RENAL PHYSIOLOGY

MICTURITION

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MICTURITION

It is the process by which the urinary bladder empties when it becomes filled

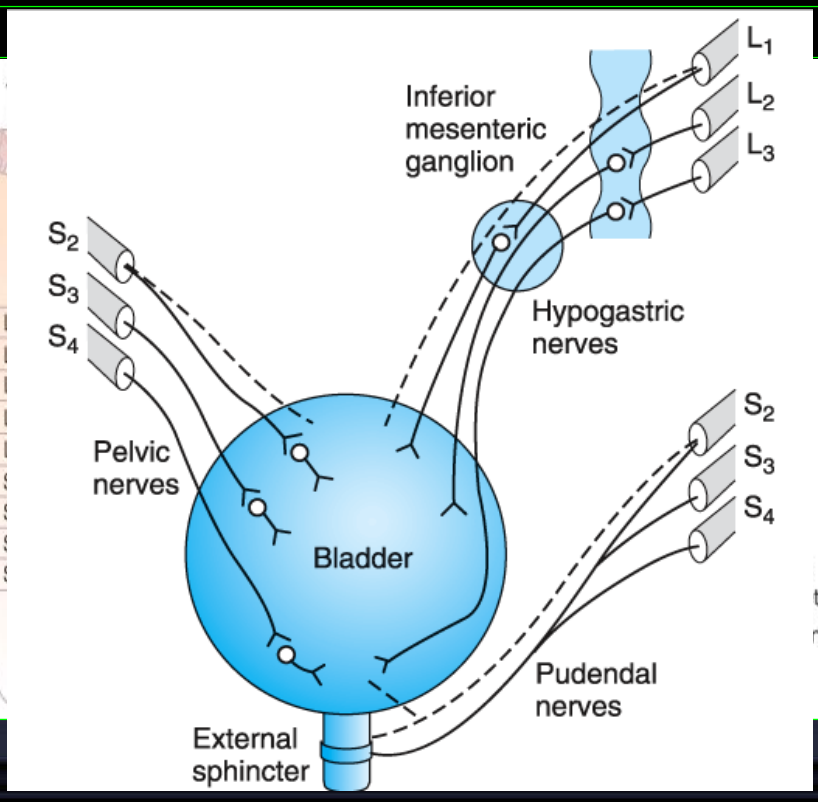
- **Filling of bladder.**
- **Micturition reflex.**
- **Voluntary control.**

Physiologic Anatomy and Nervous Connections of the Bladder

- Composed of
  1. Body
  2. Neck……..post urethra (stretch receptors)
- External sphincter.
- Pelvic diaphragm.

A reservoir … adult … 250-400ml
DETRUSOR MUSCLE … pr essure can rise up to 40-60 mmHg.
Mucosa… RUGAE …TRIGONE

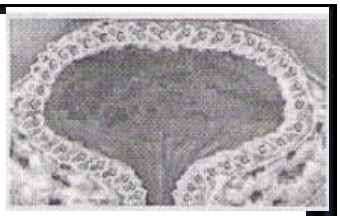
Nervous Connections of the Bladder



Nerve Supply of the Bladder

- **PELVIC NERVES** from sacral plexus mainly S2 and S3…both sensory and motor.The motor nerves transmitted in the pelvic nerves are **parasympathetic fibers**
- **PUDENDAL NERVE** contain skeletal motor fibers transmitted through the to the external bladder sphincter
- **HYPOGASTRIC NERVES (SYMPATHETIC INNERVATION)** from the sympathetic chain (L-2). Stimulate mainly the blood vessels and have little to do with bladder contraction. Some sensory nerve fibers for fullness and pain.

Receptors During Storage



During the *STORAGE* phase,

1. Parasympathetic (cholinergic) receptors are *inhibited*, prohibiting detrusor muscle contraction.

2. Sympathetic receptors are *stimulated*, resulting in:

   - Relaxation of *beta* controlled detrusor muscle and increased stretch capacity of the bladder dome.
   - Contraction of the *alpha* controlled bladder neck.

