Neurogenic Control of the Bladder and Micturition

A PowerPage Presented By

The autonomic innervation of the bladder is complicated but is relevant to the drugs used to treat disorders of micturition. This PowerPage describes the complex innervation of the bladder and the drugs that affect micturition. A separate PowerPage describes the various causes of incontinence.

Bladder Anatomy

- The bladder contains:
  - Layer of **smooth muscle**
  - **Detrusor muscle** – contracts during micturition
  - **Internal urethral sphincter** – at **neck of bladder**
    - Smooth muscle, not under **voluntary** control
  - **External urethral sphincter**
    - Striated muscle, under **voluntary** control
    - Longer in males

- Bladder innervation
  - **Efferent sympathetic**
    - **Hypogastric nerve**
      - When stimulated, causes relaxation of detrusor, contraction of trigone and internal sphincter resulting in **retention of urine**
  - **Efferent parasympathetic**
    - **Pelvic nerve**
      - When stimulated, causes detrusor contraction and relaxation of trigone and internal sphincter resulting in **emptying of the bladder**
  - **Somatic**
    - **Pudendal nerve** – under **voluntary** control
  - **Sensory** (Afferent)
    - Hypogastric and pelvic nerves – sensation due to bladder distension
    - Pudendal nerve – sensation from the urethra

Neurologic Control of Micturition

- **Micturition is controlled** by several areas of the brain
  - **Frontal cerebral cortex** – **conscious micturition**
  - **Thalamus** – conditioned micturition
  - **Brainstem** - coordination of micturition
  - **Sympathetic nervous system (L1-L4)** – Controls **storage** phase
    - Hypogastric nerve
  - **Parasympathetic nervous system (S1-S3)** – Controls **voiding** phase
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- Pelvic nerve
  - Somatic nervous system (S1-S3)
  - Pudendal nerve

### The Micturition Reflex

- **Storage phase**
  - \( \alpha \)-adrenergic stimulation (via hypogastric nerve)
    - Maintains internal urethral sphincter contraction
  - \( \beta \)-adrenergic stimulation
    - Inhibits detrusor contraction, allowing filling
  - External urethral sphincter maintains constant tone and only minimal stimulation is needed to keep sphincter closed.

- ** Voiding phase**
  - Stretch receptors in bladder wall signal to brain stem micturition center. This results in contractile waves in the detrusor and relaxation of the internal sphincter. The external sphincter must then be consciously tightened and the urge to urinate becomes apparent.
  - Voluntary micturition involves voluntary abdominal contraction and relaxation of perineal musculature
  - Increased parasympathetic tone leads to contraction of the detrusor muscle
  - Initiation of contraction leads to inhibition of \( \alpha \)-adrenergic tone to the internal sphincter and releases the \( \beta \)-adrenergic inhibition of detrusor contraction
  - Once the bladder has emptied, there is return of parasympathetic inhibition and sympathetic stimulation

### Upper Versus Lower Motor Neuron Bladder

This is also reviewed on the incontinence PowerPage

- **Lower motor neuron disease**
  - Lesions to sacral spinal cord or the pudendal nerve
    - Interfere with parasympathetic and sensory innervation and impair detrusor contraction
    - Internal sphincter tone may remain intact because hypogastric nerve arises from lumbar segments
    - Results in bladder filling followed by overflow incontinence when pressure exceeds sphincter pressure.
  - Bladder tends to be **distended, flaccid, and easily expressed**
  - Other signs of sacral lesions such as decreased anal and tail tone, fecal incontinence, and decreased perineal reflexes may be present

- **Upper motor neuron disease**
  - Lesions to the thoracolumbar spine or more cranial spinal lesions
  - Pudendal nerve disruption leads to urethral sphincter hypersensitivity and frequently, loss of coordination with bladder contraction
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- Results in incomplete urination and urine retention
- Bladder may be **difficult to express**
- Other signs of spinal cord disease may be present