

# The Urinary Sphincter and its Central Control.

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# Conflict of interest

- Current Funding:
  - Co-Investigator: Evaluation of Pudendal Nerve Block for Voiding after Spinal Cord Injury. PI: G.Creasey, VA RR&D 1I21RX001607-01.
  - Co-Investigator: Evaluation of Pudendal Nerve Block and Stimulation for Voiding and continence. PI G. Creasey DOD SCIRP SC130204.
- Other Financial Relationships:
  - Dignify Therapeutics – Scientific consultant.
- Conflicts of Interest:
  - Potentially research involving control of urethral sphincter

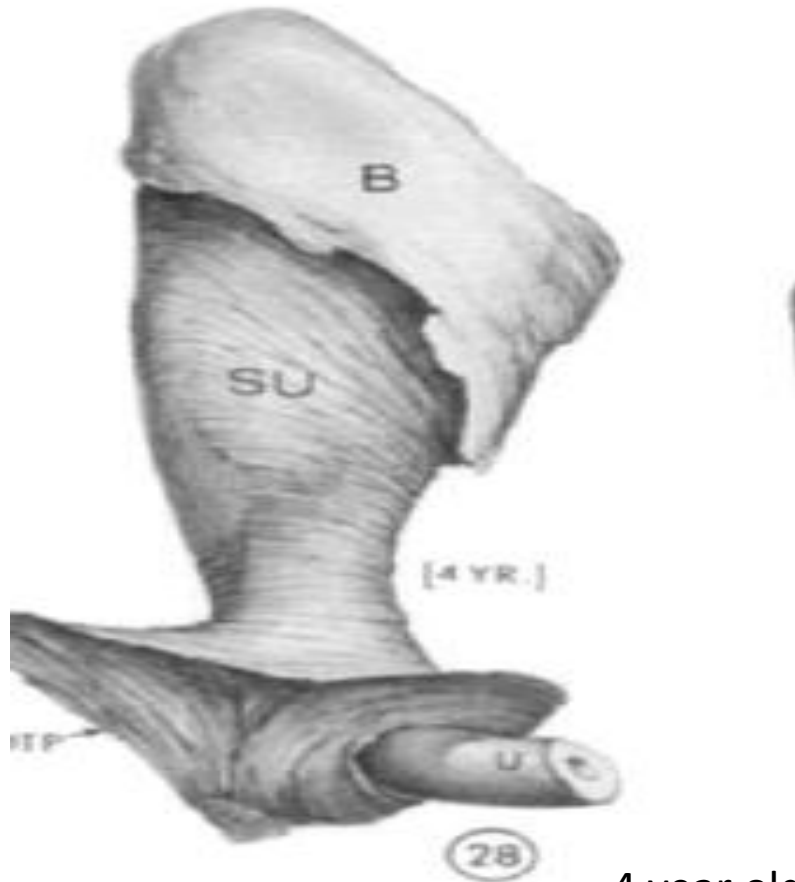
# Outline

- Significance
- State of art knowledge
- Knowledge gaps
- Research gaps.

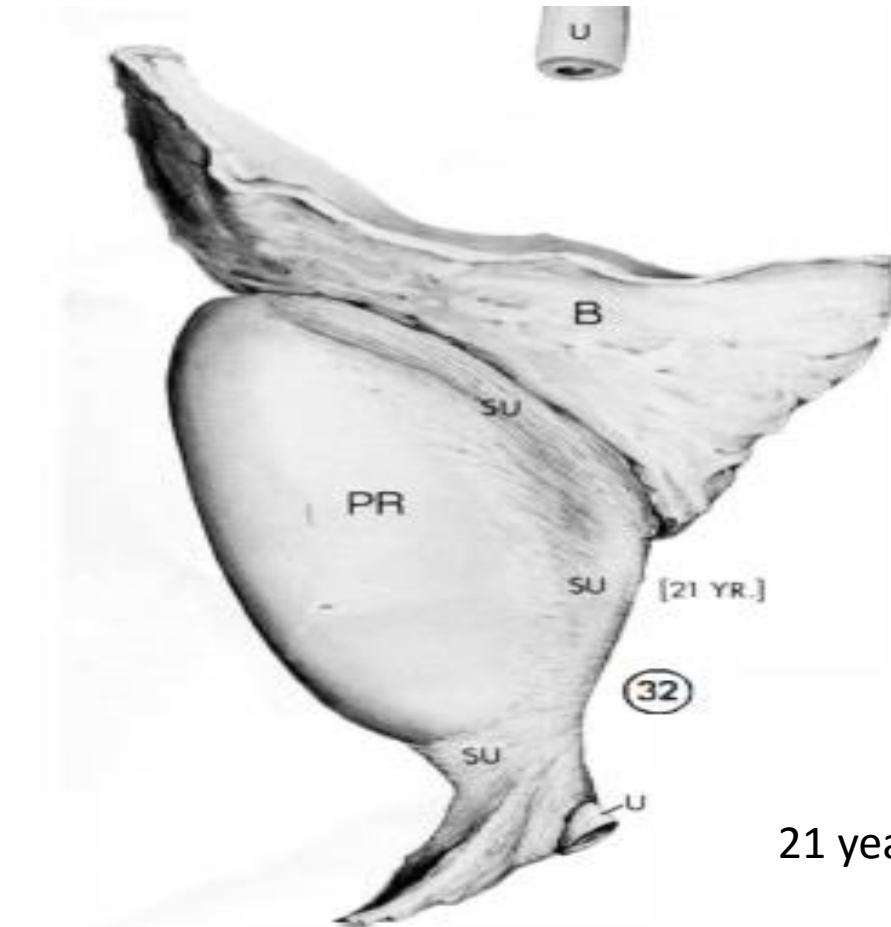
# The Urinary Sphincter – Significance.

