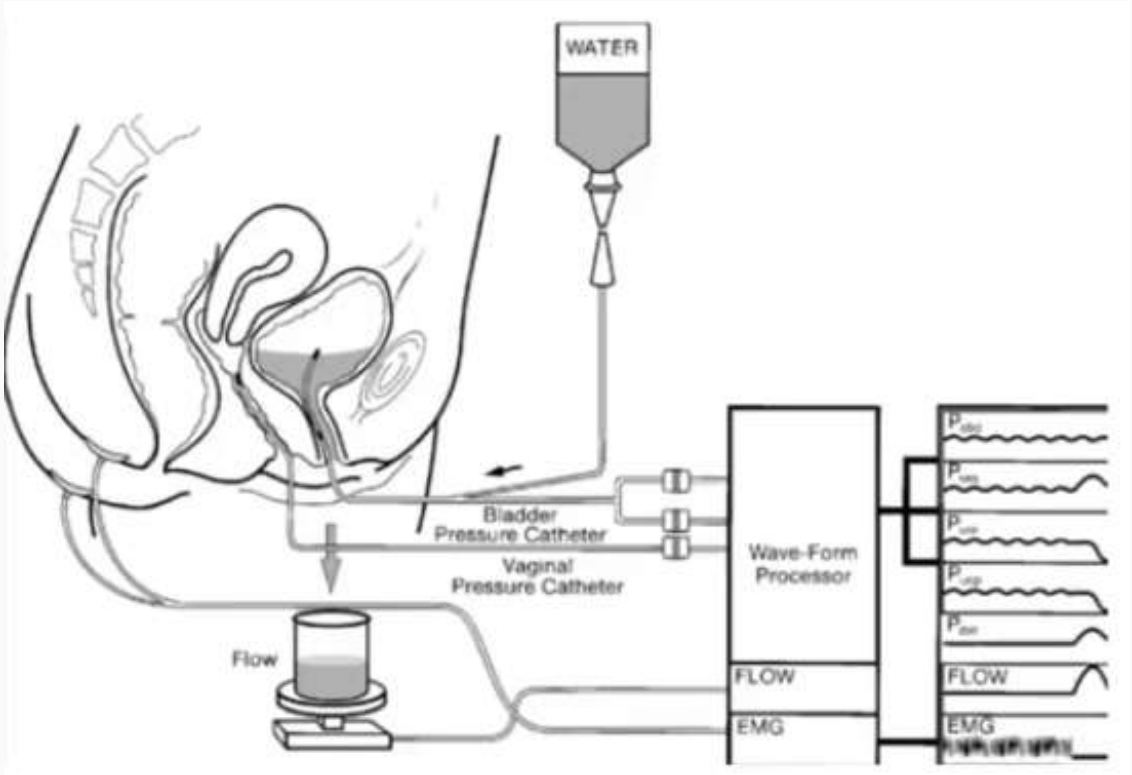
Physical

- Abdomen
  - Mass (constipation, distended bladder),
- Genitalia
  - Female – labial adhesion, vaginal voiding discharge
  - Male – circumcised, phimosis, meatal stenosis
- Neuro exam
  - Signs of occult spina bifida
  - perineal sensation, sacral reflex, gait, lower extremity reflexes

Investigations

- Urinalysis – infection, proteinuria
- Imaging – if UTI or sacral anomalies
- PVR - >10% capacity suggest incomplete emptying
- Uroflowmetry/EMG – interpretation is subjective
  - Size of bladder (small/large capacity)
  - Overactivity (high peak stream)
  - Intermittency (shuttering stream)



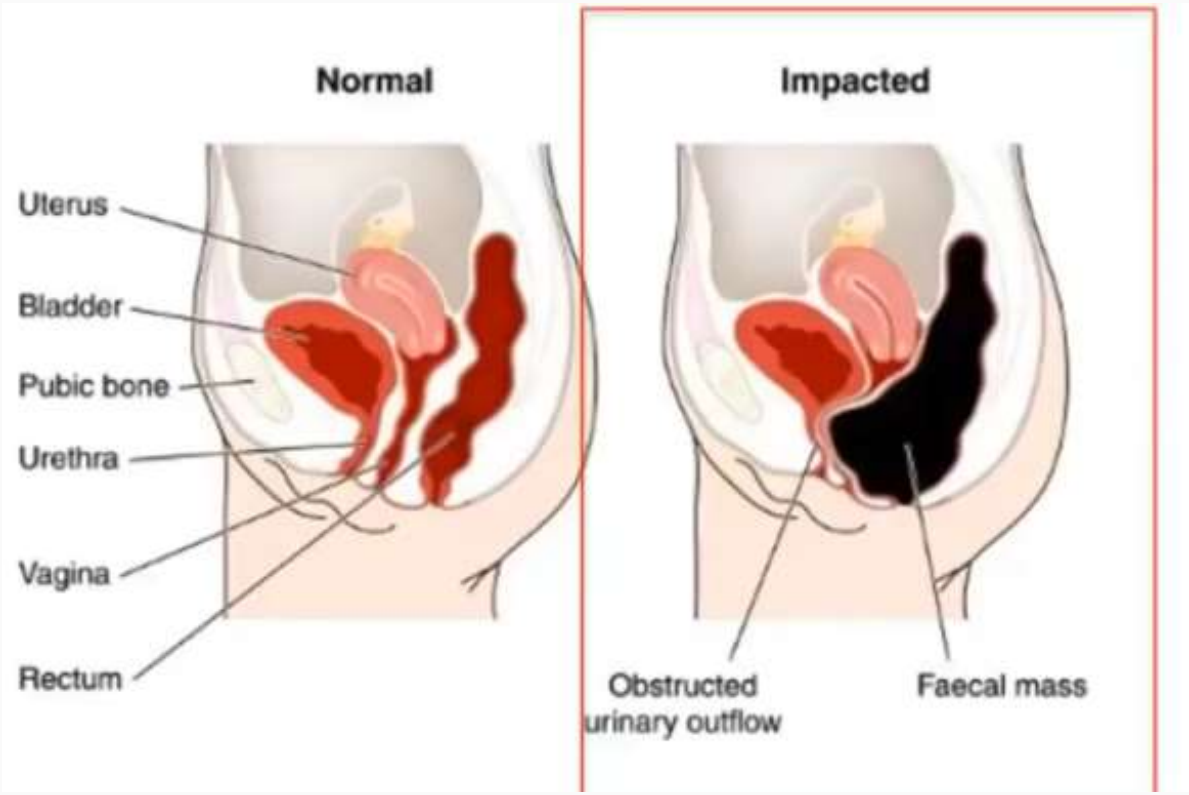


Urodynamics– Pressure–volume relationship is assessed using a double-lumen catheter in the bladder and simultaneous assessment of external sphincter function with a perineal electrode. Evaluate bladder function, capacity, compliance, voiding pattern, sphincter coordination and innervation. Normal voiding pattern is bell shaped curve.

Functional Voiding Disorders

Pathophysiology

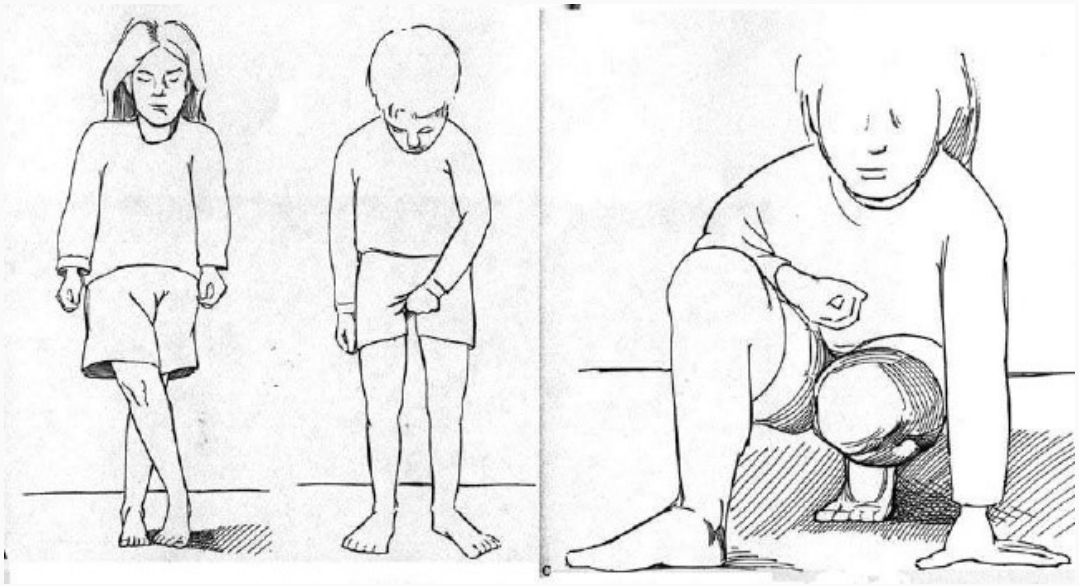
- **Withholding behavior** (behavioral/psychologic)
  - * Functional disorder (no neurologic deficit)
  - Typically manifest after toilet training
- **Unstable Detrusor contraction** (leakage/posturing)
- **retentive pattern** (Sphincter relaxes poorly during voiding)
  - Overactive bladder - elevated pressure (VUR, UTI)
  - Underactive bladder = prone to UTI and stress incontinence
- may result in **Bladder bowel dysfunction** (constipation, encopresis)

