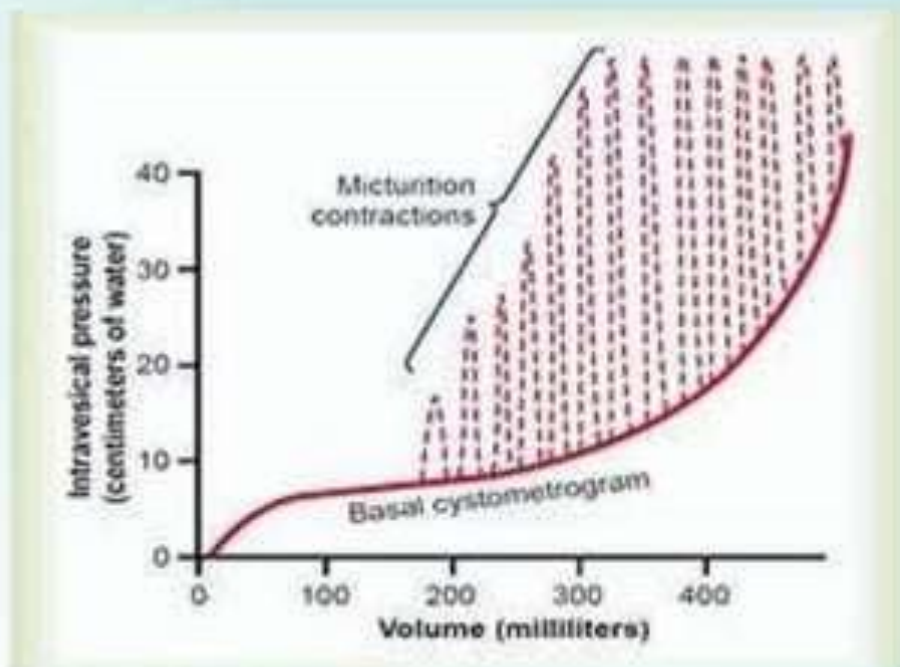


CYSTOMETROGRAM

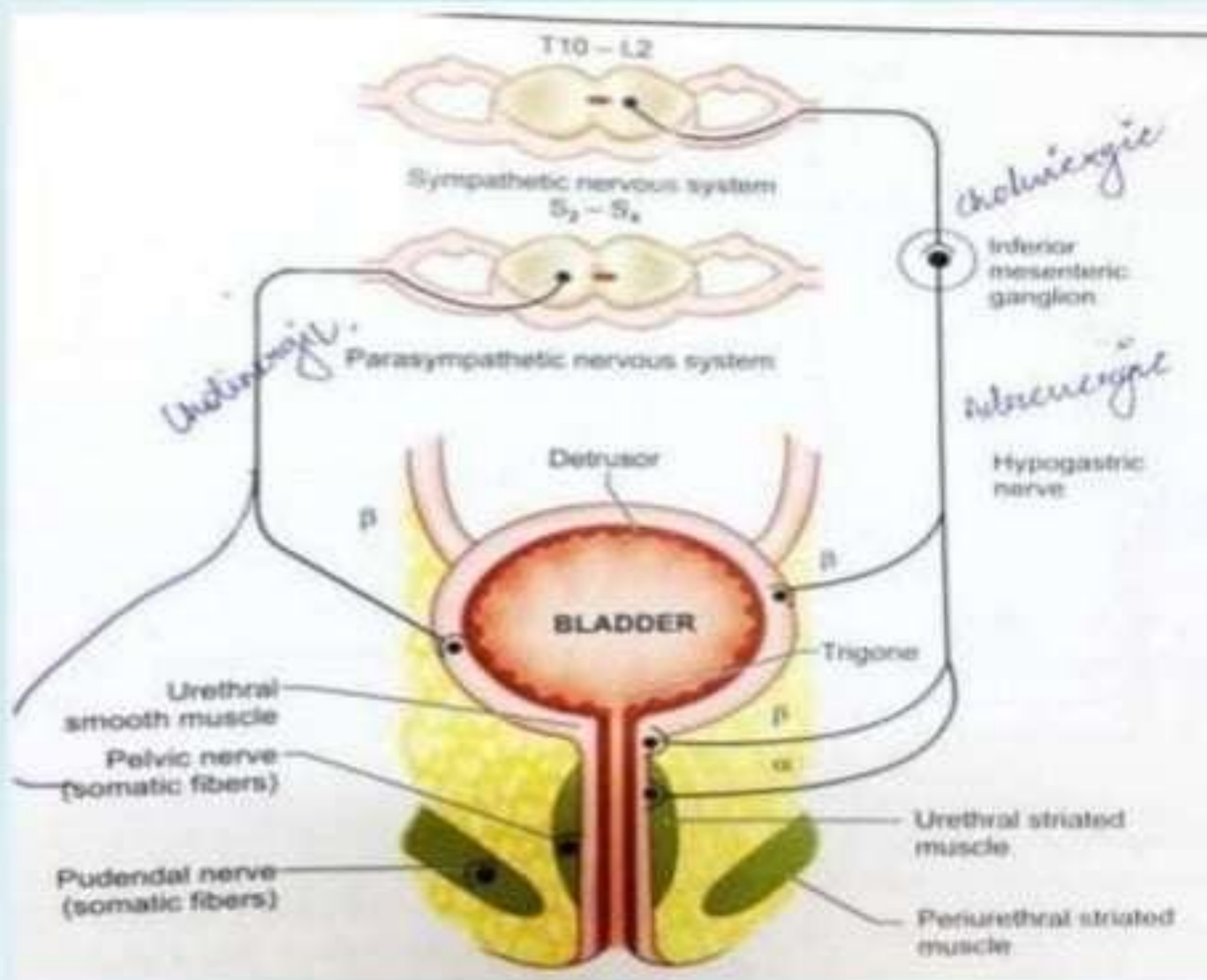


Dr. SRIKANTH. V

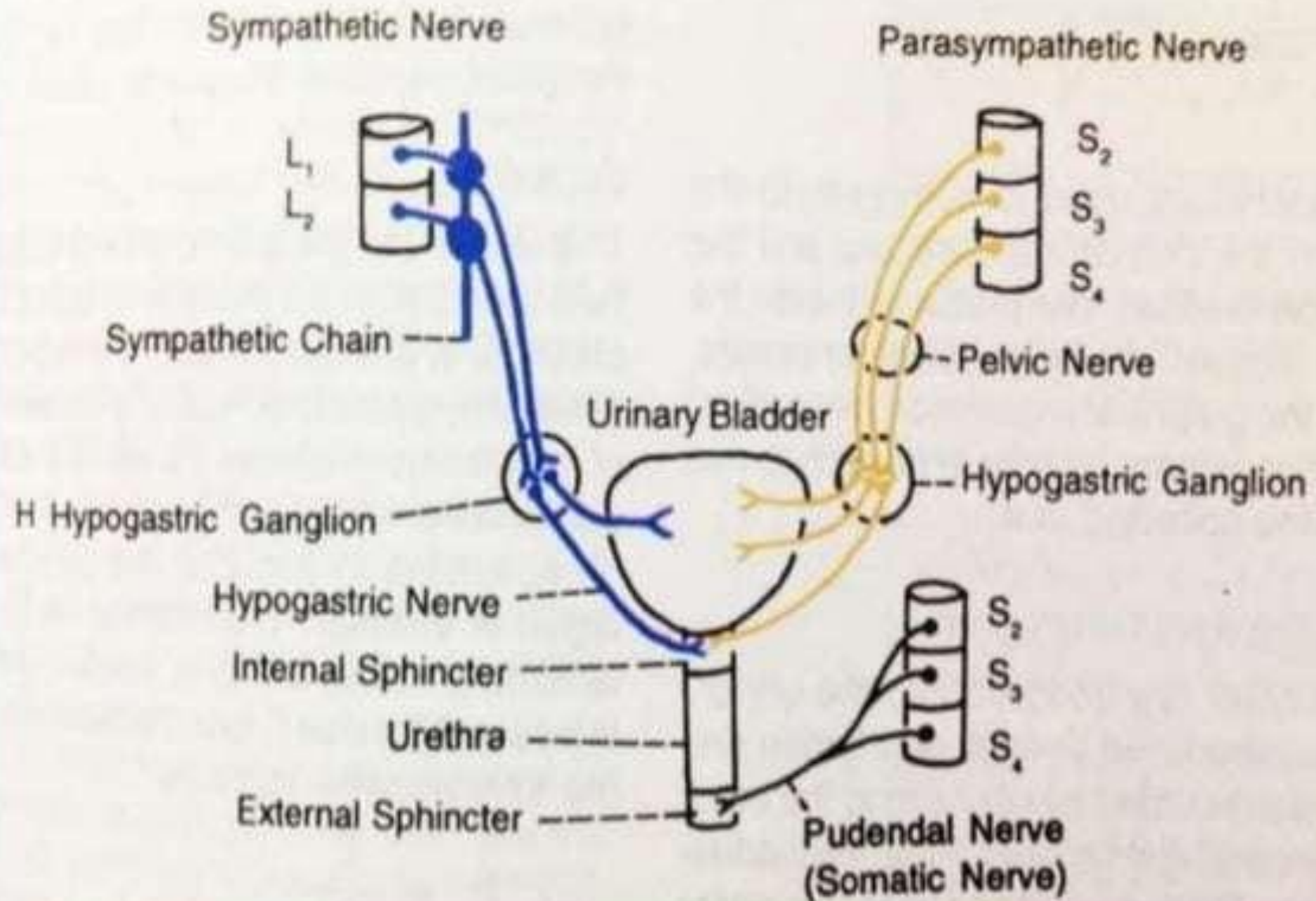
Introduction

- **Bladder** : Serosa, detrusor, urothelium, trigone and bladder neck.
- **Supports to bladder neck and urethra** :
 - 1) **INTRINSIC** : Rhabdosphincter, cavernous plexus, urethral smooth muscles, sympathetic activity.
 - 2) **EXTRINSIC**: Pubococcygeus, pubourethral ligaments and condensed endopelvic fascia, urogenital diaphragm, uterus and cervix.
- **URETHRA functions**:
 - Storage phase-effective continence mechanism
 - Voiding phase – allow adequate emptying from the bladder with minimum of resistance during micturition.

Nerve Supply of Vesicourethral Unit



Nerve Supply of Urinary Bladder and Urethra



Micturition Reflex



➤ **HIGHER CENTRES FOR MICTURITION:**

- Periaqueductal gray area(PAG) of midbrain-receive afferents in pelvic nerves via spinal cord.
 - Pontine Micturition Centre(PMC) of brainstem- essential centre in coordinating micturition process.
 - Suprapontine areas of brain-frontal cortex,hypothalamus,para-central lobule,limbic system and cingulate gyrus.
- 1) Important in conscious and unconscious control of PMC.
 - 2) Role in delaying micturition ,inhibiting premature detrusor contractions and in initiating voiding at appropriate time.

PHYSIOLOGY OF MICTURITION:

STORAGE PHASE: 99% of the time

- Fills at a rate of 0.5- 5 ml/min.
- Compliance of bladder: receptive relaxation of bladder-accomodating the increase in volume without increase in intravesical pressure.
- Under sympathetic control predominantly

Factors contributing to Compliance:

1. Passive elastic properties of tissues of bladder wall
2. Proximal urethral musculature.
3. Neural reflexes controlling detrusor tension during filling.
4. Spinal centres inhibiting cholinergic system.
5. External sphincter.