- Responsible for maintaining continence.
  - Allows the bladder to store urine
  - Allows for preservation of self
  - Allowed humans to become hunter
- Allows for procreation
  - Complex mechanism that separates urine from semen
  - Complex mechanism to control ejaculation.

# Male Urethral Sphincter



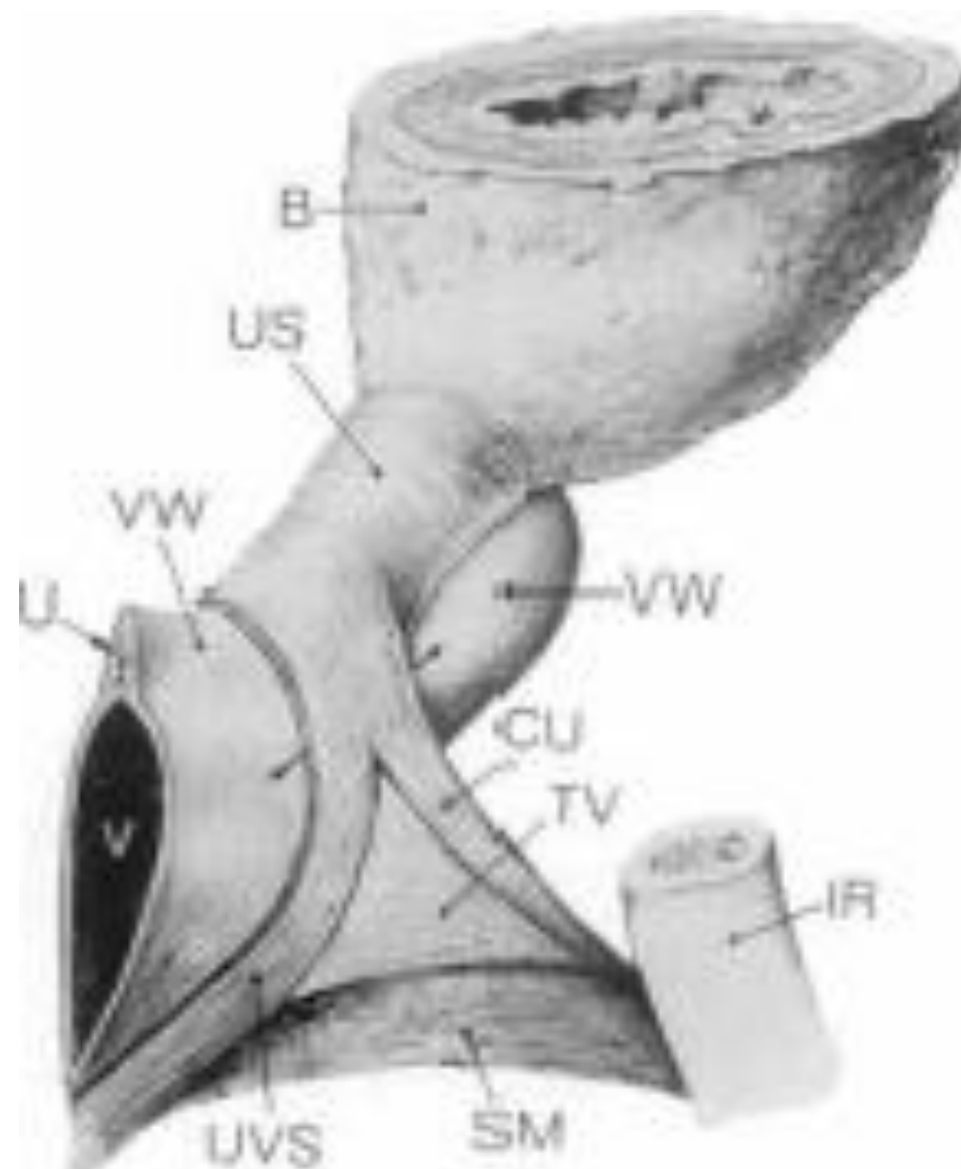
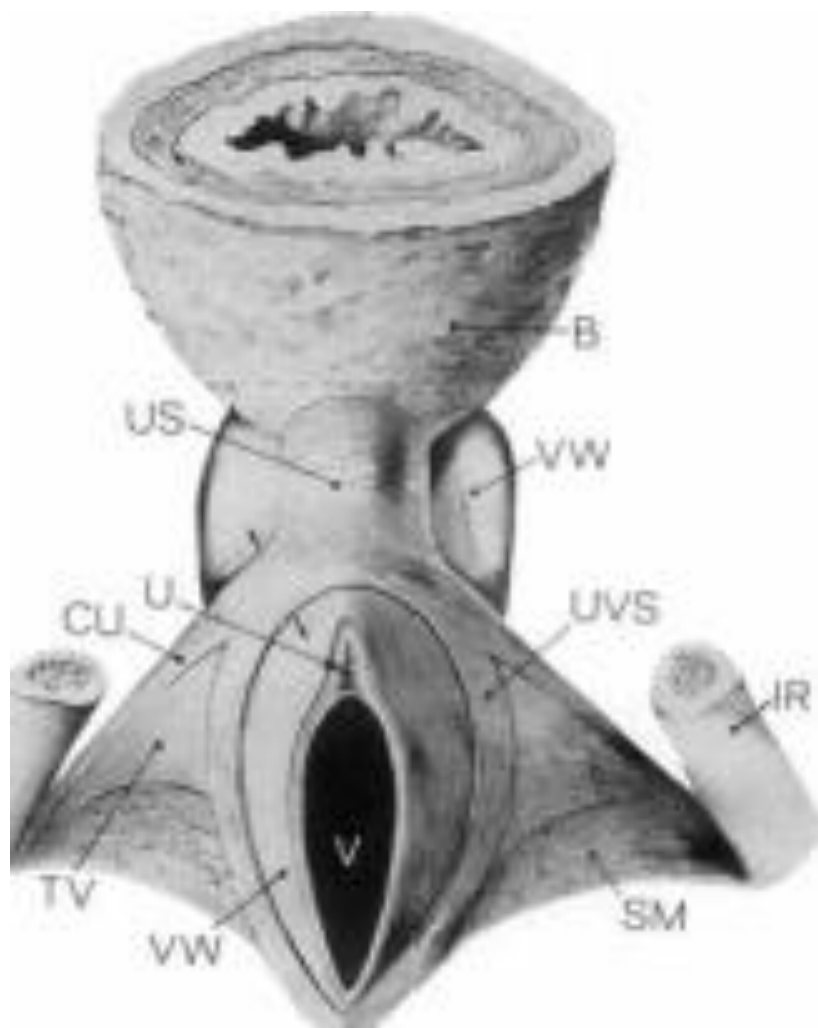
4 year old