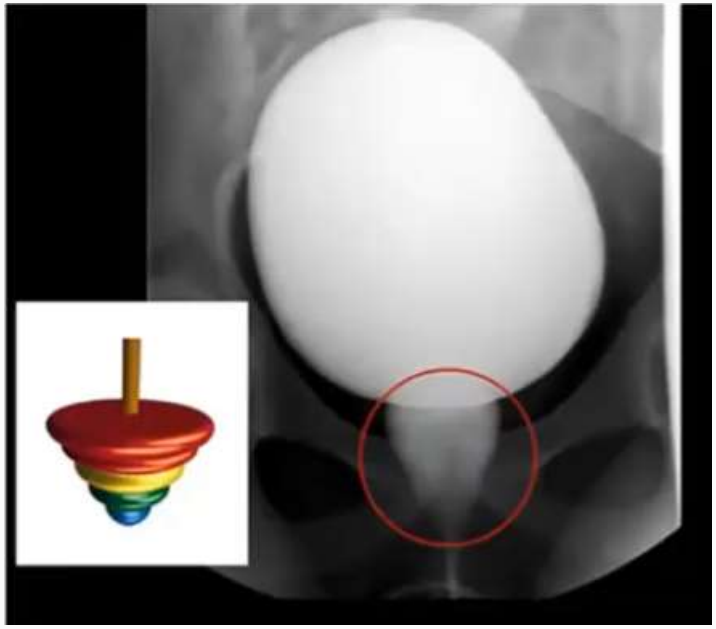


Bladder and Bowel Dysfunction (BBD) = Voiding dysfunction + bowel symptoms . Problem with elimination in one is associated with problems in the other. Rectal mass can push on base of bladder and cause difficulty emptying bladder. Alternatively urine retentive behavior with sphincter over activity may carry on to anal sphincter to cause functional constipation.

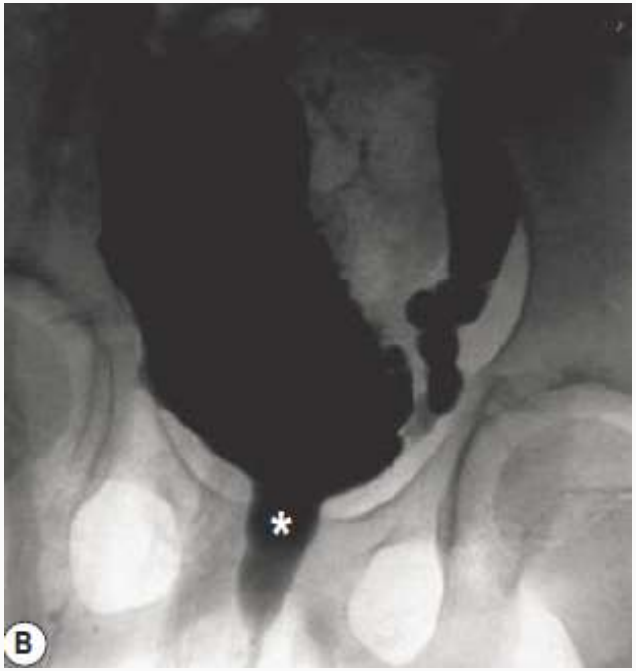
Presentation

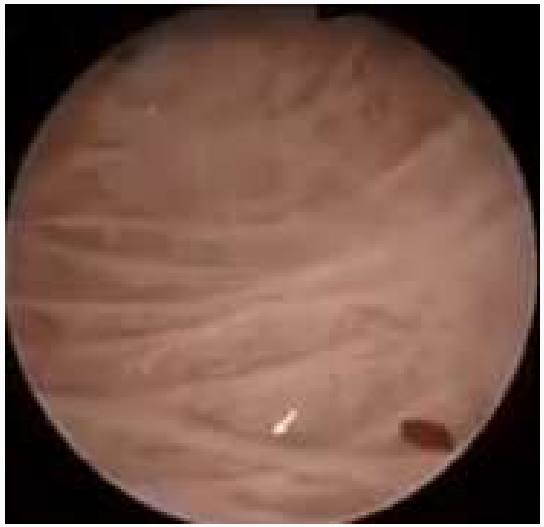
- **Benign**= Episodic, self limiting (majority)
  - Related to stressful events
  - Maybe associated with UTI & constipation
  - No hydronephrosis, VUR or trabeculation
- **Pathologic =** persistent / chronic (Require intervention)
  - Can be progressive and severe (Hinman syndrome)





Witholding behaviour- When bladder contraction comes they dash to the bathroom or try to "hold it in." Boys grab and compress the penis, girls often cross their legs and dance around or squat with the heel compressed over the perineum (Vincent's curtsy). VCUG may show Lollipop/Spinning top deformity (open BN against closed external sphincter)





Hinman syndrome (non neurogenic neurogenic bladder) – severe voiding dysfunction can present with persistent incontinence, recurrent febrile UTI, hydronephrosis, high bladder storage pressure and poor emptying. Imaging can be similar to neurogenic. VCUG shows trabeculated bladder, severe reflux and dilated posterior urethra due to chronic contraction

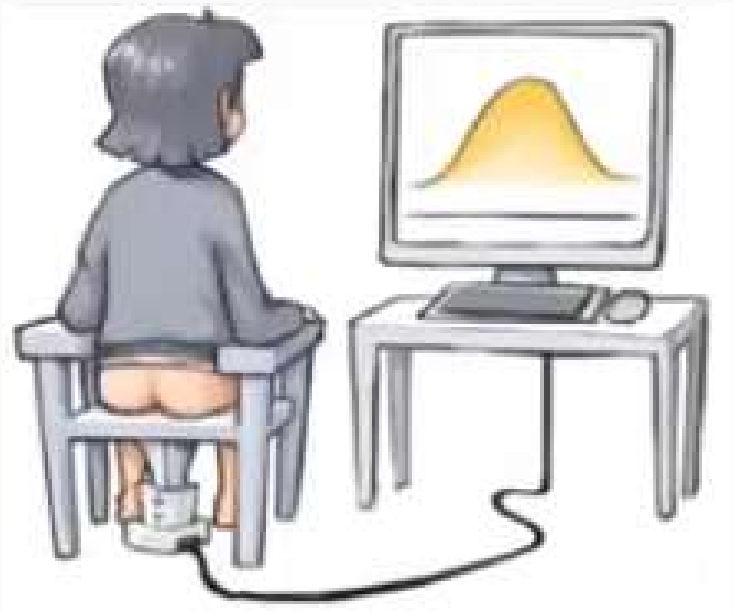
Treatment

All aspects should be managed simultaneously

- Voiding schedule – drink water, timed voiding, diary, alarm watch, school note
- Treat Constipation (bowel habit, fiber, laxative, enema)
- Treat recurring UTI (prophylactic antibiotic)
- **Meds (adjunct)** = Anticholinergic +/- CIC (inc PVR) +/- alpha blocker (DSD)
- **Biofeedback** - Electrode placed on perineum can be attached to monitor/audio signal so children can learn to relax sphincter
- *Cystoscopic botox injection (detrusor/sphincter)*
- *Neuromodulation (transcutaneous/surgically implanted)*
- *Diversion/augmentation rarely required (severity wanes with maturation)*

Time	Drinks		Trips to the Bathroom		Accidental Leaks		Did you feel a strong urge to go?	What were you doing at the time?
	What kind?	*How much?*	*How many times?*	*How much urine? (circle one)*	*How much? (circle one)*		*Circle one*	*Sneezing, exercising having sex, lifting, etc.*
Sample	**Soda**	**2 cans**	✓✓	sm (med) lg	(sm) med lg		Yes (No)	**Running**
7–8 p.m.				sm med lg	sm med lg		Yes No	
8–9 p.m.				sm med lg	sm med lg		Yes No	
9–10 p.m.				sm med lg	sm med lg		Yes No	
10–11 p.m.				sm med lg	sm med lg		Yes No	
11–12 midnight				sm med lg	sm med lg		Yes No	
12–1 a.m.				sm med lg	sm med lg		Yes No	
1–2 a.m.				sm med lg	sm med lg		Yes No	
2–3 a.m.				sm med lg	sm med lg		Yes No	
3–4 a.m.				sm med lg	sm med lg		Yes No	
4–5 a.m.				sm med lg	sm med lg		Yes No	
5–6 a.m.				sm med lg	sm med lg		Yes No	

Voiding diary –Some use them for 7-14 d but recent research shows 3 days is adequate to capture adequate information. 90% will improve with behavioral modification. 30-50% improvement with timed voiding alone.