Process of Micturition



Drop in intraurethral pressure, sympathetic blockade, obliteration of post

urethrovesical angle



Detrusor contracts



Funneling of bladder neck and proximal urethra



Urine flows into upper urethra

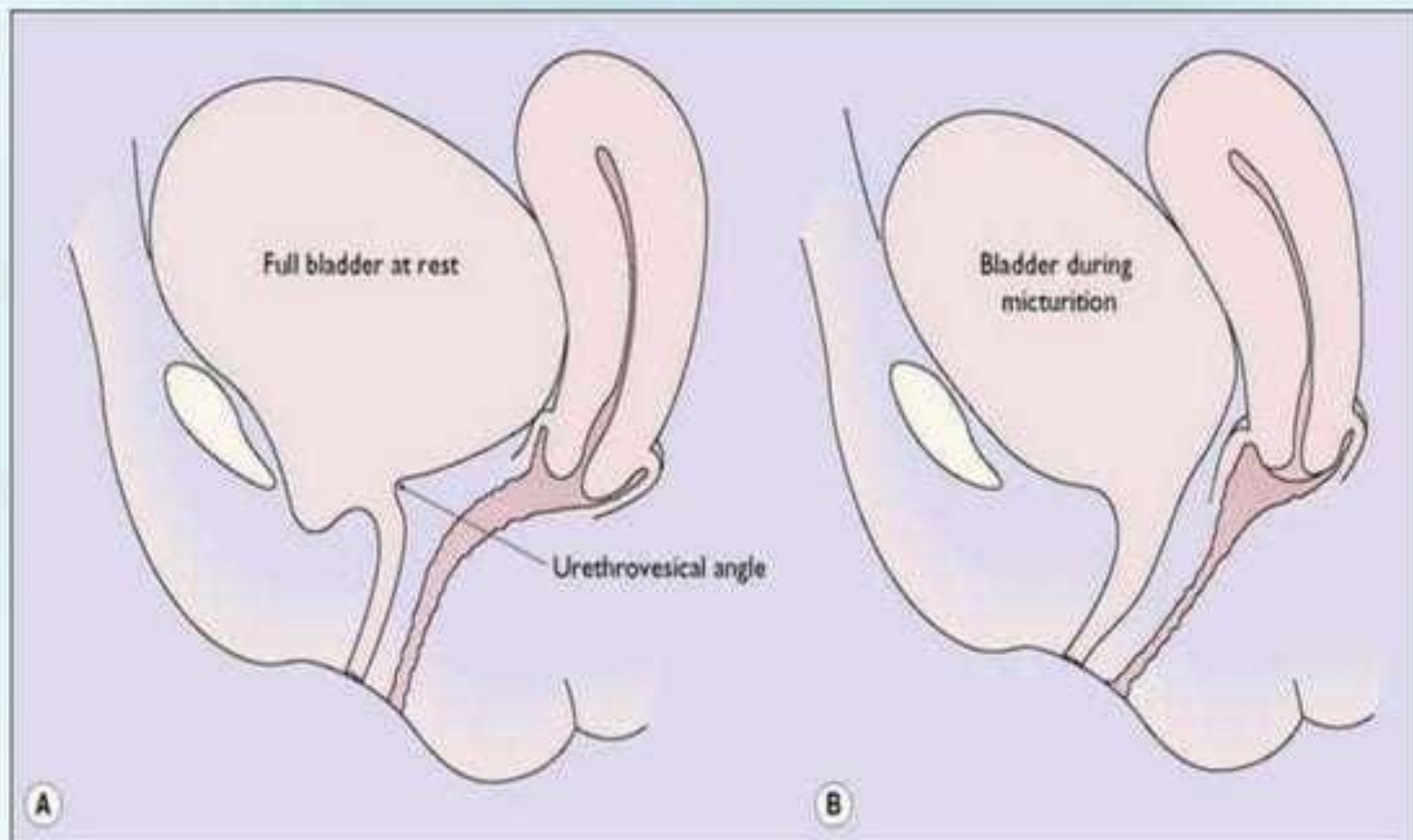


EUS opens & Voiding occurs



Distal end of urethra closes, milking back last drop into bladder

Radiographic tracing of Bladder & Urethra Rest & Micturition



CYSTOMETRY

- Measurement of intravesical bladder pressure during bladder filling (measures volume-pressure relationships).
- Simultaneous measurement of bladder pressure and voiding function-allowing the site of dysfunction to be localised specifically to either bladder or bladder outlet/urethra
- Principal aim: to reproduce patients symptoms and correlate symptoms with UDS findings.
- Can be used to define the behaviour of bladder and urethra during both phases.
- Used to assess bladder compliance, sensation, capacity, flow rate and detrusor activity.

CYSTOMETRY TECHNIQUES

- Simple Cystometry- only intra-vesical pressure is measured, so inaccurate.
- Subtraction cystometry:
 - measure both Pves and Pabd simultaneously.
 - $P_{ves} - P_{abd}$ gives us the Pdet.
 - Accurate determination of Pdet and do not involve any radiation of pressure.
- VCMG: combines subtraction cystometry with contrast media bladder filling and radiological screening, visualise lower tract during storage and voiding phases. Hence is a **GOLD STANDARD** urodynamic inv.
- AUM: allow bladder to fill naturally.

COMPLICATIONS

- Discomfort during the procedure
- Discomfort and dysuria following the procedure
- Transient bleeding post procedure
- UTI- in 2-4% patients , prophylactic antibiotic for at risk patients
- Radiation exposure during videoCMG
- Failure- urdynamic question may remain unanswered.

EQUIPMENT SETUP

- Transducers to measure pressures
- Fluid filled catheters to transmit intravesical & intraabdominal pressures to the transducers
- Second intravesical catheter to fill bladder with fluid.
- Infusion pump
- Flowmeter to measure flow rate.

- ❑ Catheter placement:
 - ✓ Intra-vesical : per urethrally or suprapubic route.
 - ✓ Intra-abdominal : inserting catheter in rectum.(stoma or upper vagina).
 - Catheter has a balloon at the rectal end, it should be filled only by 10-20%.
 - Rectal catheter inserted 10 cm above the anal verge and secured
- ❑ Transducers: 3 are in common use
 - ✓ External fluid charged pressure transducers-recommended by ICS.
 - ✓ Catheter mounted transducers-no ref height,no movt artefacts.
 - ✓ Air charged, pressure sensing technology- newest

Filling the bladder

▶ CATHETER TYPES:

- Dual lumen –recommended by ICS. Can be used for both intra-vesical pressure measurement and also for bladder filling. Thinnest possible is used to limit the artefacts. 8 Fr preferred.
- Single lumen- requires 2 separate catheters.

➤ FILLING FLUID:

- Sterile water
- Normal saline
- Radiological contrast-VCUG

▶ FLUID TEMPERATURE:

- Ideal- at body temperature
- More practical to use fluid at room temp, doesnot appear to affect results.
- Colder fluids – may irritate the bladder –ppt detrusor overactivity.