21 year old

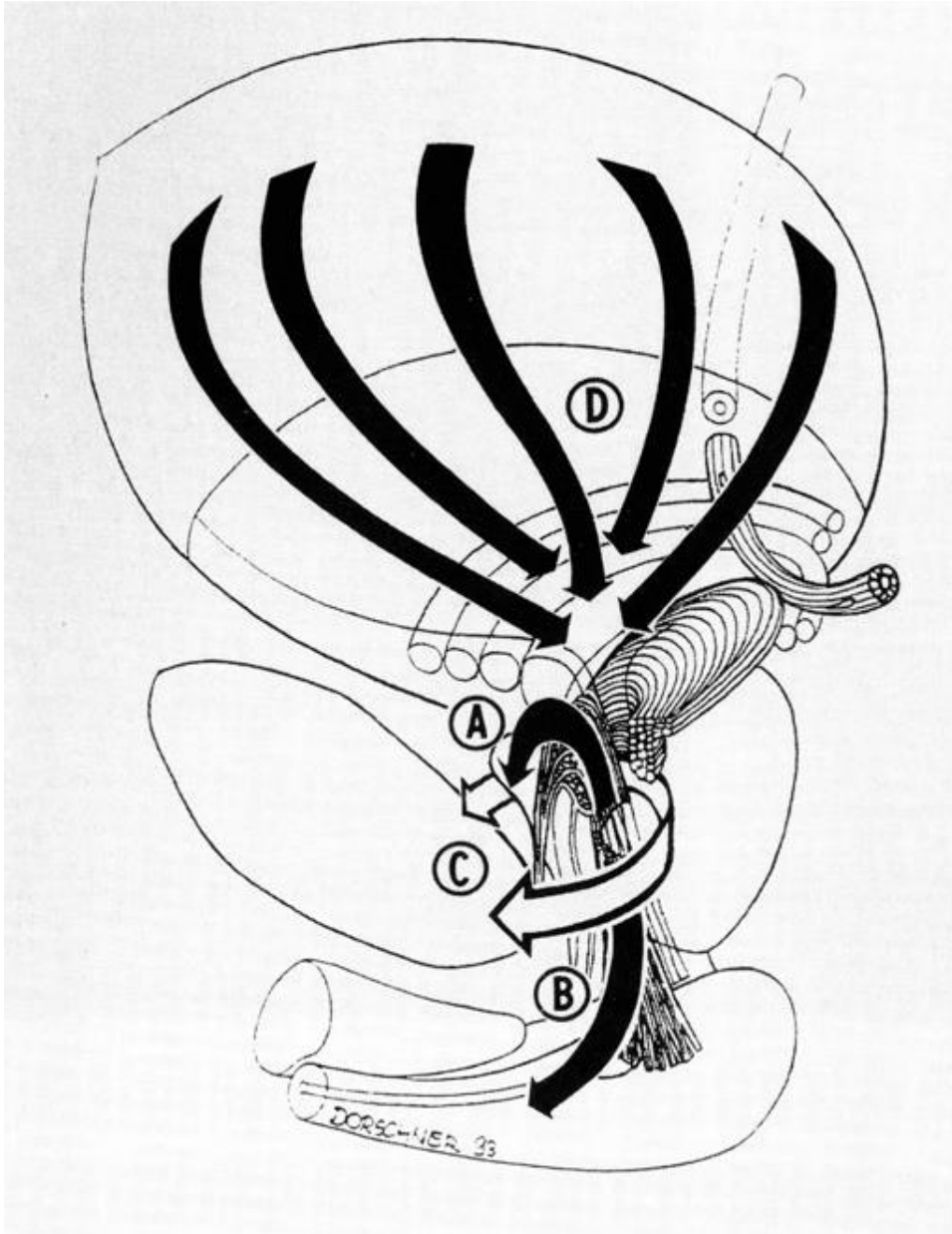
Oelrich TM, Am J Anat 158: 229-246, 1980