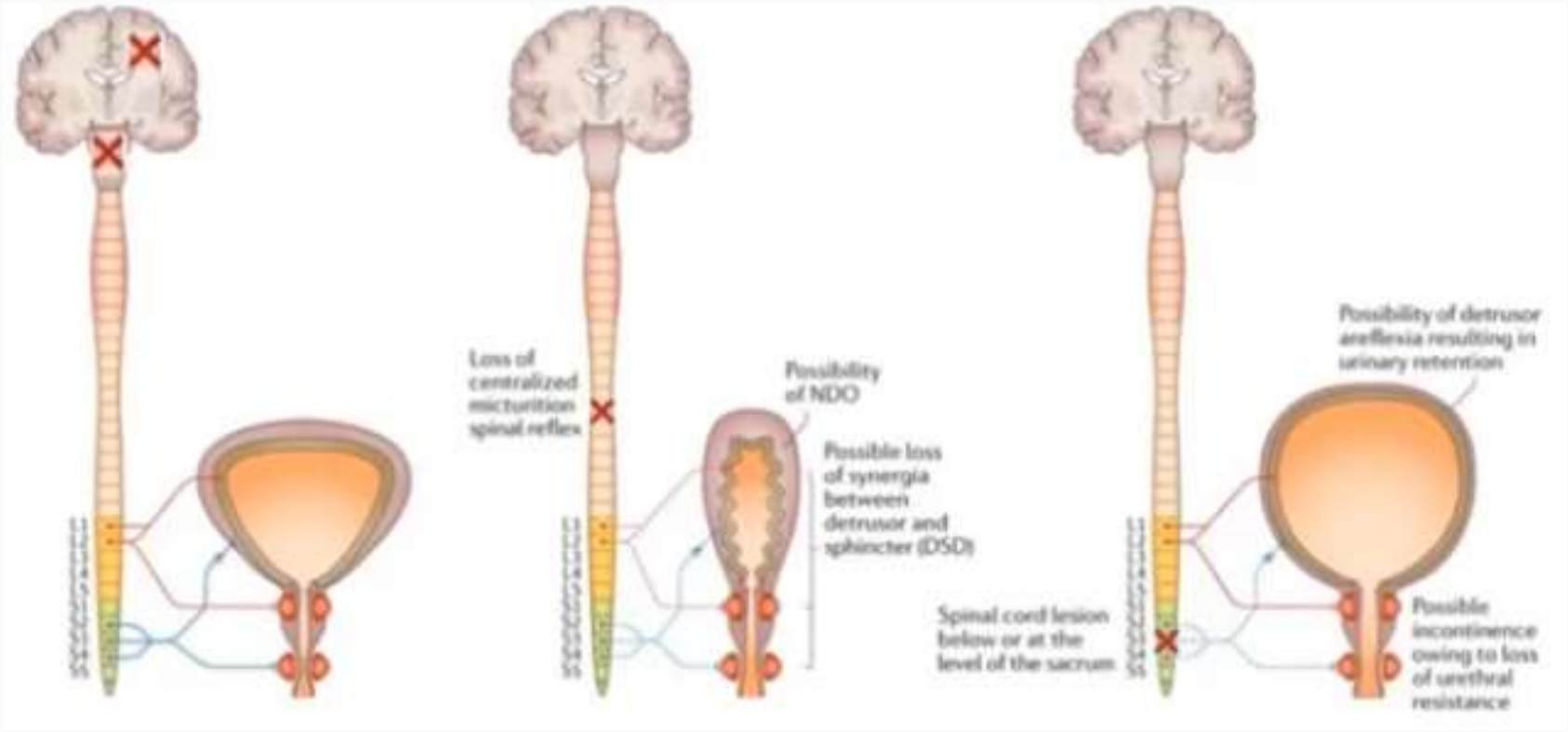


Biofeedback – Aim is to train child to recognize bladder sensation and learn to control sphincter relaxation (90% success). Animation is an adjunct to the therapy. It is done by trained physical therapists. It is important to tell the therapist what you are training (Most non-experienced centers may advise Kegel's which is not beneficial in DSD). It also requires motivated children and parents.

Neurogenic Bladder

Pathophysiology

- Bladder dysfunction due to disease of CNS or peripheral nerve
- Level of lesion determines type of anomaly
  - **Failure to store =** Small capacity
    - Overactive bladder (inc contractions)
    - Incompetent bladder neck
  - **Failure to empty =** Large capacity
    - Under active bladder (areflexic)
    - Sphincter dyssynergia
  - **Combination**



Type of neurogenic bladder with level of lesion – **Brain** (Cerebral palsy, hydrocephalus, tumor, trauma) leads to interruption of inhibitory center with overactive bladder, sphincter coordinated. **Spine** (NTD, trauma, tumor, infection) leads to interruption of communication b/n spinal cord and brain with over active bladder and DSD. **Sacral** (NTD, sacral agenesis…) leads to interruption of parasympathetic and somatic with underactive bladder, sphincter with minimal function

Spina bifida

- Most common cause of neurogenic bladder (95%)
  - 90% of neonates have normal upper tract.
  - 50% will develop upper tract deterioration or reflux in 5 years if untreated
  - 50% are incontinent (skin breakdown, infection, poor self esteem)
- Neurologic intervention
  - Fetal intervention doesn't have impact on bladder function '
  - Closure delayed beyond 72hr has negative impact on bladder.
- Urologic intervention
  - Early evaluation and follow up is indicated
  - Postvoid residuals should be measured before discharge (CIC if residual >15 mL)
  - Avoid credé maneuver (ineffective in emptying the bladder and magnifies VUR)

Society guidelines

Neonatal - CIC q4hr to measure residuals (bladder US)

- if low>>q6hr>>stop. If high>home with CIC

3 months - ultrasound, RFT, urodynamic test, VCUG if abnormality detected

Further Follow-up – periodic assessment is key b/c may develop tethering

- Ultrasound every 6mo for 2 yrs then yearly
- Asses UTI, RFT every year after age 5 or if imaging changes.
- Urodynamic testing yearly first 3 yr, repeat if bladder hostility, imaging change, UTI
- CIC & anticholinergic if indicated (recurrent UTI, upper tract change, hostile bladder)
- Continence program at 3-6yr (discuss options, repeat urodynamics)
- Transition to self management after age 13

Assessment

Upper tract imaging

- Hydronephrosis
- renal scarring

RFT

- Cr is poor indicator (loss of lower limb muscle mass in spina bifida)
- Other = cystatin, Iothalamate, DPTA

UTI

- fever >38
- +ve UA (>10WBC, nitraite/leocyte esterase)
- +ve culture (50,000 for sterile, 100,000 for clean)

Urodynamics

- Hostile bladder = need CIC
  - DLPP > 40(detrusor leak point pressure)
  - DSD (detrusor sphincter dyssynergia)
- Non hostile - allow volitional voiding
  - normal capacity
  - low pressure
  - minimal detrusor overactivity
  - minimal residual

Aim of treatment

Primary

- Normal **renal function**
- Urinary **continence** as early as possible
- Urologic **independence**

Secondary

- Eliminate **hostile bladder** dynamics
- Reduce **surgical** reconstruction
- Minimize **expense** of studies
- Reduce **UTI and antibiotic** overuse

Approach: Renal preservation

CIC and anticholinergic. 3 approaches

- Everyone - CIC in everyone, anticholinergic based on urodynamic (ESPU)
- Proactive – CIC+ anticholinergic based on urodynamic
- Reactive – after kidney changes

Treat UTI

- **Chronic bacteriuria** (50-80%)- doesn't need treatment
- **Symptomatic recurrent UTI** (30%) warrant evaluation
  - Catheterization technique (storage,lubricant)
  - Bowel management
  - Renal comp - Urolithiasis, hydronephrosis, diverticuli, VUR, bladder dynamic

Surgery (worsening UTI, HN, VUR, urodynamics)

- **Temporizing** – vesicostomy (young age), ureteral diltation (girls), botox (not for fibrotic bladder)
- **Definitive** – augmentation (old enough) >> diversion (failed augmentation)

Approach: Incontinence

- **CIC**
- **Alpha agonist:** low outlet resistance
- **Bladder outlet surgery:** refractory incontinence
  - *asses storage capacity first (may need simultaneous augmentation)
- **Continent catheterizable channels**: unable to self catheterize urethra (spinal deformity, discomfort, or false passage)

<u>New change in continence warrant evaluation</u>

- Tethering
- Poor adherence to CIC: cognitive, dexterity, Anatomic (obesity, stenosis, stricture)

Clean Intermittent Catheterization

- Popularized in 1970s and revolutionized treatment
- Cornerstone of all treatment programs
- **Indication**
  - Unstable (renal preservation) - periodic low-pressure emptying

    (Interval determined coupling UD data with hourly output)
  - Stable (Continence) - delayed until social continence is desired
- **Comp**
  - Catheter trauma
  - Bacteriuria (60% in a year), symptomatic UTI (1-2 episodes per year)

Pharmacologic

Unsafe / Overactive bladder – relax detrusor (dec storage pressure)