➤ QUALITY CONTROL:

- Setting zero pressure- zeroed either to the surrounding atm pressure or the internal pressure. 3-way taps are used to zero.

ICS recommends surrounding atm pressure-as it standardises.

- Setting reference height(level at which transducers must be placed)
 - i. External fluid filled systems: superior edge of symphysis pubis.
 - ii. Microtip transducers: transducer itself
 - iii. Air filled transducers: position of the internal balloon.

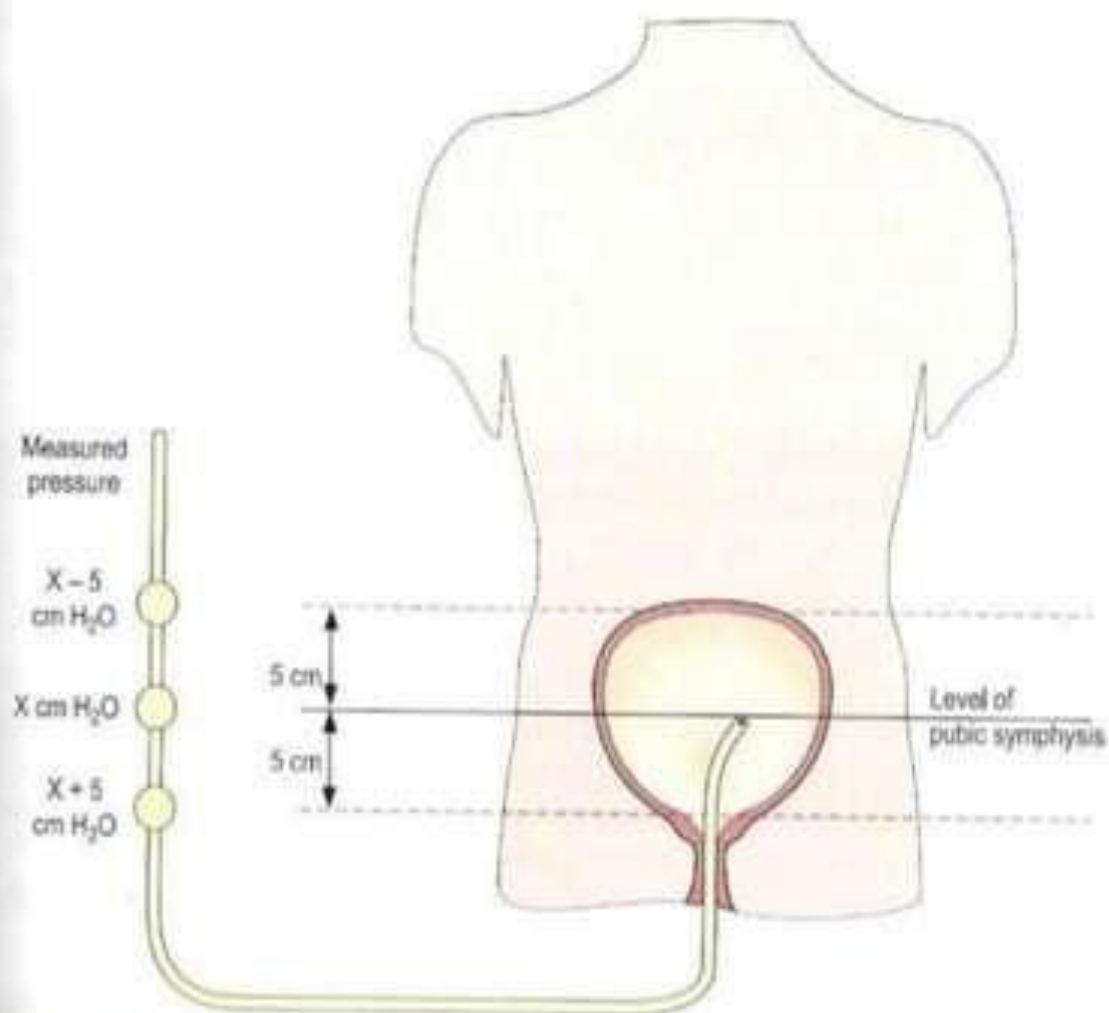


Figure 4.10 *Position of external fluid filled transducers.* These should be set at the level of the pubic symphysis to allow standardization and comparison. Increasing the height of the external transducer lowers the measured pressure whereas lowering the height increases the measured pressure. The position of the catheter in the organ has no effect on the measured pressure.

- ❑ Resting pressures :
 - Pdet should be < 6 cm water and ideally as close to zero as possible .
- ❑ Dampening :poor transmission of pressure to the transducer.
 - Cough before and after the investigation
 - Assessed through out the procedure –cough every 1 min, cough on changing position,voids.
- ❑ Medications:

Drugs affecting LUTS should be discontinued.

One week prior to study normally.