# Female Urethral Sphincter



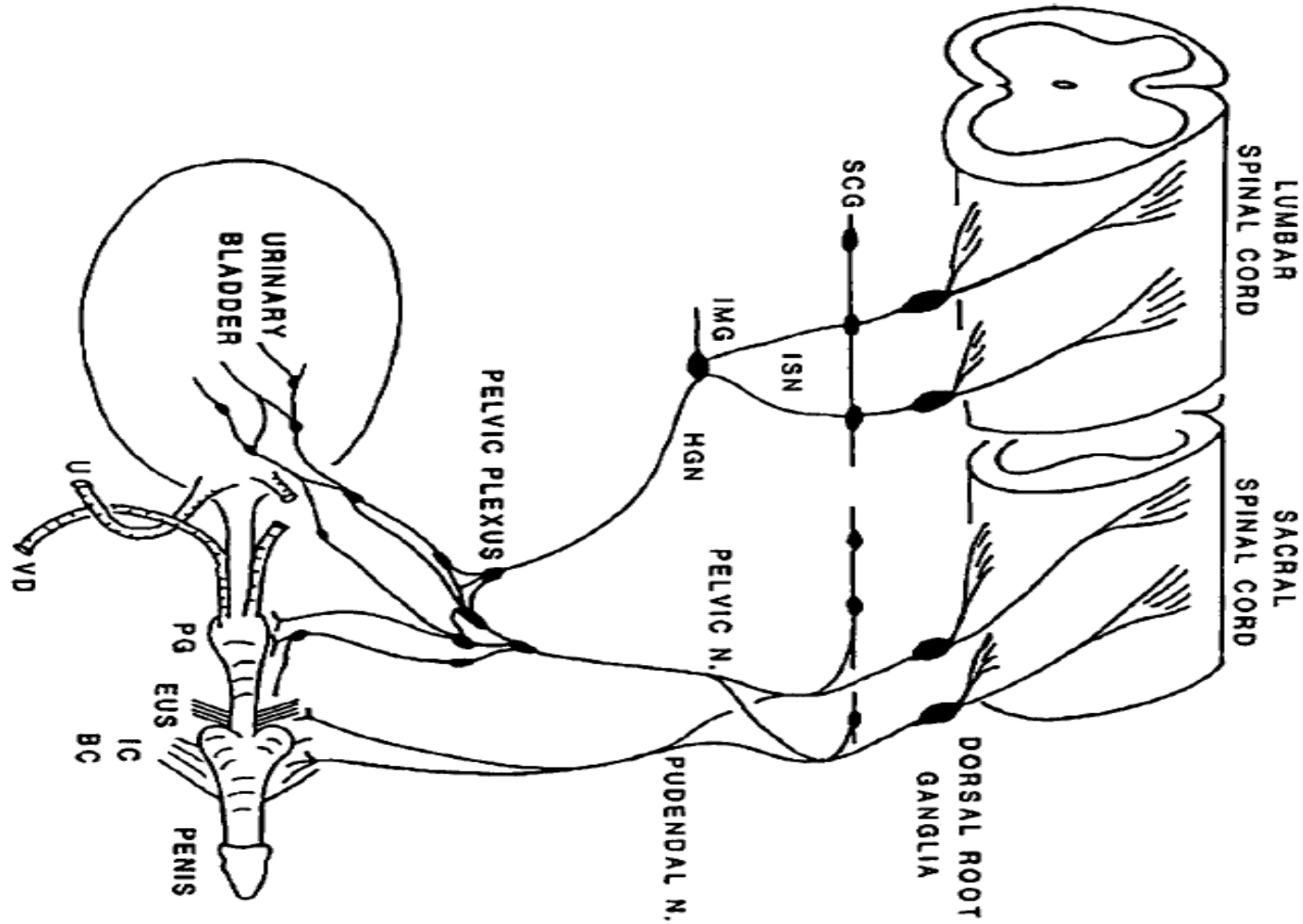
DeLancey, JOL, *Neurourology & Urodynamics* 1988 7:509-519.

# Movement of Sphincter - Theory



- 1. Bladder neck moves downwards
- 2. Relaxation of the sphincter mechanism
- 2. Dilation of urethra with caudal movement
- 3. Detrusor contracts
- 4 Urine flows.