- Anticholinergic: Oxybutynin
- TCA: imipramine – also tightens outlet

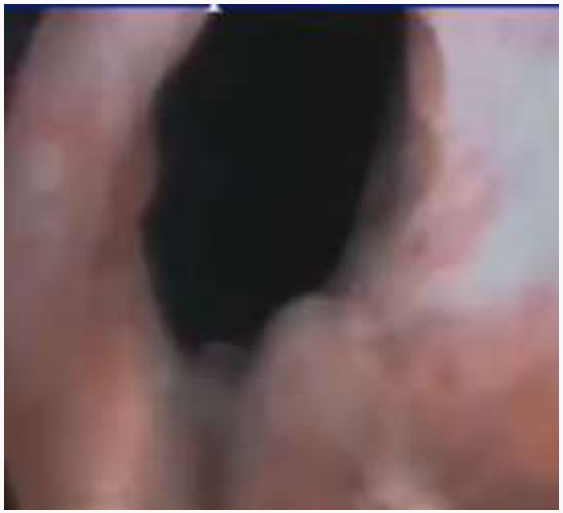
Incontinent/ Low resistance - inc outlet resistance (inc leak point pressure)

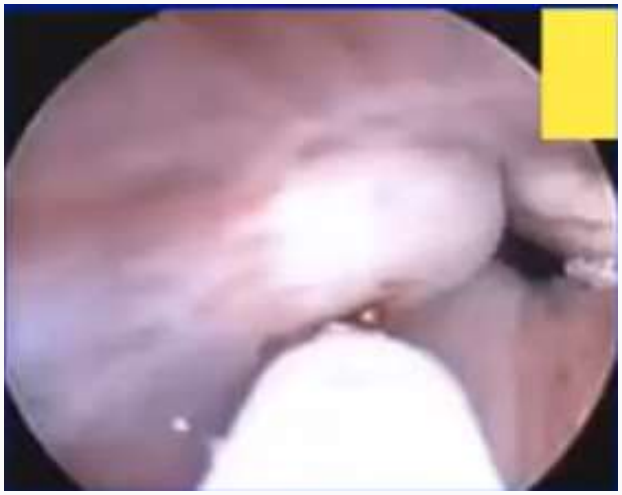
- Alpha agonist: Pseudoephedrine

Bladder outlet procedures

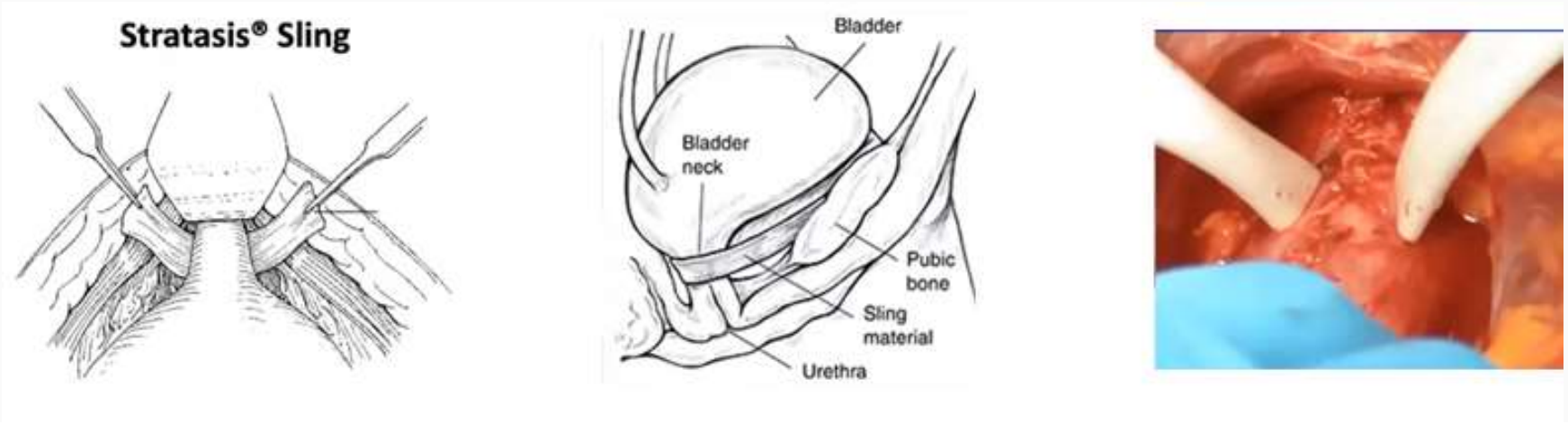
25-50% also need augmentation - *May worsen renal status if non compliant with CIC*

- **BN injection** (Deflux)
- **BN sling** (SIS, rectus fascia)
- **Cinch procedure**
- **BNR** (YDL, Mitchel)
- **BN flaps** (Kropp's, Pippi Salle's)
- **Artificial urinary sphincter**
- **BN closure**

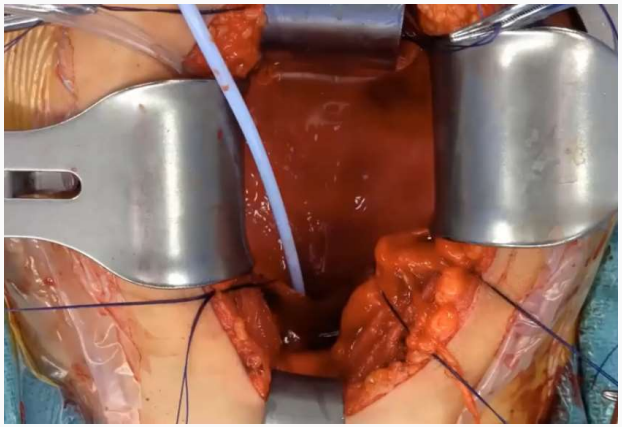


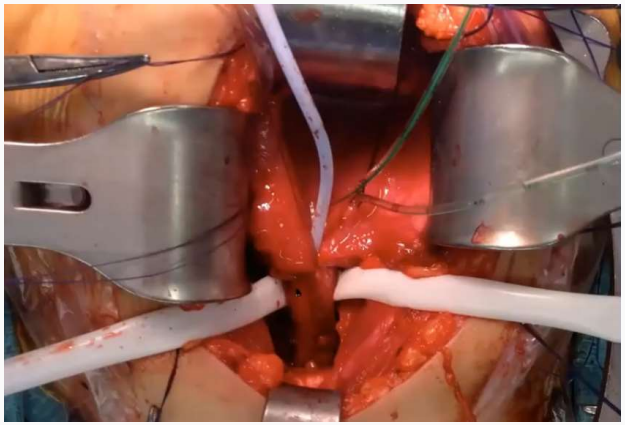


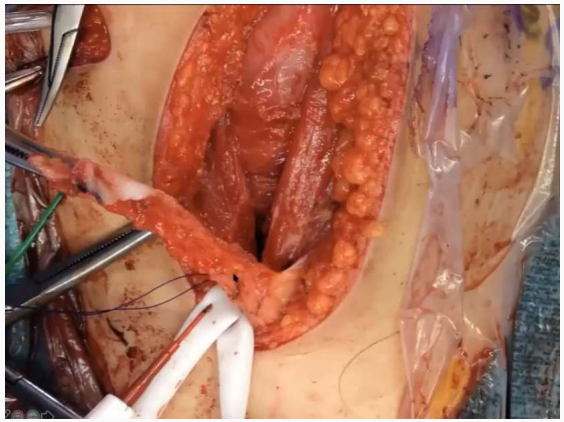
BN injection- in select patient requiring minimal inc in pressure. Bulking agent closes bladder neck. 70% improvement at 18 mo



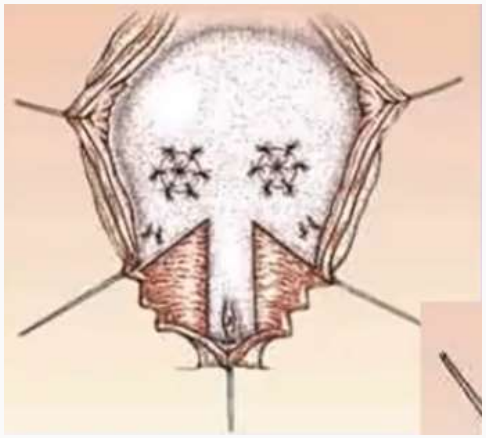
BN sling- 360 wrap and suspend from anterior rectus fascia or pubis. This elevates and compress urethra. SIS 70% success (45-85%) with less sucess in ambulatory male because have to displace & occlude prostatic urethra which is difficult when upright
rectus fascial sling- 80-90% success