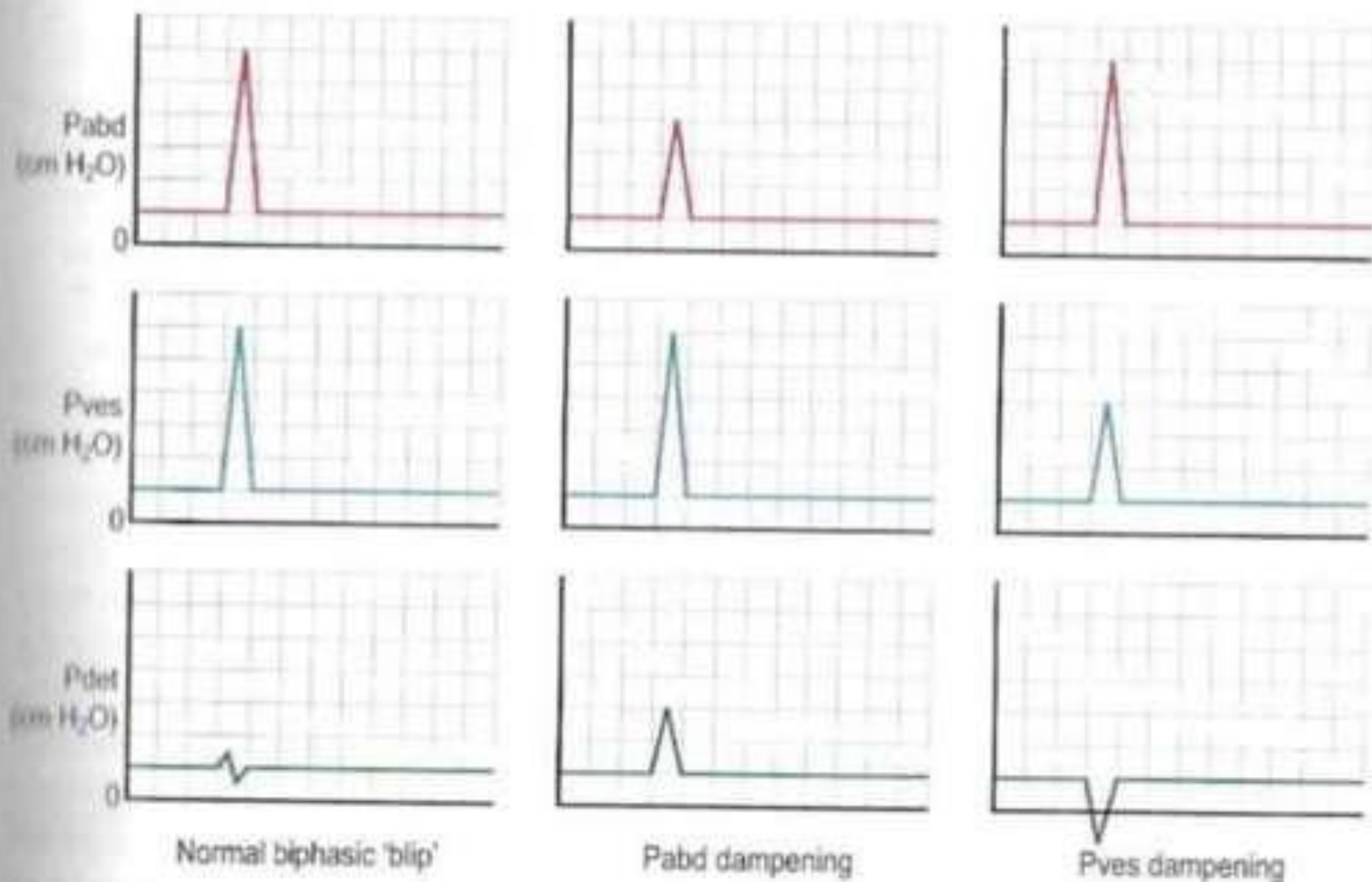


Figure 4.12 Normal and dampened pressure transmission. Left – good subtraction with no dampening. Middle – intra-abdominal line dampening. Right – intravesical line dampening.

Cystometry stages

Urethral and bladder function evaluated in both phases.

1. Storage phase /filling cystometry : pump on to maximum tolerated capacity (permission to void)
 2. Voiding phase / voiding cystometry : permission to void to complete voiding.
- Liquid cystometry is more physiologic.
 - Bladder filling either by diuresis or through a catheter.

➤ FILL RATES –

- Slow (upto 10ml/min)-more physiological, used in neurogenic patients
- Medium (10 to 100 ml/min) most frequently used
- Rapid (> 100 ml/min)
- ▶ ICS recommends 50ml/min in non-neurogenic patients and 20 ml/min in neurogenic patients.

➤ PATIENT POSITION :

- ✓ Standing position is ideal atleast for some part of filling phase.
- ✓ Supine position – helpful as catheters are placed in supine position.
- ✓ Patient should be brought to standing as soon as possible.
- ✓ Supine may be the only position in patients with neurological dysfunction or very small children.