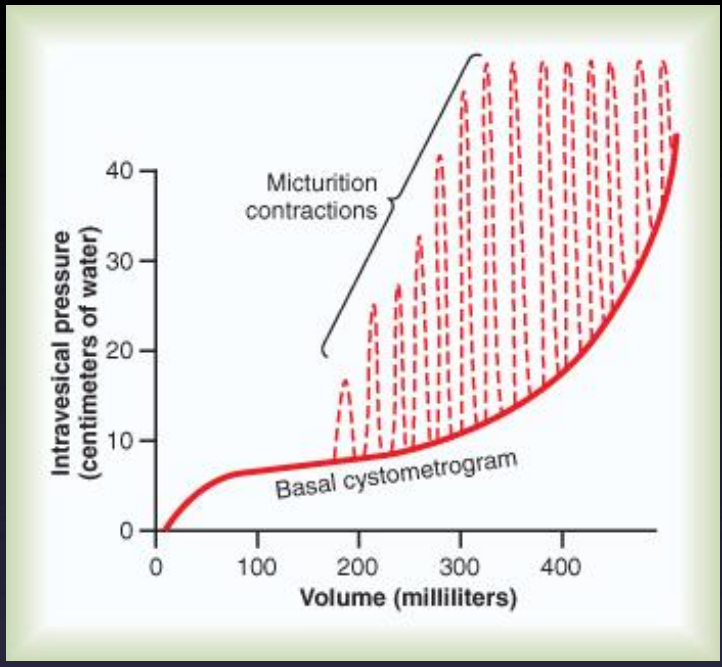
To remember…..

- **Sympathetic supply to the bladder cause storage of urine.**
- **Parasympathetic supply leads to the Passage of urine.**

FILLING OF BLADDER AND ITS TONE...

- 0 … when empty.
- 30-50 ml … 5-10 cm of water.
- 200 – 300 ml … small additional rise of pr.
- Beyond 300 – 400 ml … pr rises rapidly.
- Micturition waves… acute pr peaks superimposed on the tonic pr changes can range from few to > 100 cm of water caused by micturition reflex.
- Cystometrogram.