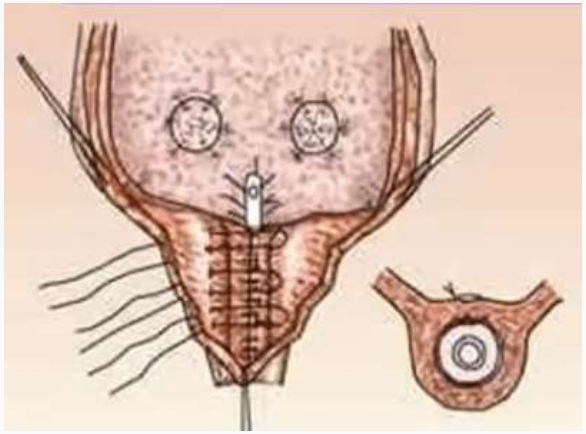


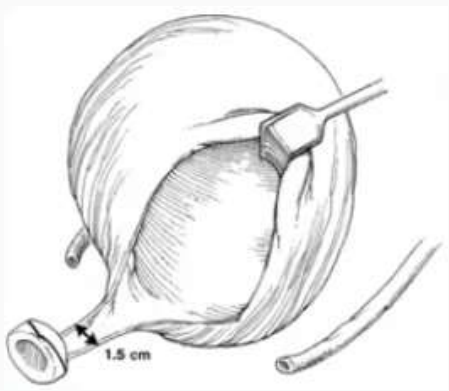




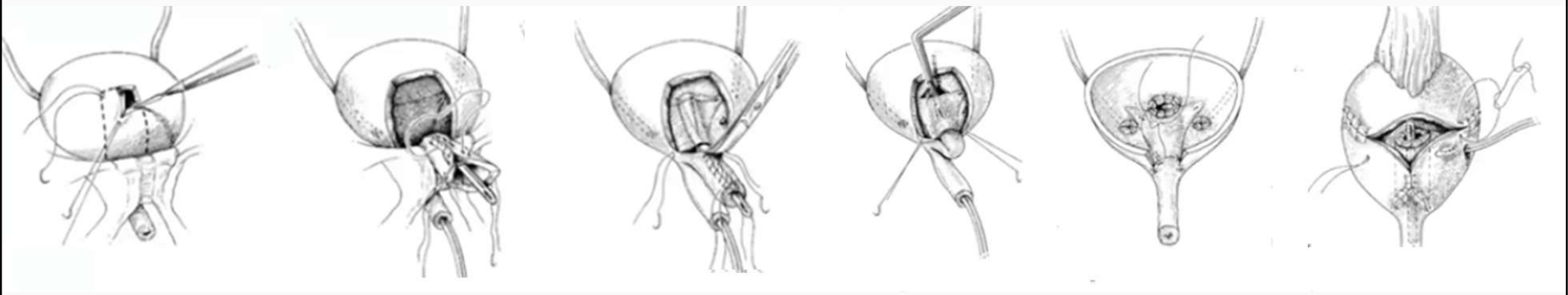
Cinch procedure (BNR plus Sling). For a wide bladder outlet (sling alone wont work) 90% success.

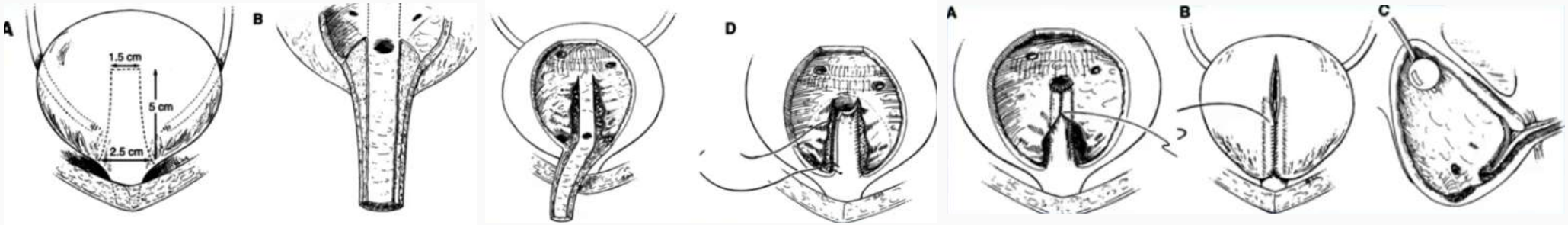




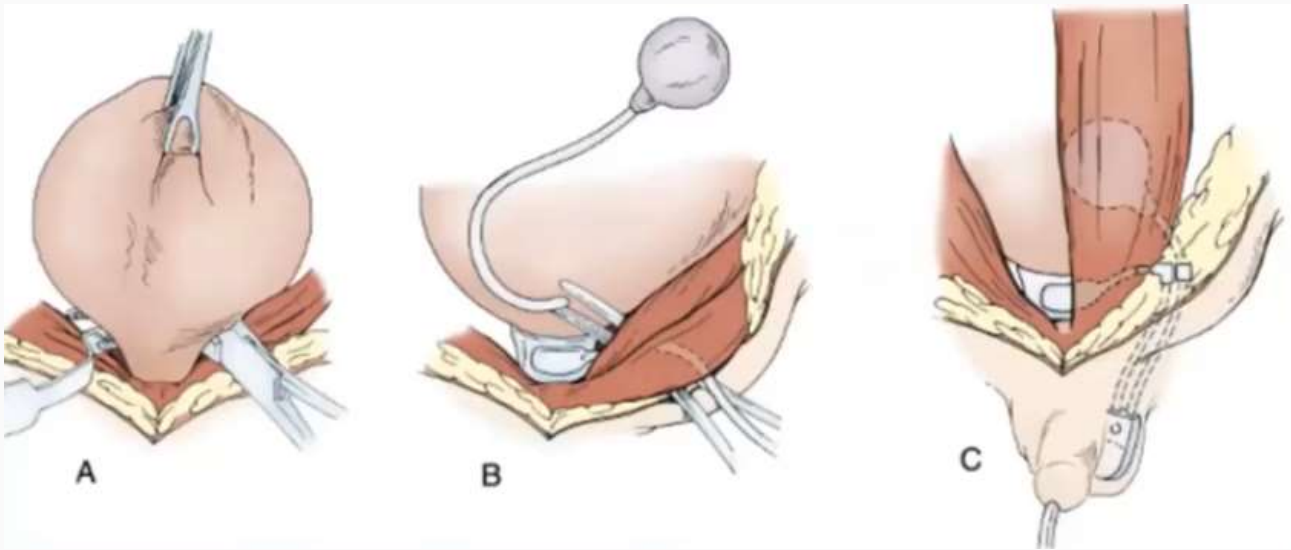


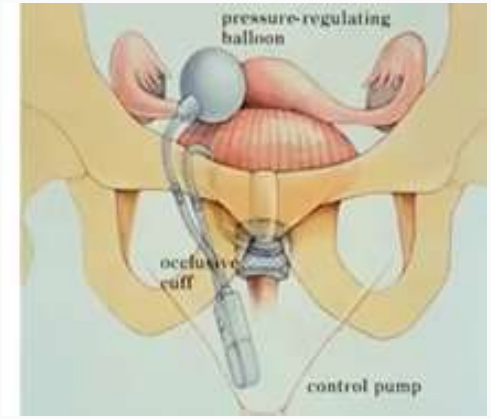
BNR: The Young–Dees technique, which lengthens the urethra by infolding and tubularizing the trigone of the bladder, still has some advocates. Mitchell preserves more bladder (v shaped incision, pull back bladder and tubularize). 80% dry, 30% required repeat procedure