# Innervation of pelvic organs. (CAT)

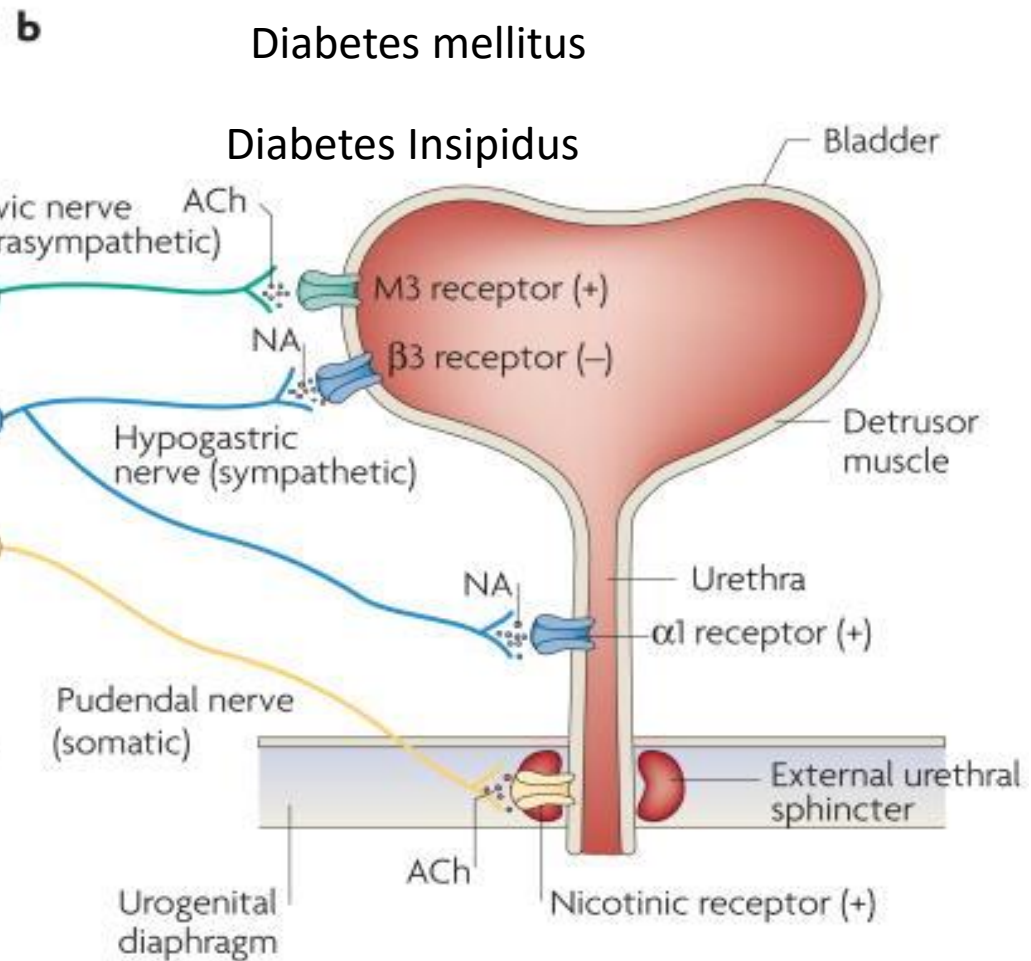
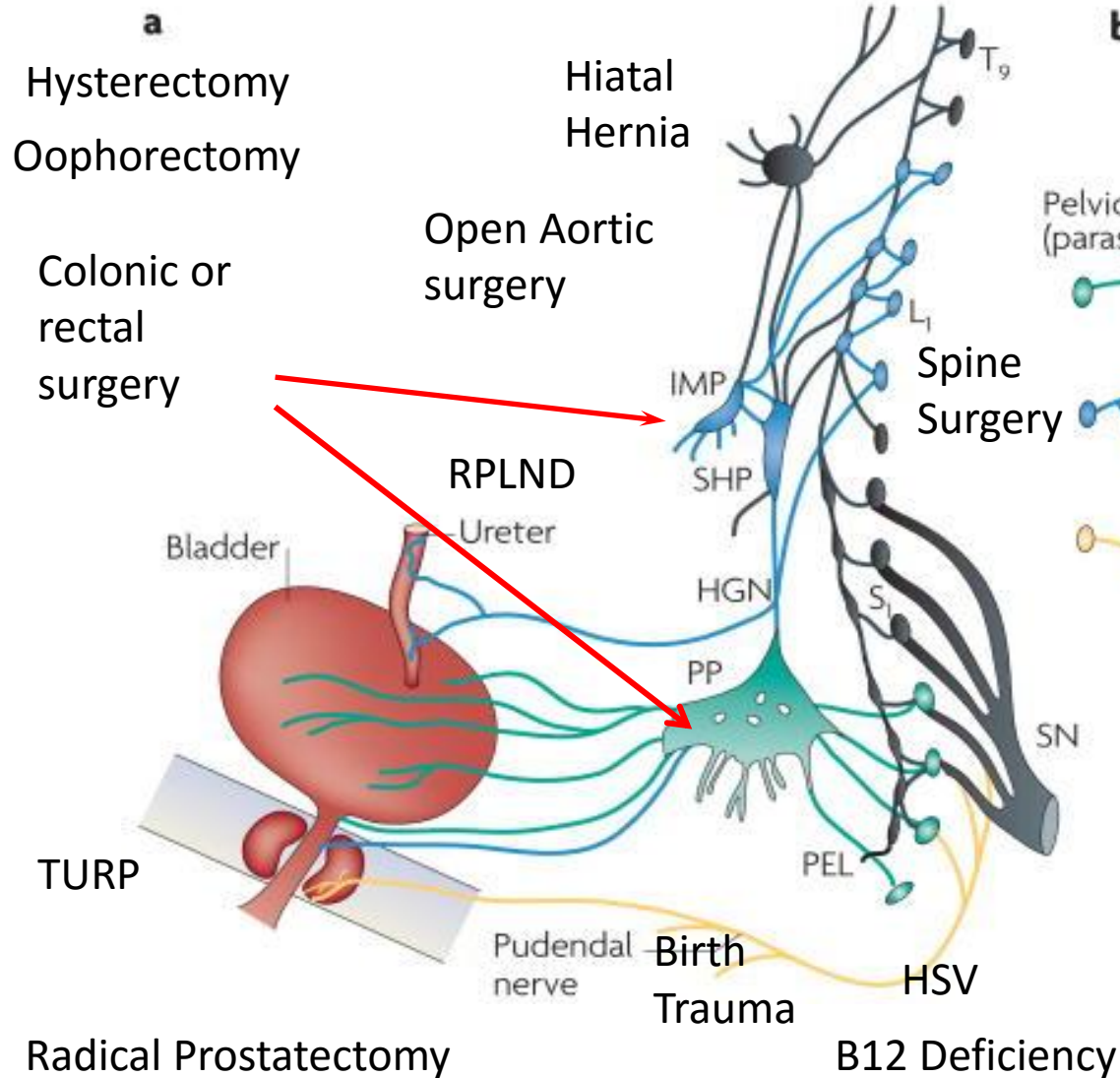