CYSTOMETROGRAM

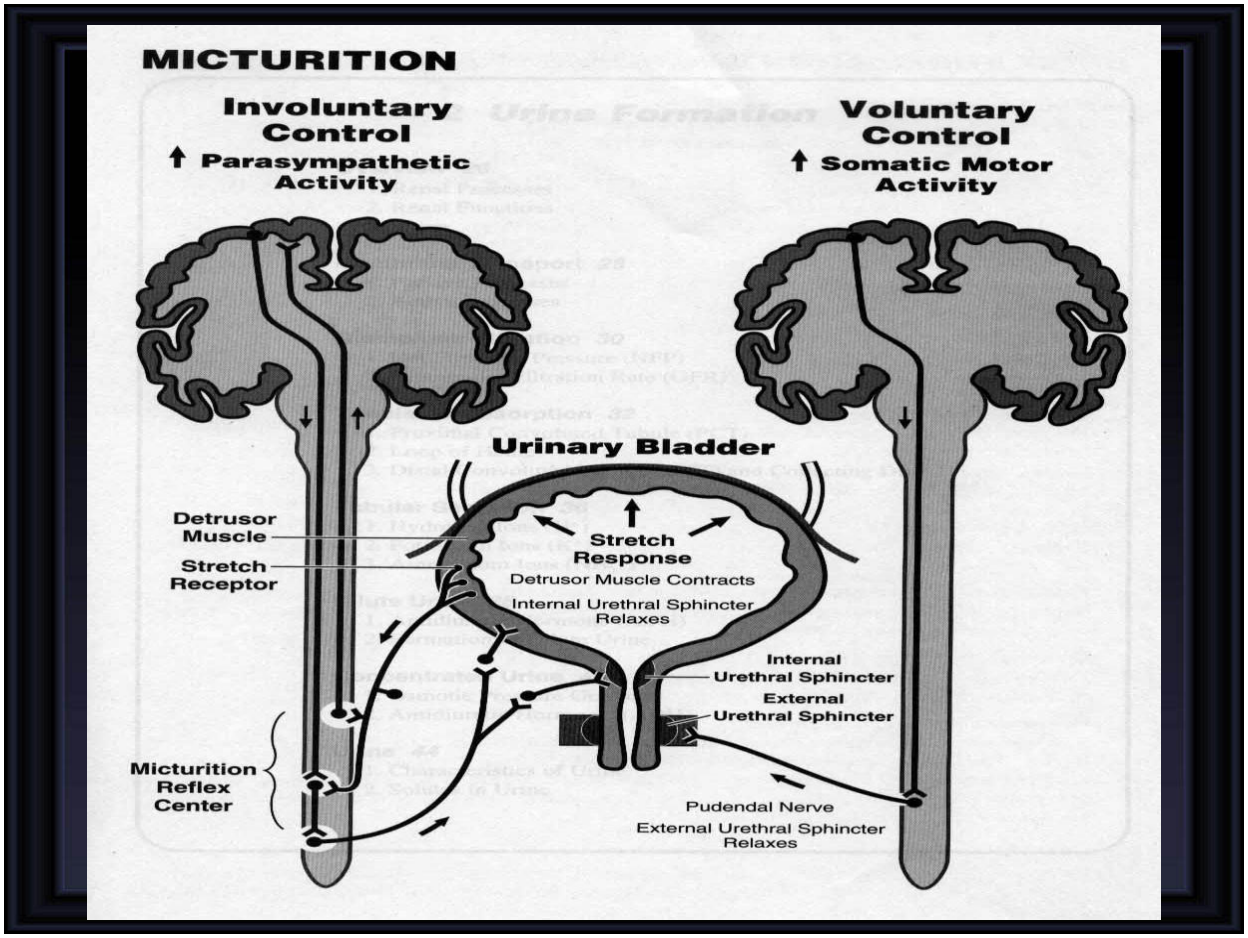


INNERVATION OF THE BLADDER

	Nerves	Characteristic	Function
1	Pelvic nerves (parasympathetic fibers) S-2 and S-3	Both sensory and motor nerve fibers	Contraction of bladder The sensory fibers detect the degree of stretch in the bladder wall
2	Pudendal Nerve	somatic nerve	Fibers that innervate and control the voluntary skeletal muscle of the sphincter
3	Hypogastric Nerves	sympathetic innervation (L2)	Stimulate mainly the blood vessels and have little to do with bladder contraction. Sensory nerve fibers of the sympathetic nerves also mediate the sensation of fullness and pain.

MICTURITION REFLEX

- Completely AUTONOMIC SPINAL REFLEX.
- When bladder only partially filled..relax spontaneously after a fraction of a min, Detrusor muscle contraction stops … pressure falls to baseline.
- As bladder fills more… reflexes increase in frequency and intensity.
- Positive feedback mechanism.


MICTURITION
Involuntary Control
Parasympathetic Activity
Voluntary Control
Somatic Motor Activity
Urinary Bladder
Detrusor Muscle
Stretch Receptor
Stretch Response
Detrusor Muscle Contracts
Internal Urethral Sphincter Relaxes
Internal Urethral Sphincter
External Urethral Sphincter
Micturition Reflex Center
Pudendal Nerve
External Urethral Sphincter Relaxes

HIGHER CONTROL

- **The higher centers ordinarily keep the reflex partially inhibited except when micturition is desired.**
- **Higher center can prevent the reflex by tonic contraction of external bladder sphincter through the pudendal nerves until a convenient time.**
- **the cortical centers facilitate the sacral micturition center to initiate the reflex and inhibit external urinary sphincter so that urination can occur.**

SUPRA SPINAL CONTROL

Micturition is a vesicovesical reflex which is facilitated and inhibited by higher cortical and pontine micturition center.

1. PONTINE CENTER;

A. L or lateral center;

Spinoreticular fiber synapse in the L nucleus of pons and then it activates ONUF'S NUCLEUS in the sacral spinal cord thereby closing tightly external urinary sphincter. This onuf's nucleus is situated in the anterior horn of the spinal cord and through the pudendal nerve it supplies the external urinary sphincter.

SUPRA SPINAL CONTROL (cont…)

B. M: medial pontine center.

It projects to the intermediolateral column of the spinal cord. When stimulated it produces a decrease in urethral pressure and rise in the detrossor muscle pressure causing emptying of the bladder.

Note: pontine centers take 2-3 yrs. to develop hence there is automatic emptying of bladder.

- **In adult 300-400 ml of urine normally required to initiate this reflex.**

SUPRA SPINAL CONTROL (cont…)

HIGHER CORTICAL CONTROL

- Cerebral cortex for example paramedian lobule present on the medial surface of frontal lobe.
- Hypothalamus it is one of the highest center of autonomic control is also involved.