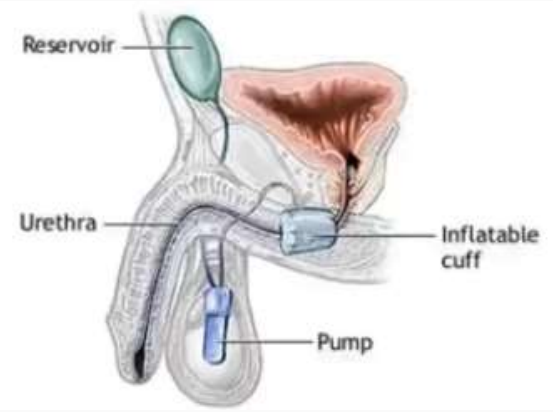




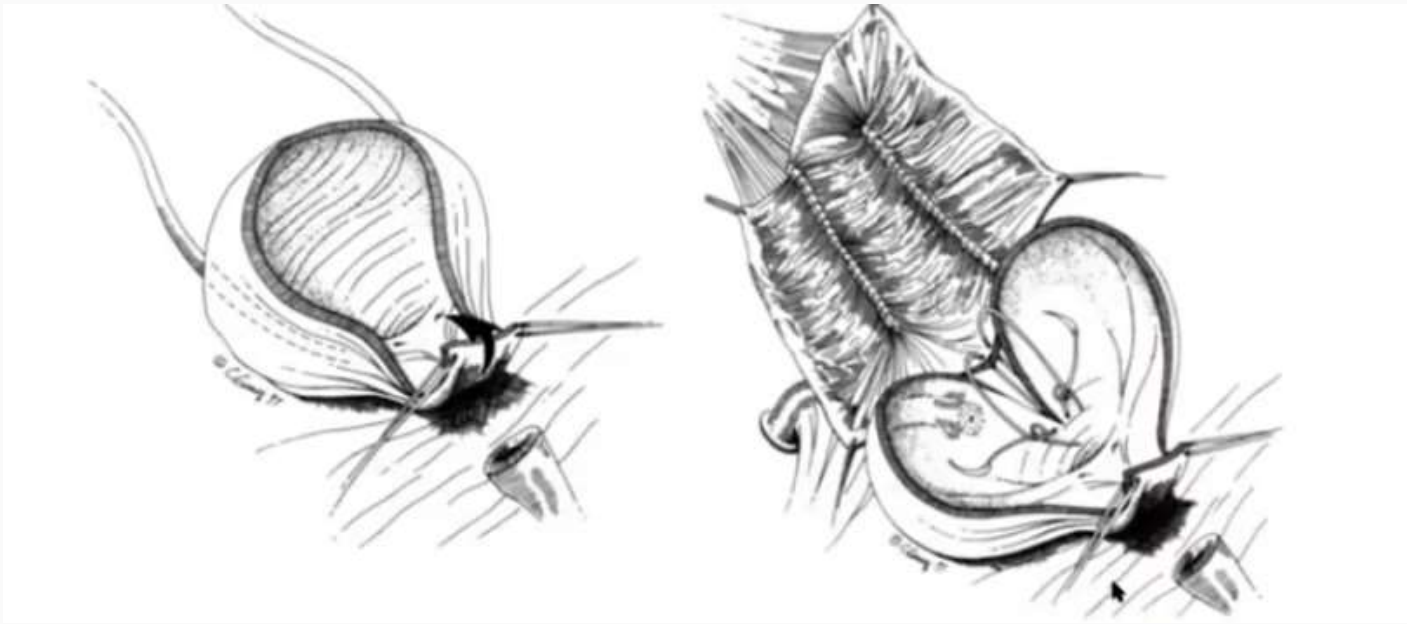
BN flap: ideal for big bladder with low pressure. Kropp's procedure uses a tubularized anterior bladder strip reimplanted in the submucosa of the trigone to gain continence by a flap valve mechanism. Pippi Salle's procedure is similar but takes only small anterior bladder flap to onlay onto a posterior incised strip up the middle of the trigone. Minority required 2ry BN procedures







Artificial urinary sphincter. fluid-filled pressurized cuff around the urethra or bladder neck holds urine. Scrotal pump deflates it by pumping fluid to reservoir. This permits the urethra to open. Can erode into the urethra and malfunction over time. Revision rates 30%, with erosion in 20%.



BN closure. is last resort – intact bladder neck provides alternate access to bladder. Procedure has 3 basic principles Create bladder flap.(part urethra) Create space to close urethra. Put tissue in between (myofascial flap, omentum..) 95% continence

Continent Catheterizable channels

Mitrofanoff principle: tubular structure implanted into the bladder and anastomosed to the skin

- **Apendicovesicostomy**
- **Monti–Yang ileovesicostomy**
- **Spiral monti**
- **Continent vesicostomy**

- Difficult catheterization
  - Stomal stenosis – dilate and catheterize, topical steroid,
  - Channel stricture/false passage/angulation/polyp – incise or dilate urethra

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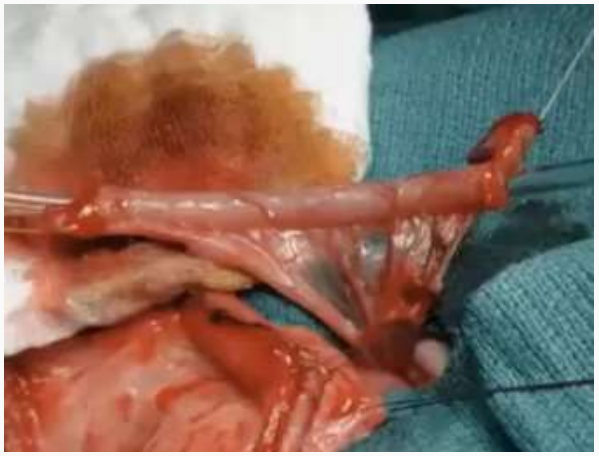
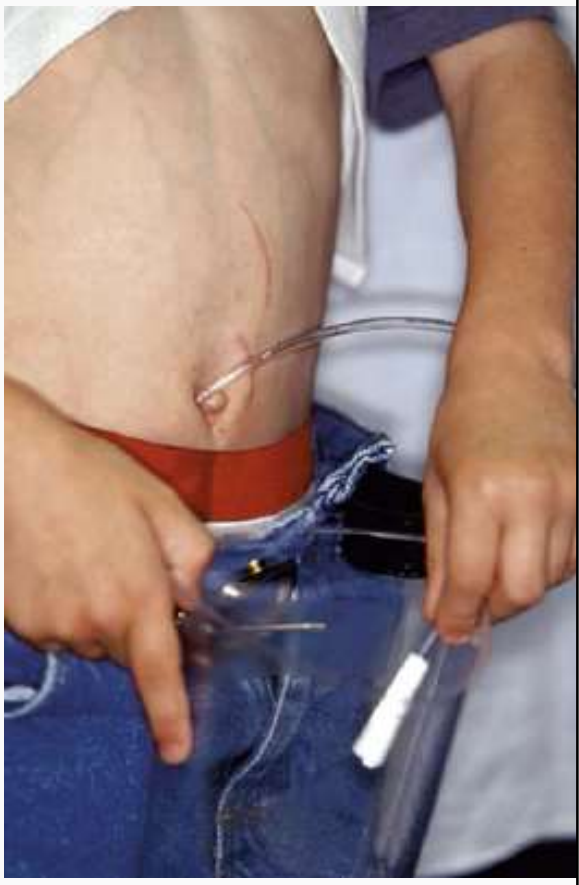
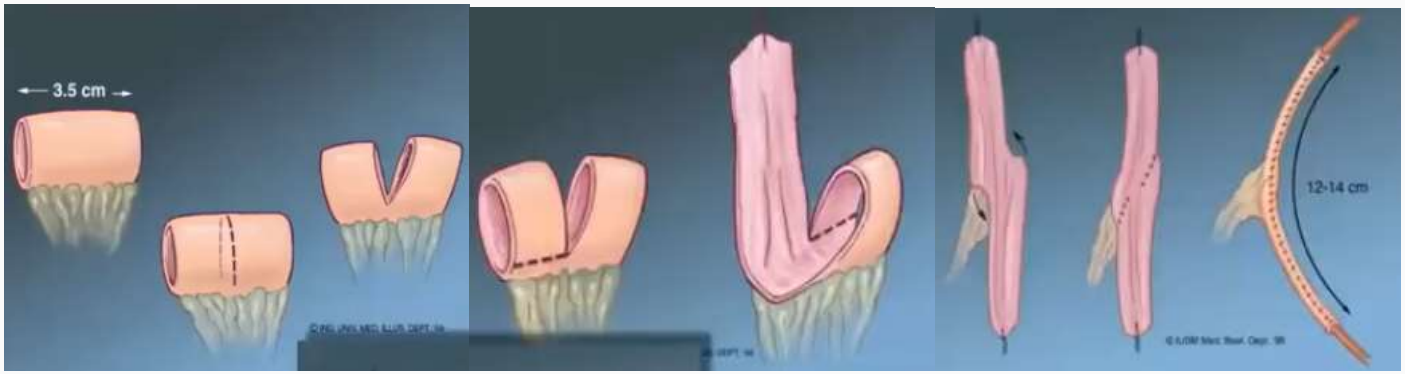
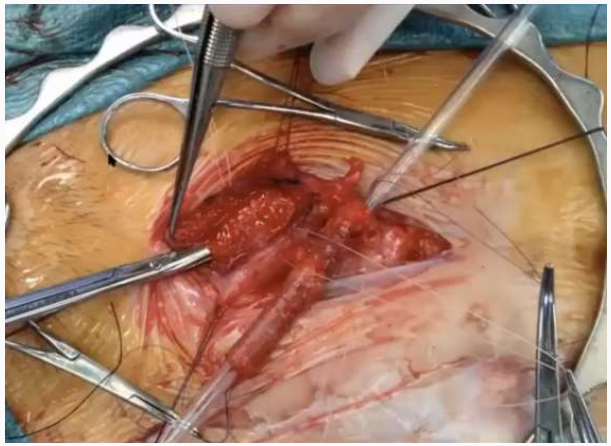
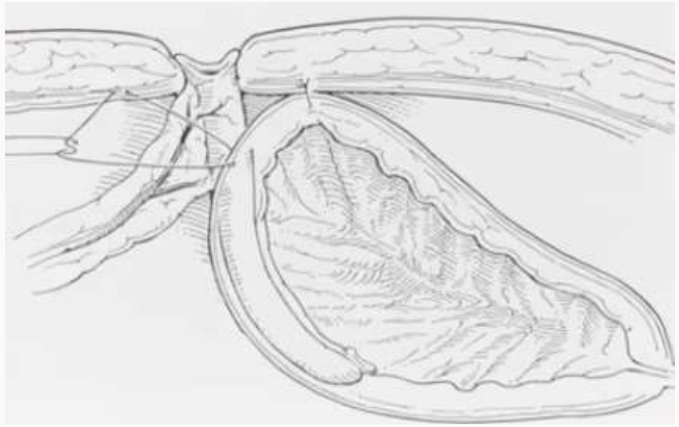


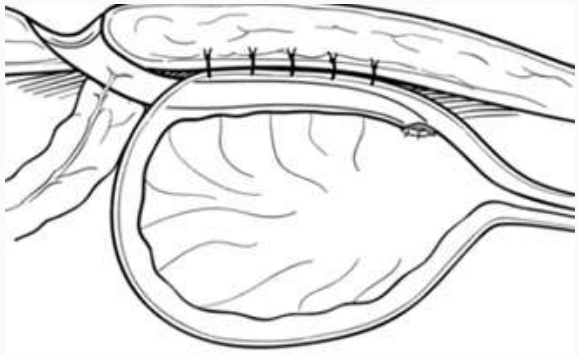




Catheterizable stoma: can use appendix or ileum. Spiral monti creats long channel for obese. Umbilical positioning permits easy access for clean intermittent catheterization.





