

Micturition

- What is it?

The process by which the urinary bladder empties when it becomes filled. → This process involves two main steps:

- 1- The bladder fills progressively until the tension in its wall rises above **threshold level**.
- 2- Nervous reflex (**Micturition reflex**)

- Physiology & Anatomy of the bladder:

- The lower part of the bladder neck called:

Posterior urethra.

- **Detrusor muscle**: Smooth muscle of the bladder. →

Contraction of it is the **major step** in emptying the bladder.

- The urethra passes through the **urogenital diaphragm** → contains layer of muscle called **external sphincter of the bladder** (Skeletal muscle = voluntary) → Can be used to prevent urination even when involuntary controls are attempting to empty the bladder.

- The **stretch signals** from the post. urethra are especially strong and **mainly responsible for initiating the reflexes that cause bladder emptying**.

- The skeletal motor fibers transmitted through the **puddendal nerve** (S2,3,4 AHCs) to the external bladder sphincter.

- Transport of urine from the kidney through the ureters & into the bladder:

- Urine flowing from collecting ducts into the renal calyces stretches the calyces & increase their inherent **pacemaker** activity → initiate **peristaltic contraction** → spread into renal pelvis → bladder.

- Peristaltic contractions in the ureter are enhanced by **paraSymp. Stimulation** (Pelvic nerves; S2,3,4 LHCs) & inhibited by symp. stimulation (Hypogastric nerve; mainly L2 LHCs)

- **Vesicoureter reflex**: a condition in which some of the urine in the bladder is propelled backward into the ureter.

- When ureter become **blocked** → intense reflex constriction occurs → severe pain → the pain impulses cause **symp. reflex** back to the kidney to **constrict renal arterioles** → Decrease urine output → This effect is called **Uretorenal reflex**.

- Cytometrogram:

- Filling of the bladder & bladder wall tone.

- Shows the approximate changes in **intravesicular pressure** as the **bladder fills with urine**.

- When there is no urine in the bladder, the intravesicular pressure is ~ 0.

- 150 – 300 ml → 1st urge to void urine.

- 300- 400 ml → Sense of fullness of the bladder.

- 400-600 ml → Sense of discomfort.
- 600-700 ml → Sense of pain.
- ≥ 700 ml → micturition reflex can not be suppressed.
- هو العلاقة بين حجم البول الداخل للبلادر وضغط اليلادر، التناسب بينهم طردي.
- إذا مرة زاد حجم البول -> بيزيد المكتوريشن رفلكس -> يبصير فيه شيئين:
 - 1- فيه أوامر من فوق تعطي أوامر للكونتر اكشن للاكسترنال مسل.
 - 2- فيه أوامر من تحت يسويها الباراسمبثك عشان تسوي انهيشن للاكسترنال.
- اللي يتغلب منهم هو اللي ببسوي الاكشن حقه.

- Micturition reflex:

- As the bladder **fills**, many superimposed micturition contractions begin to appear.
- They are the result of a **stretch reflex** initiated by **sensory stretch receptor** in the bladder wall, especially in the **posterior urethra** & trigone.
- The micturition reflex is a single complete cycle of:
 - 1- Progressive & rapid ↑ of pressure.
 - 2- a period of sustained pressure.
 - 3- return of the pressure to the basal tone of the bladder.
- Once the micturition reflex becomes **powerful enough** → it causes another reflex, which pass through the **pudendal nerves** to inhibit the external sphincter. * If this inhibition is **more** potent in the brain than the voluntary constrictor signals to the external sphincter → **Urination will occur**.

- Facilitation or inhibition of micturition by the brain:

- **The micturition reflex is a complete autonomic spinal cord reflex**, can be inhibited or facilitated by centers in the **brain**.
- These centers include:
 - 1- Strong facilitated & inhibitory centers in the brain stem, (in **Pons**)
 - 2- **Cerebral cortex**. (stimulation or inhibition of micturition).
 - 3- Midbrain. (Inhibition of micturition)
- The micturition reflex is the basic cause of **micturition**, but the higher centers normally exert final control of micturition as follows:
 - 1- The higher centers keep the micturition reflex partially inhibited, except when micturition is desired.
 - 2- The higher centers can **prevent** micturition, even if the micturition reflex occur, by **tonic contraction** of the external bladder sphincter.
 - 3- When it is time to urinate → the cortical centers can facilitate the sacral micturition centers to help initiate a micturition reflex and **at the same time inhibit** the external urinary sphincter → urination occur.

- **Voluntary urination** is usually initiated in the following way:

Contract abdominal muscles → ↑ the pressure in the bladder → allows extra urine to **enter** the bladder **Neck & post. urethra** → **stretching** their walls → stimulate stretch receptors → excites the micturition reflex and simultaneously **inhibit** the external urethral sphincter.