# Central innervation of the urinary sphincter

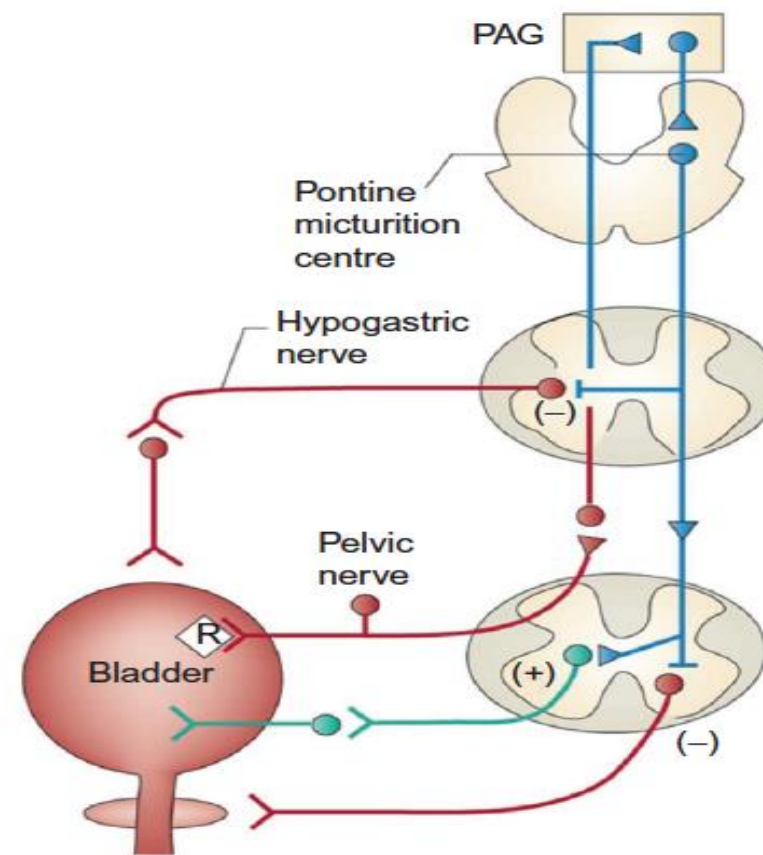
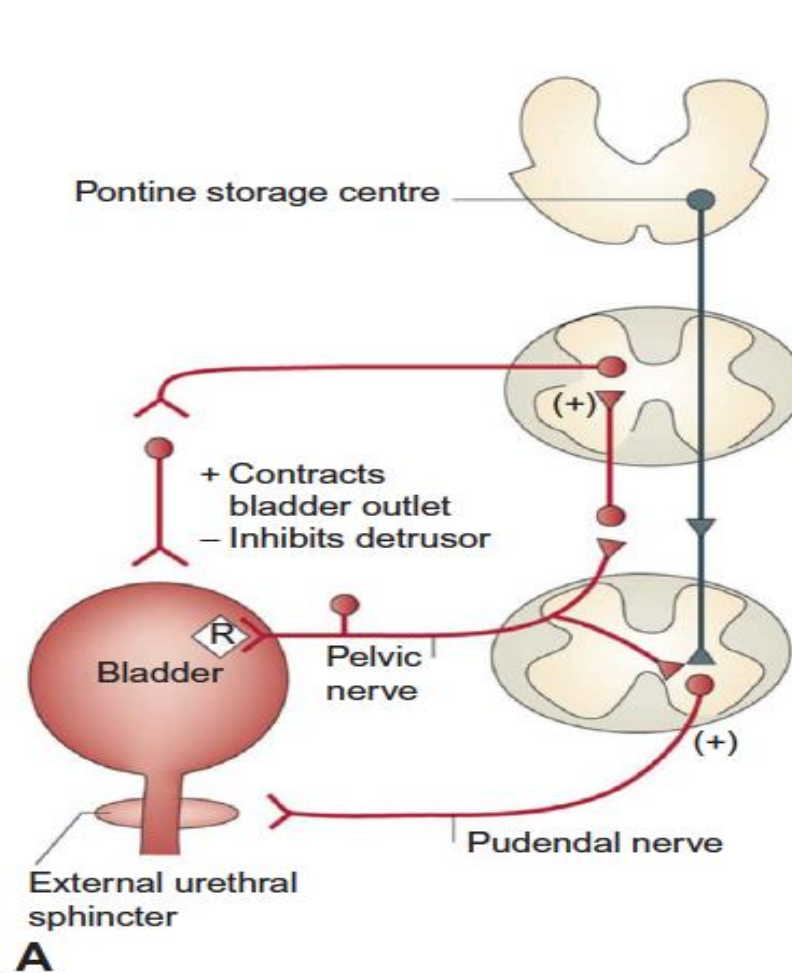
- Pudendal nerve has mixed contributions:
  - Somatic
  - Parasympathetic
  - Sympathetic
- There are cross connections between the pelvic nerves and pudendal.
- Interconnections in the Spinal cord at Sacral & Thoracic levels.