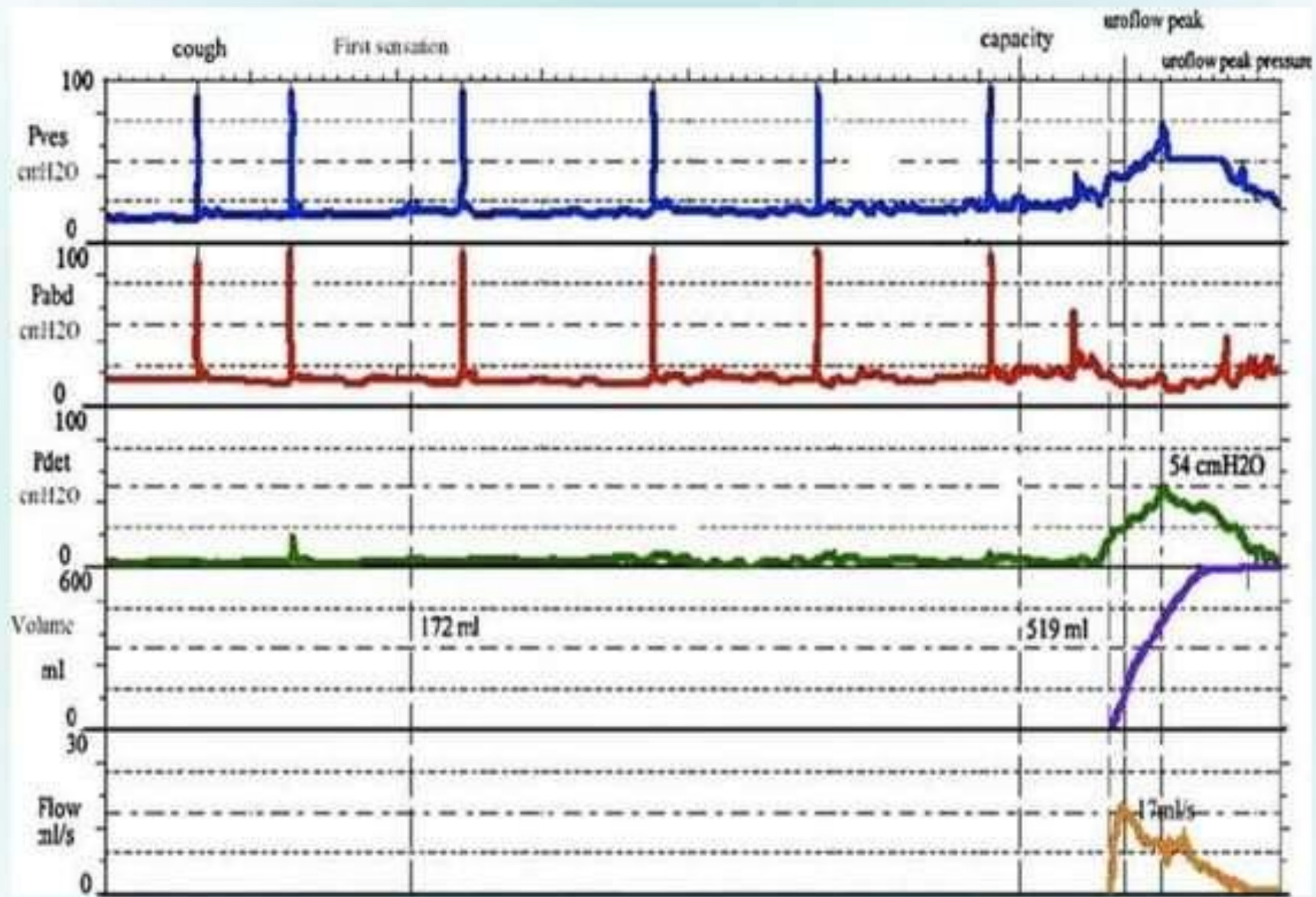
NORMAL CMG

- Capacity 350 – 600 ml
- First desire to void between 150- 200 ml
- Constant low pressure that does not reach more than 6 – 10 cm H₂O above baseline at the end of filling.
- Provocative maneuvers (cough, fast fill etc.,) should not provoke a bladder contraction normally
- Absence of systolic detrusor contractions.
- No leakage on coughing.
- A voiding detrusor Pressure rise of < 70 cm H₂O with a peak flow rate of >15 ml / s for a volume > 150 ml.
- Residual urine of < 50 ml.

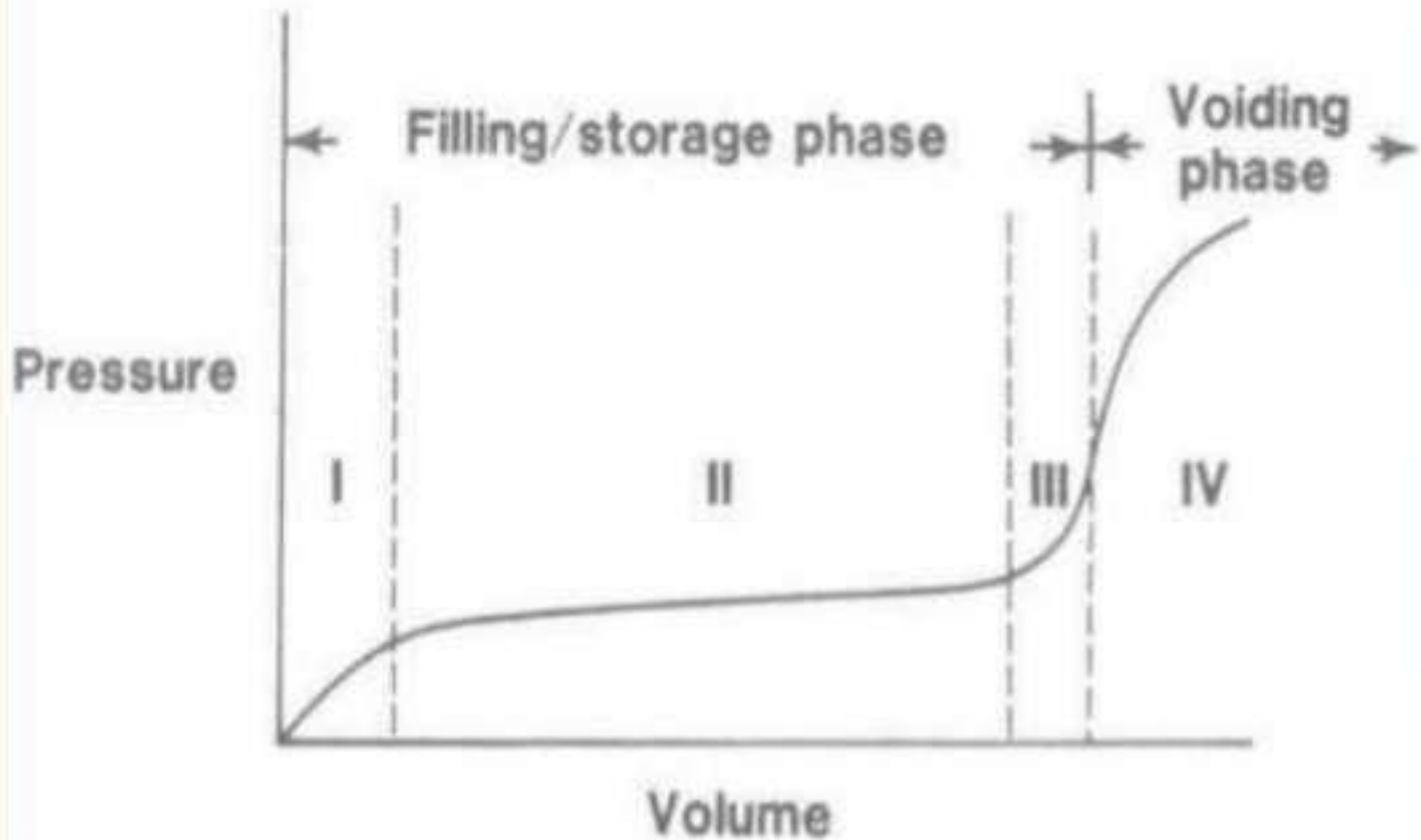
CMG PARAMETERS

- ▶ *Intravesical pressure (P_{ves})* : Total pressure within the bladder.
- ▶ *Abdominal pressure (P_{abd})* : Pressure surrounding the bladder, currently estimated from rectal, vaginal or extraperitoneal pressure or a bowel stoma.
- ▶ *Detrusor pressure (P_{det})* : Component of intravesical pressure created by forces on the bladder wall, both passive and active.
- ▶ *True detrusor pressure = Intravesical pressure – intraabdominal pressure. ($P_{det} = P_{ves} - P_{abd}$)*

- ▶ ***First sensation of bladder filling*** : Volume at which patient first becomes aware of bladder filling.
- ▶ ***First desire to void*** : Feeling during filling cystometry that would lead the patient to pass urine at the next convenient moment.
- ▶ ***Strong desire to void*** : Persistent desire to void without fear of leakage.