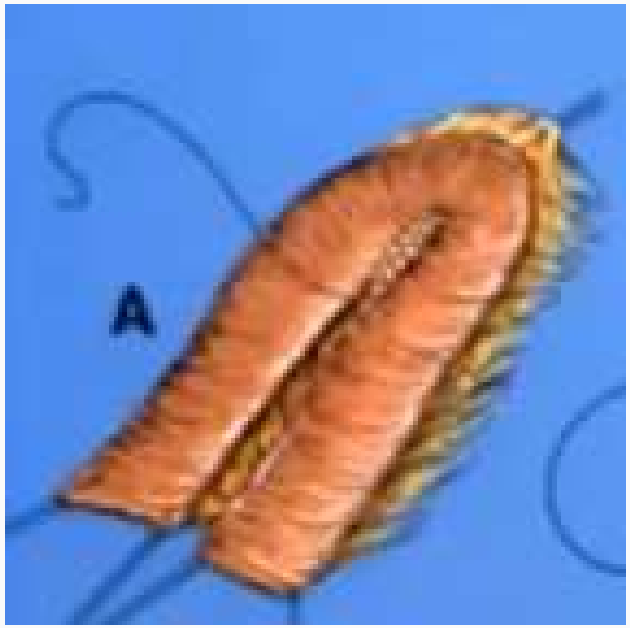


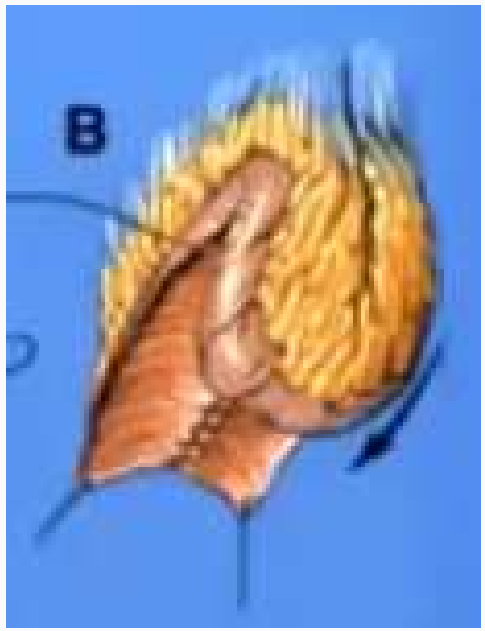
Catheterizable stoma:. After extra/intravesical reimplant of mitrofanoff, Fix bladder to fascia (short, straight channel avoid complication) most complications are subfasial. Good outcome if bladder, facia and channel all coalesce at the hiatus.

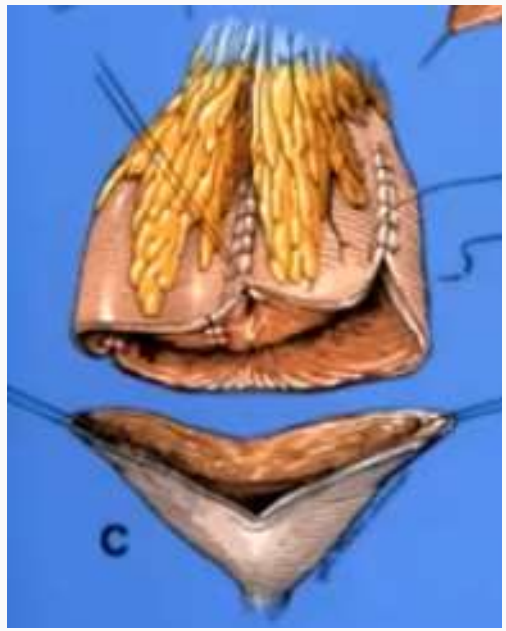
Bladder Augmentation

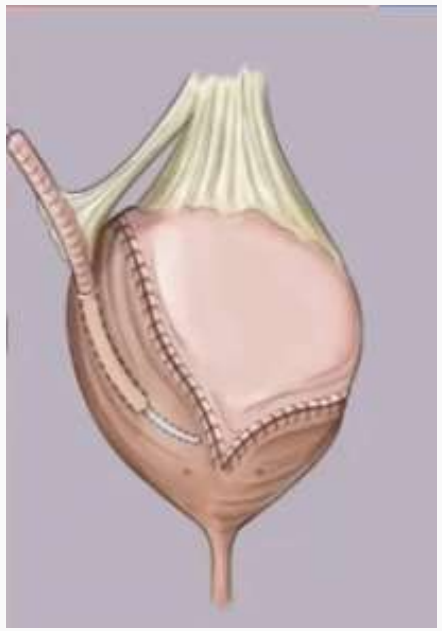
- *Poorly compliant **bladder** that is not responsive to medical therapy*
  - *Very important decision: Counsel and counsel and prepare*
  - **temporary diversion (vesicostomy) may be needed if If age not appropriate*

- **Gastro-cystoplasty** = fallen out of favor (hematuria-dysuria syndrome, risk of adenoca)
- **Entero-cystoplasty =** secretion (mucus) and absorption (hyperchloremia)
- **Auto-augmentation =** deterruserectomy +/- bowel/stomach patch
- **Uretero-cystoplasty=** huge ureter with poor renal function (not common in neurgenic)