- Abnormalities of micturition:

Ab.	Lesion	Causes	Features
Atonic bladder	Sensory nerve (Aff)	<ul style="list-style-type: none"> - Crush injury to the sacral region. - Tabes dorsalis : Syphilis → constrictive fibrosis → The resulting bladder condition Tabetic bladder. 	<ul style="list-style-type: none"> - Micturition reflex can not occur → prevent transmission of stretch signals from the bladder → Lose bladder control even if Eff & neurogenic connection are intact. - The bladder fills to capacity → overflow a few drops when Volume > capacity. → (Overflow incontinence) - The bladder becomes distended, thin walled & hypotonic.
Automatic bladder	Spinal cord damage above sacral region *Sacral segment are intact.	Crush injury to area above sacral region.	<ul style="list-style-type: none"> - Typical micturition reflex can still occur, but are no longer controlled by the brain. - During the 1st few days after the damage, the micturition reflexes are suppressed bc of the state "Spinal shock" caused by sudden loss. But the excitability of the reflex gradually increase until typical micturition reflex return. - Some pts control urination by stimulating the skin in the genital region. - مثل الطفل، يصير ما فيه تحكم بالسوماتك نيرف، فأول ما تتعبى البالدر بيؤل. الخلل في التوصيل فقط!
Uninhibited neurogenic bladder	Partial damage in the spinal cord or brain stem that interrupts most of the inhibitory signals.	Lack of inhibitory signals from the brain	<ul style="list-style-type: none"> - Result in frequent & relatively uncontrolled micturition. - Small quantity of urine elicits an uncontrollable micturition reflex → promoting frequent urination
Deneration of the aff & eff	Aff & Eff	<ul style="list-style-type: none"> - Tumour - Injury to cauda equine - ↓ Degradation of acetyl choline by process of reuptake. - ↓ Cholinesterase in the tissue - ↑ No. of cholinergic receptors. 	<ul style="list-style-type: none"> - Reflexes are abolished. - Intrinsic responses of the smooth muscles are increased. - The bladder is hypertonic. - Associated with uncontrolled periodic micturition about 25 – 100 ml at a time. - كأنها عضلة مفصولة من الجسم -> تصير هايبرتونك -> في انقباضات دائمة -> أي تجمع يصير فيها تطلعه خارج الجسم دفعة وحدة (بدون قطرات)

Notes

- Bladder → Store urine, controlled by symp. & parasymp.
- Innervation of bladder & bladder neck:
 - Parasympathetic: Pelvic nerve (S2,3,4 in LHCs)
 - Sympathetic: Hypogastric nerve (L1,2 in LHCs), Storage of urine.
 - Somatic nerve: Pudendal nerve (S2,3,4 in AHCs)
- Babies have a normal micturition, but they urinate spontaneously bc the innervation of external sphincter muscle still developing.
- Trigon & post. urethra → more sensitive → ↑ stretch receptors.
- In cystometrogram, there is a region of pressure constant (~ from 90 – 250 cm\H₂O) this is bc of the type of bladder epithelium (transition) → widening, and Laplas law => $P=2T/r$ الضغط في هذي الحالة يبقى ثابت لأن كلما زاد الشد بيزيد نصف القطر مرتين.
- About cystometrogram curve: البلادر مثل البالونة، أول ما أبدأ يصير صعب النفخ، بس بعدها تصير تنتفخ بسهولة لكن لما توصل حدها تنفقع.
- Hypothalamus → control of autonomic.
- Micturition reflex: Aff → لما يدخل الحبل الشوكي يرسل رسالة للدماغ يعلمه إن فيه كمية بول عشان يثبّط عمل ال pudendal nerve وينشّط الباراسمبتك أكثر، النتيجة حالتين:
 - 1- إذا كنت في حالة you want to urinate هنا بيصير الانهيشن لل pudendal n.
 - 2- إذا كنت في محاضرة مثلاً، و you don't want to urinate هنا راح يصير: Stimulation of pudendal nerve to continue contraction of external sphincter muscle.
- Injury to lumbar region → X sympathetic, ✓ parasympathetic → ✓ micturition reflex.
- Injury above sacral → ✓ parasympathetic, X control → يصير فيه تبول مثل الطفل.
 - أول الأسابيع بعد الحادث ما يشتغل أي شيء، فيصير يتبول بالتقطير، لكن بعد فترة يستوعب إن الباراسمبتك يشتغل كويس فيسوي شغله.

- Resources: Guyton & Hall and Dr.mannan's 2016 lecture & notes.

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