Phases of CYSTOMETROGRAM



- Detrusor function during storage phase:
 - Normal – little or no change in pdet during storage phase. Any detrusor activity prior to voiding phase is Involuntary detrusor activity.
 - DO-Detrusor Overactivity –
 - Characterised by involuntary detrusor contractions during storage phase.
 - Spontaneous or provoked.
 - Idiopathic DO-OAB
 - Neurogenic DO

Compliance :

- ▶ Intrinsic ability of bladder to change in volume without significant alteration of detrusor pressure.
- ▶ Relationship between change in bladder volume and change in P_{det} ($\Delta\text{volume}/ \Delta\text{pressure}$) : measured in ml/cm H₂O.
- ▶ Normal bladder is highly compliant, and can hold large volumes at low pressure. Normal compliance is >30-40 cm H₂O
- ▶ Normal pressure rise during the course of CMG in normal bladder will be only 6-10 cm H₂O.
- ▶ Decreased compliance < 20 ml/cm H₂O, poorly distensible bladder.

Impaired Compliance is seen in :

- ▶ **Neurologic conditions** : Spinal cord injury/lesion, spina bifida, usually results from increased outlet resistance (e.g., detrusor external sphincter dyssnergia [DESD] or decentralization in case of lower motor neuron lesions.
- ▶ **Long term BOO** (e.g., from benign prostatic obstruction)
- ▶ **Structural changes** : Radiation cystitis or tuberculosis.
- ▶ Impaired compliance with prolonged elevated storage pressures is a urodynamic risk factor and needs treatment to prevent renal damage

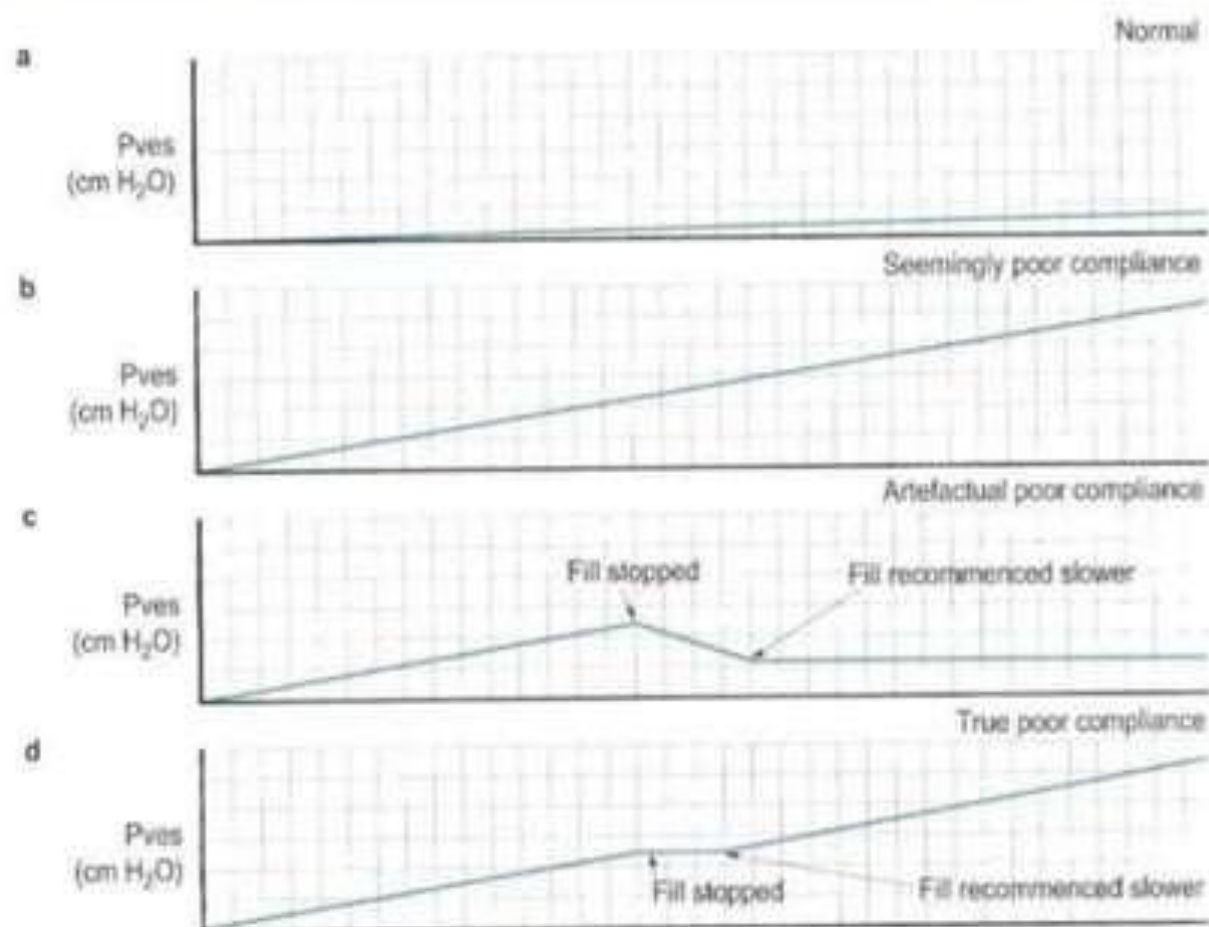


Figure 4.15 Bladder compliance. (a) Normal compliance with each 30–40 ml increase in bladder volume causing a less than 1 $\text{cm H}_2\text{O}$ increase in pressure. (b) Seemingly poor compliance. (c) Artefactual poor compliance due to high fill rate: when filling stopped pressure decreases and when recommenced at lower rate the compliance is seen to be normal. At the end of filling it is recommended to wait approximately 30 seconds before recording the end filling pressure. (d) True poor compliance: stopping filling does not cause a drop in pressure and filling further at any fill rate continues to show poor compliance.