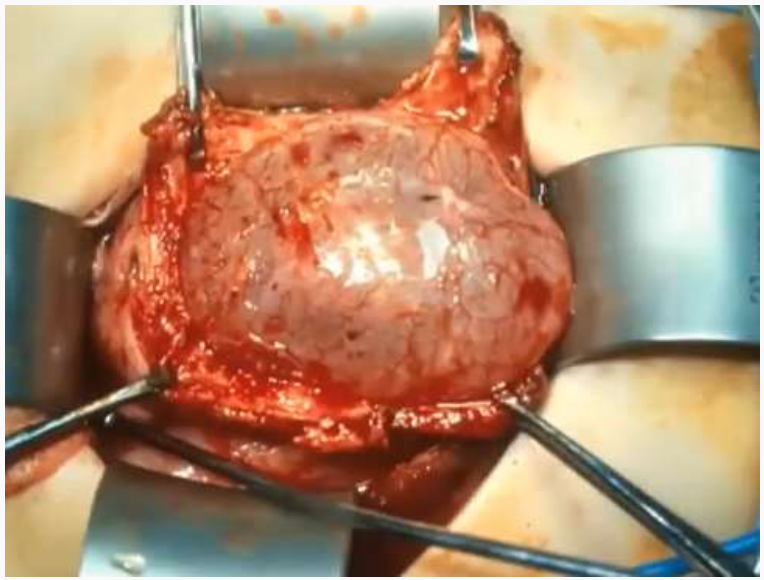


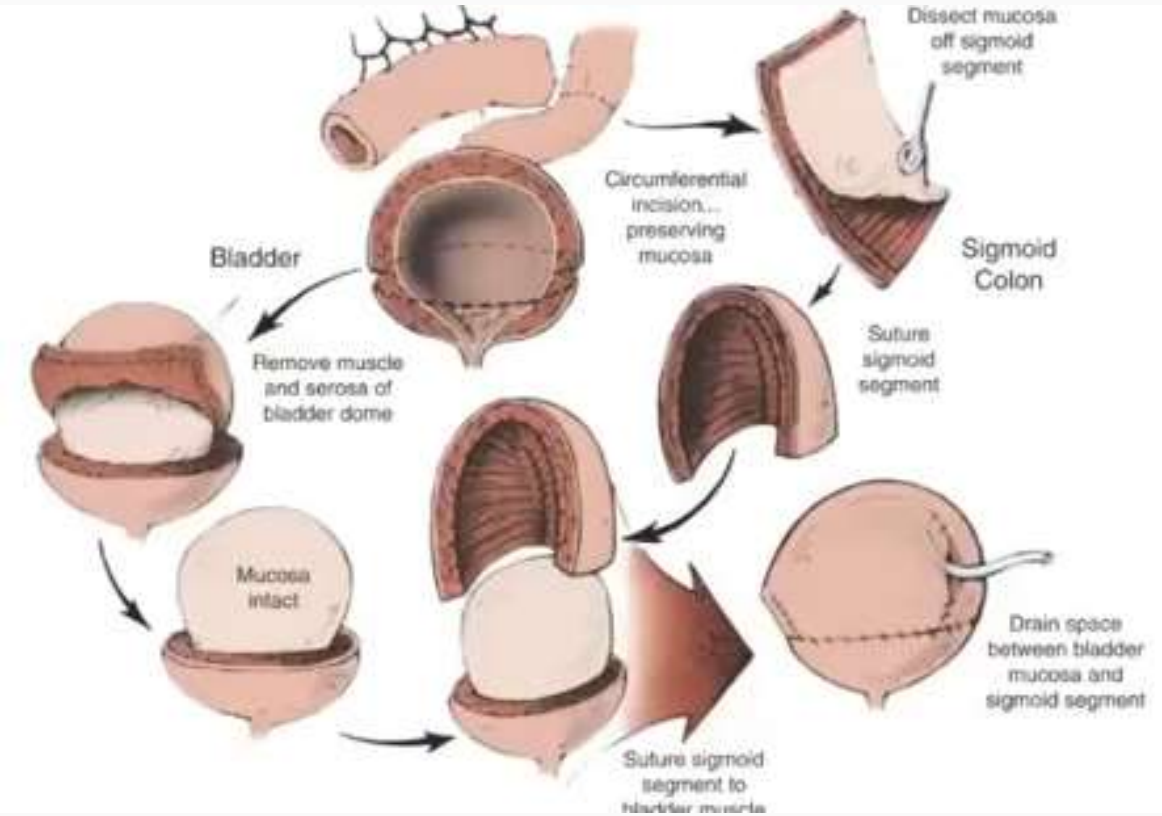






Enterocystoplasty - Preserve >15cm terminal ileum to prevent rapid transit and steatorrhea (B12, fat sol vitamin & bile salt absorption). Bivalve widely to avoid waisting or hour glass effect. Take multiple staff breaks, serial counts. Secure tubes !! Suprapubic stays 1 wk after cic started (3wk mitrofanoff, 4wk monti).



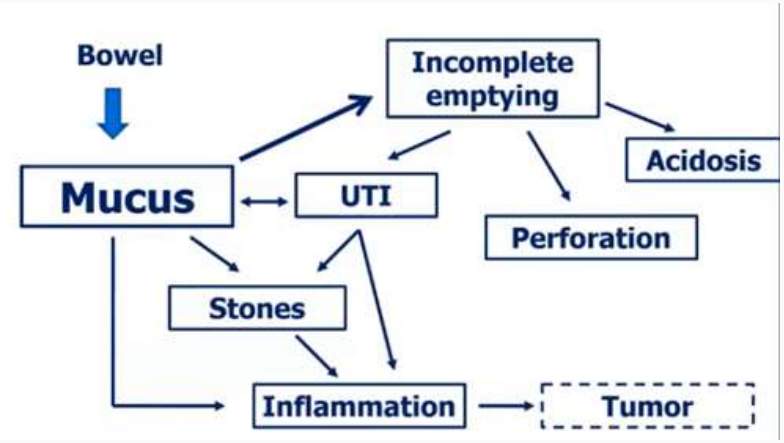


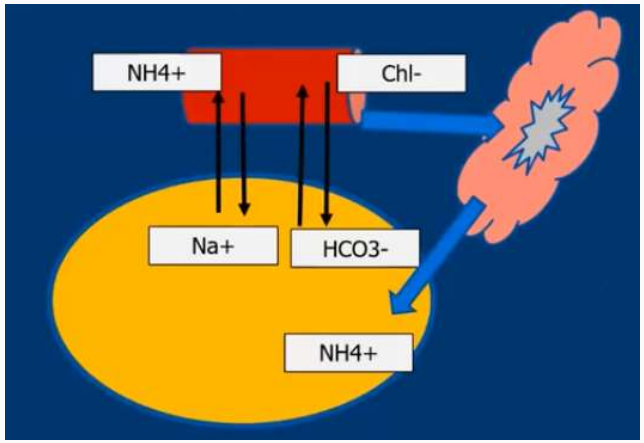
<u>Bladder autoaugmentation or detrusorectomy</u>- for use in bladders with reasonable capacity and mainly poor compliance. Removal of detrusor over the superior portion of the bladder, leaving the underlying bladder mucosa intact creates a large diverticulum, which decreases pressures. Advantage of avoiding GI epithelium complication as in bowel augmentation. The concept has been extended to create “composite” bladders by placing demucosalized bowel or stomach patches over the urothelial bulge.

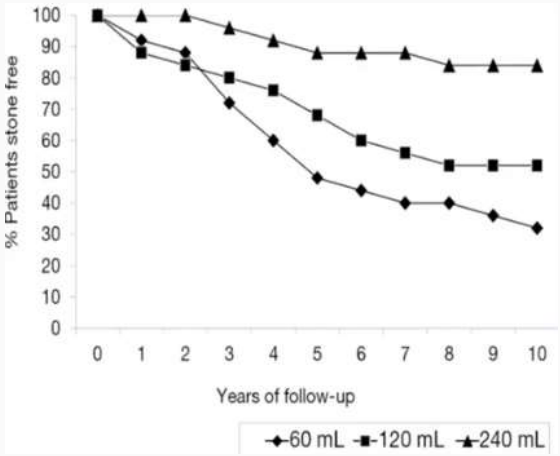
Augmentation: Complications

0.8% mortality, 30% require reoperation

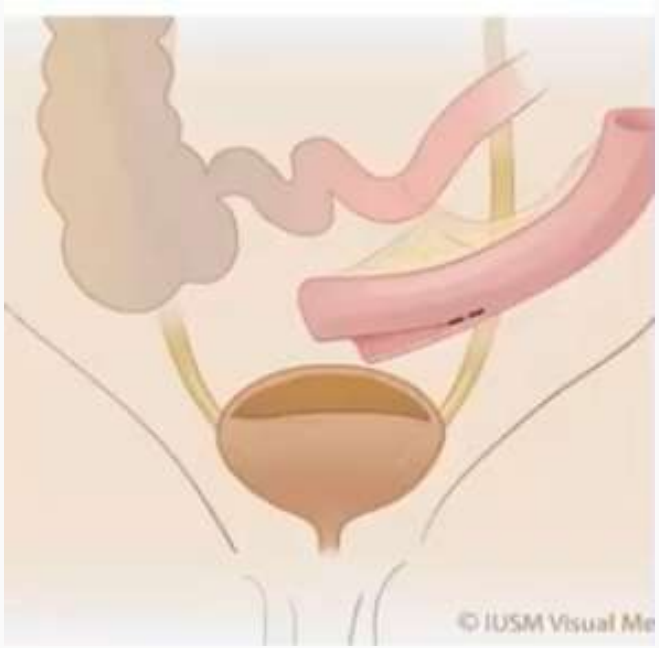
- **Stone (10%)**: yearly US and KUB (10% risk, 50% recur)
- **B12 deficiency (20%) :** B12 yearly after 5 year (store depletion)
  - oral supplement effective. Parenteral if don't respond or poor compliance
- **Hyperchloremic metabolic acidosis**: ?DEXA scan (b/c late effect is bone demineralization)
- **Malignancy (5%, 1.5% per decade)** : risk of TC
  - Cystoscopy after 18yr if >3UTI per year, gross hematuria, chronic pain…
- **Perforation**(10%), adolescent (alcohol abuse, CIC non adherent) traumatic, chronic infection, ischemia
  - Surgery: laparotomy, bladder closure, drainage
- **Diversion** (3%) – perforation, incontinence, upper tract deterioration, inability to catheterize
- **Bowel obstruction/leak**
- **VP Shunt infection** - <2% with care (bowel prep, isolate shunt, follow closely postop)

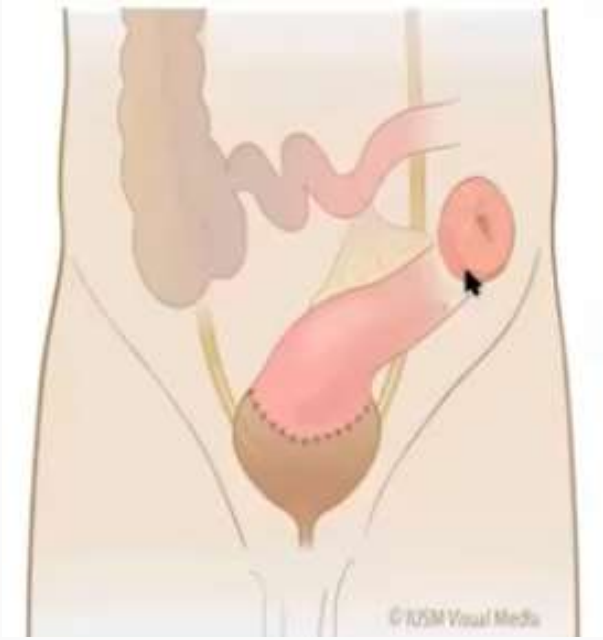






Augmentation compliations: Mucus is a universal issue that may dec after early healing. Causes infection & odor in addition to other complications. Need BID irrigation at first then daily. Hyperchlor metabolic acidosis Ammonium and Cl are exchanged with bicaarb and Na. Amonium recirculates. Acidosis is related to surface area and dwell time (irrigate by time rather than sensation) Stone – risk doesn't change overtime. only way to reduce risk is high volume lavage (200ml).





Diversion: For those not taking care (multiple perforation, hydronephrosis). Convert to Ileal chimney to drains continuously and protect kidney. Can put it back and augment later if get more compliant