Role of higher centers in micturition reflex.

- Higher centers keep the micturition reflex partially inhibited except when micturition is desired.
- It prevents micturition even if micturition reflex is operating by tonic contraction of external sphincter (pudendal nerve) until a convenient time is found.
- When it is time to urinate cortical center can facilitate the sacral micturition centers to help and initiate a micturition reflex at the same time it inhibits the external urinary sphincter hence it is relaxed causing urination.

22.49 NEUROGENIC BLADDER: CLINICAL FEATURES AND TREATMENT

	Site of lesion	Result
Atonic ('lower motor neuron')	Lesions of sacral segments of cord (conus medullaris) Lesions of sacral roots and nerves	Loss of detrusor contraction Difficulty initiating micturition Bladder distension with overflow
Hypertonic ('upper motor neuron')	Pyramidal tract lesion in spinal cord or brain stem	Urgency with urge incontinence Bladder sphincter incoordination (dyssynergia) Incomplete bladder emptying
Cortical	Post-central Pre-central Frontal	Loss of awareness of bladder fullness Difficulty initiating micturition Inappropriate micturition Loss of social control

Effects of Deafferentation

- **Damage Site:** When the sacral dorsal roots (Afferents) are interrupted by diseases of the dorsal roots, such as tabes dorsalis and long standing DM
- **Features:** Reflex contractions of the bladder are abolished. The bladder becomes **distended**, **thin-walled**, and **hypotonic**, but some contractions occur because of the intrinsic response of the smooth muscle to stretch.

Effects of Denervation

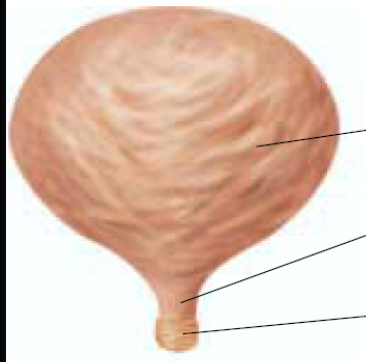
- **Damage Site:** When the afferent and efferent nerves are both destroyed, as they may be by tumors of the cauda equina or filum terminale,
- **Feature:** the bladder is flaccid and distended for a while. Gradually, however, the muscle of the "decentralized bladder" becomes active, with many contraction waves that expel dribbles of urine out of the urethra. The bladder becomes **shrunken** and the bladder wall **hypertrophied**.

Effects of Spinal Cord Transection

- **Damage Site: Spinal Cord injuries (Paraplegia)**
- **Feature: During spinal shock, the bladder is flaccid and unresponsive. It becomes overfilled, and urine dribbles through the sphincters (overflow incontinence). After spinal shock has passed, the voiding reflex returns, with no voluntary control and no inhibition or facilitation from higher centers. Sometime voiding reflex becomes hyperactive called spastic neurogenic bladder.**

ABNORMALITIES OF MICTURITION

	ATONIC BLADDER	AUTOMATIC BLADDER
Lesion	Sensory nerve fibers from the bladder to the spinal cord are destroyed Crush injury to the sacral region of the spinal cord *and tabes dorsalis*	Spinal Cord Damage Above the Sacral Region resulting in Spinal shock
Feature	Bladder fills to capacity and overflows a few drops at a time through the urethra. This is called *overflow incontinence*.	return of excitability of micturition reflex until typical micturition reflexes returns & then, periodic (but unannounced) bladder emptying occurs which may be controlled by scratching or tickling



Muscle	Innervation		
	Type	During filling	During micturition
Detrusor (smooth muscle)	Parasympathetic (causes contraction)	Inhibited	Stimulated
Internal urethral sphincter (smooth muscle)	Sympathetic (causes contraction)	Stimulated	Inhibited
External urethral sphincter (skeletal muscle)	Somatic motor (causes contraction)	Stimulated	Inhibited

RENAL DISEASES

Effects of Disordered Renal Function

Effects of Disordered Renal Function

- Proteinuria
- Albuminuria (Orthostatic albuminuria)
- Hematuria
- Polyuria and nocturia
- Oliguria or even anuria
- Uremia (breakdown products of protein accumulate)