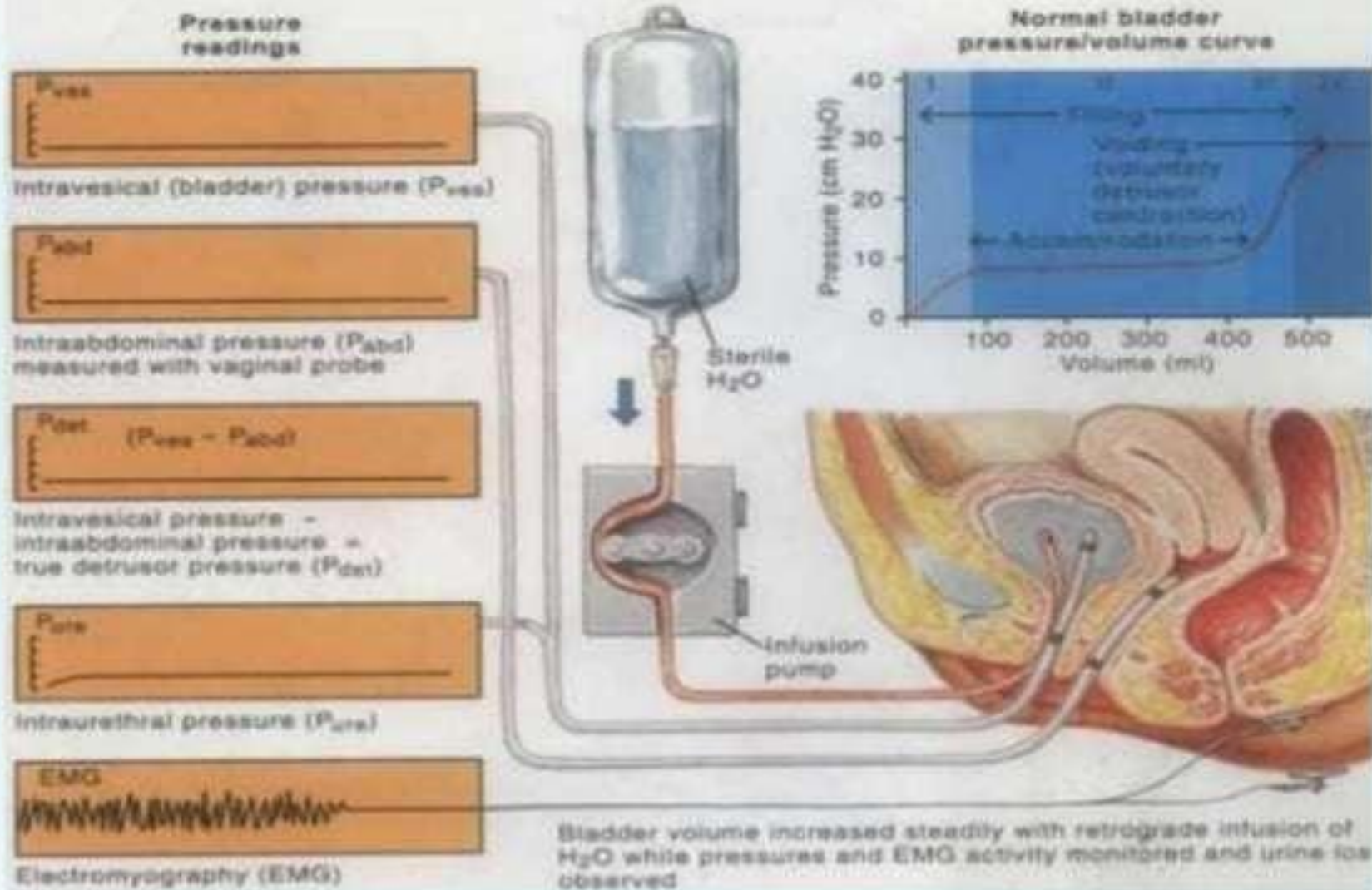
- ▶ ***Urgency*** : A sudden compelling desire to void.
- ▶ ***Normal detrusor function*** : Allows bladder filling with little or no change in pressure, no involuntary contractions.
- ▶ ***Detrusor overactivity*** : Involuntary detrusor contractions during the filling phase , spontaneous or provoked.
- ▶ ***Storage greater than 40 cm H₂O is associated with harmful effects on the upper tract.***
- ▶ ***Overactive bladder*** : Storage symptoms of urgency with or without urgency incontinence , usually with frequency and nocturia.
- ▶ ***Neurogenic detrusor overactivity*** : Overactivity accompanied by a neurologic condition , also k/a detrusor hyperreflexia.

- ▶ *Abdominal leak point pressure (ALPP)*: Intravesical pressure at which urine leakage occurs because of increased abdominal pressure in the absence of a detrusor contraction.
- ▶ ALPP is a measure of sphincteric strength or ability of the sphincter to resist changes in P_{abd} .
- ▶ Applicable to stress incontinence ; ALPP can be demonstrated only in a patient with SUI.
- ▶ There is no normal ALPP , because patients without stress incontinence will not leak at any physiologic P_{abd} .
- ▶ Lower the ALPP, weaker is the sphincter.

- ▶ ALPP < 60 cm H₂O : significant ISD
- ▶ ALPP 60-90 cm H₂O : equivocal
- ▶ ALPP > 90 cm H₂O : urethral hypermobility, little or no ISD.

- ▶ ***Detrusor leak point pressure (DLPP)*** : Lowest detrusor pressure at which urine leakage occurs in the absence of either a detrusor contraction or increased abdominal pressure (risk with > 40 cm H₂O).
- ▶ It's a measure of P_{det} in a patient with decreased bladder compliance.
- ▶ Higher the urethral resistance, higher the DLPP, the more likely is upper tract damage as intravesical pressure is transferred to the kidneys.

Complex Cystometry



THANK YOU !