# Peripheral Nerves Involved.



Fowler CJ, Griffiths D, deGroat WC. Nat Rev Neurosci. 2008 Jun; 9(6): 453–466. doi: [10.1038/nrn2401](https://doi.org/10.1038/nrn2401)

# Brain centers / Nuclei involved

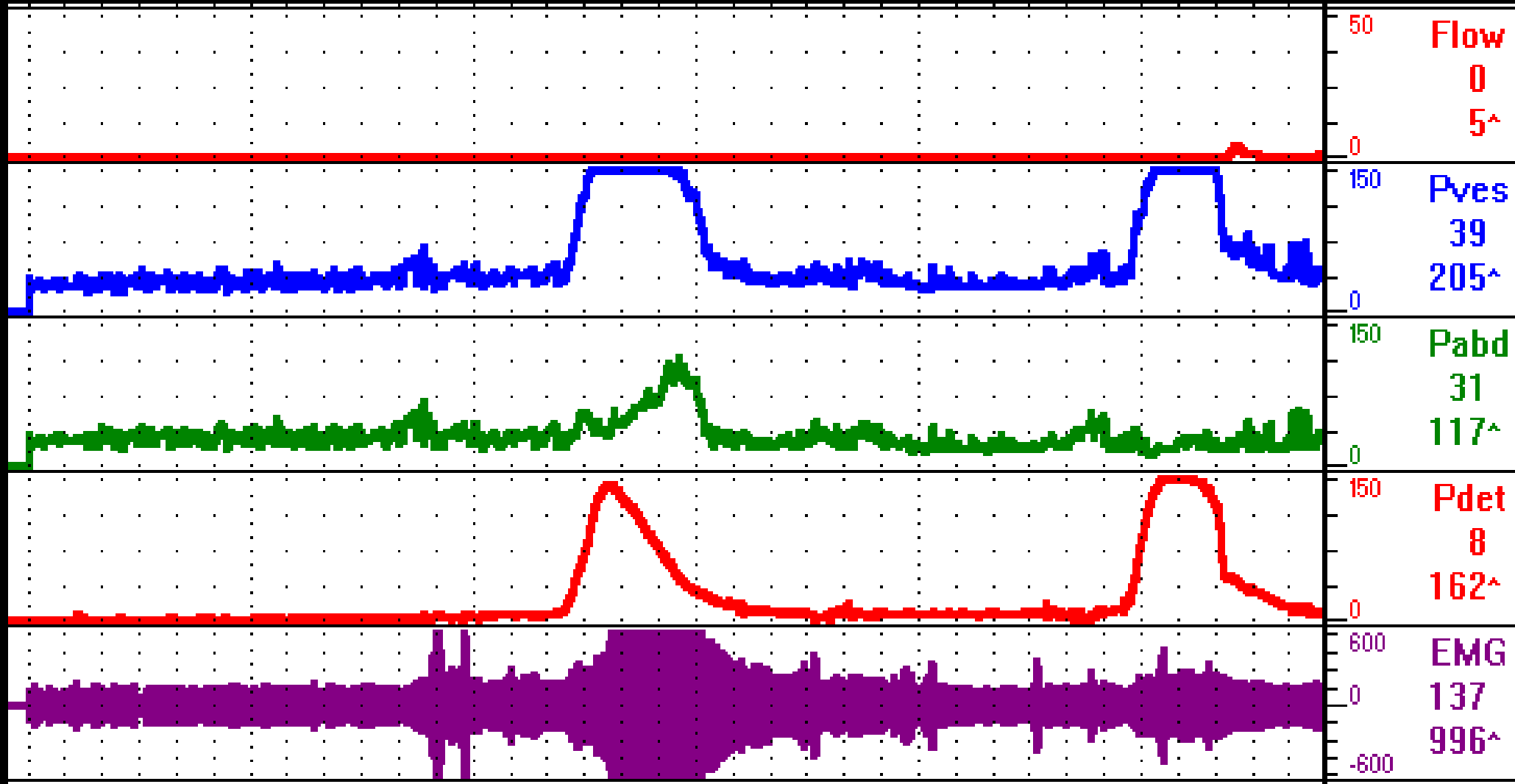


**B** deGroat, Wc & Yoshimura N, Handbook of Clinical Neurology 2015 vol 130 61-

# Normal voiding pattern



# DSD

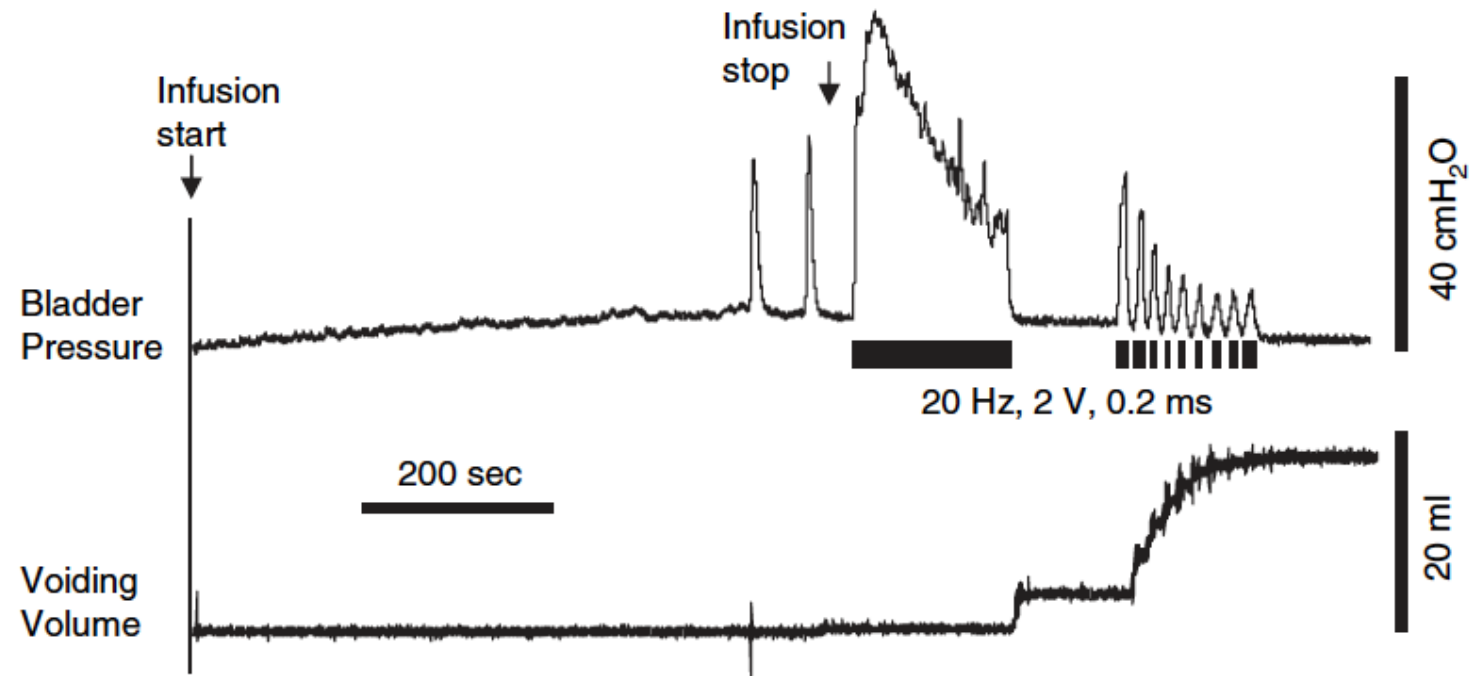


Courtesy C. Smith



Courtesy C. Smith

# Potential Relief of DSD for SCI patients.



**Fig. 3.** Voiding induced by 20-Hz stimulation of the pudendal nerve in a chronic SCI cat (9 months). Total 23 ml was infused into the bladder and 18 ml was voided. The black bars under the bladder pressure trace indicate stimulation durations. Stimulation: 20-Hz frequency, 2 V intensity, 0.2 msec pulse width. Infusion rate: 2 ml/min.

# Research gaps

- How is the micturition reflex actually started.
  - Thought a little drop of urine gets in urethra.....?
  - Has urethral urothelium different receptors, permeability's, sensory function?
- What happens during prostatectomy?
  - How to patients stay dry – radical prostatectomy
    - TURP or similar procedures
- How does DESD keep patients with SCI dry.
- Why does the urethra scar so much – strictures