

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

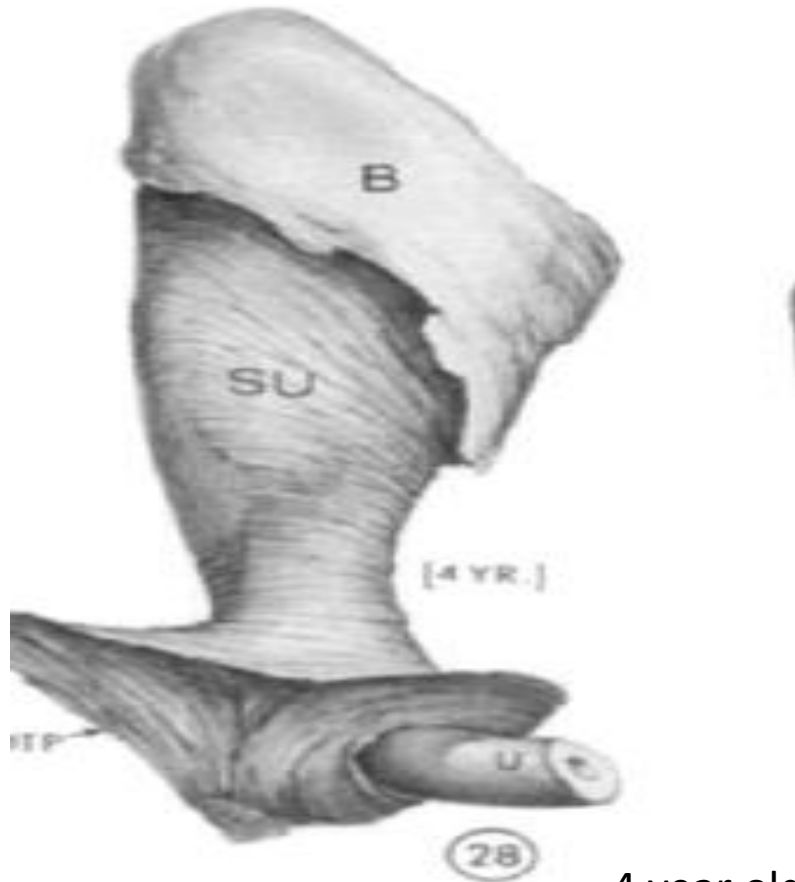
Outline

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

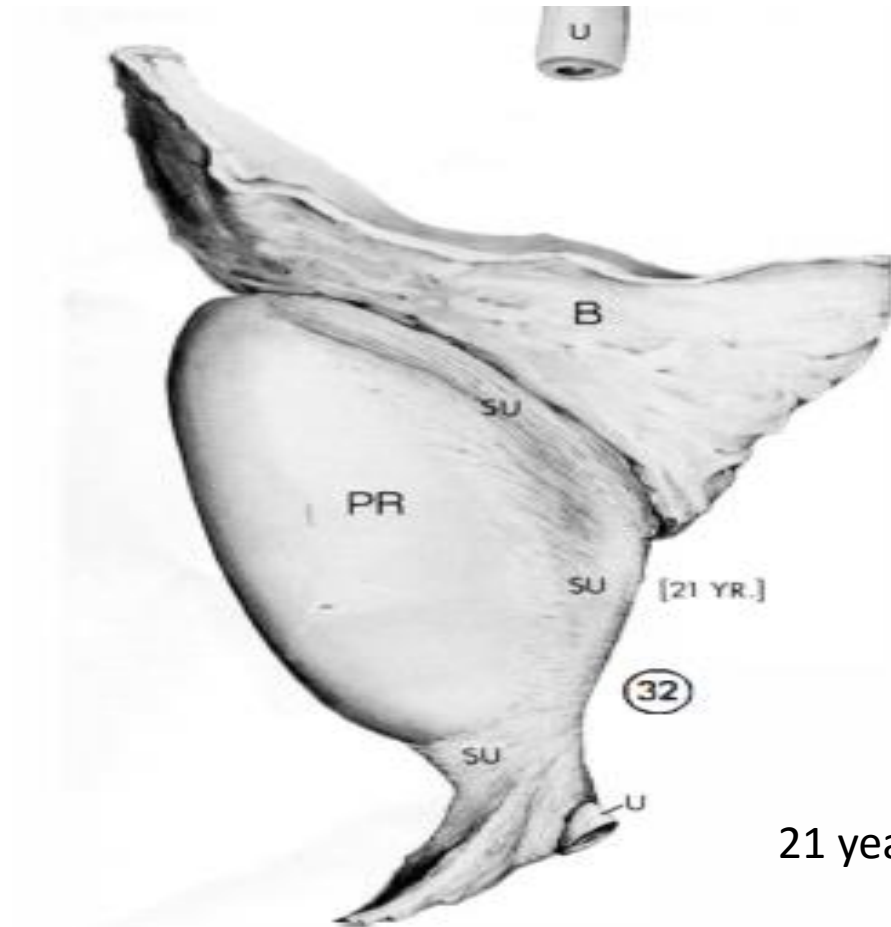
The Urinary Sphincter – Significance.

- 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



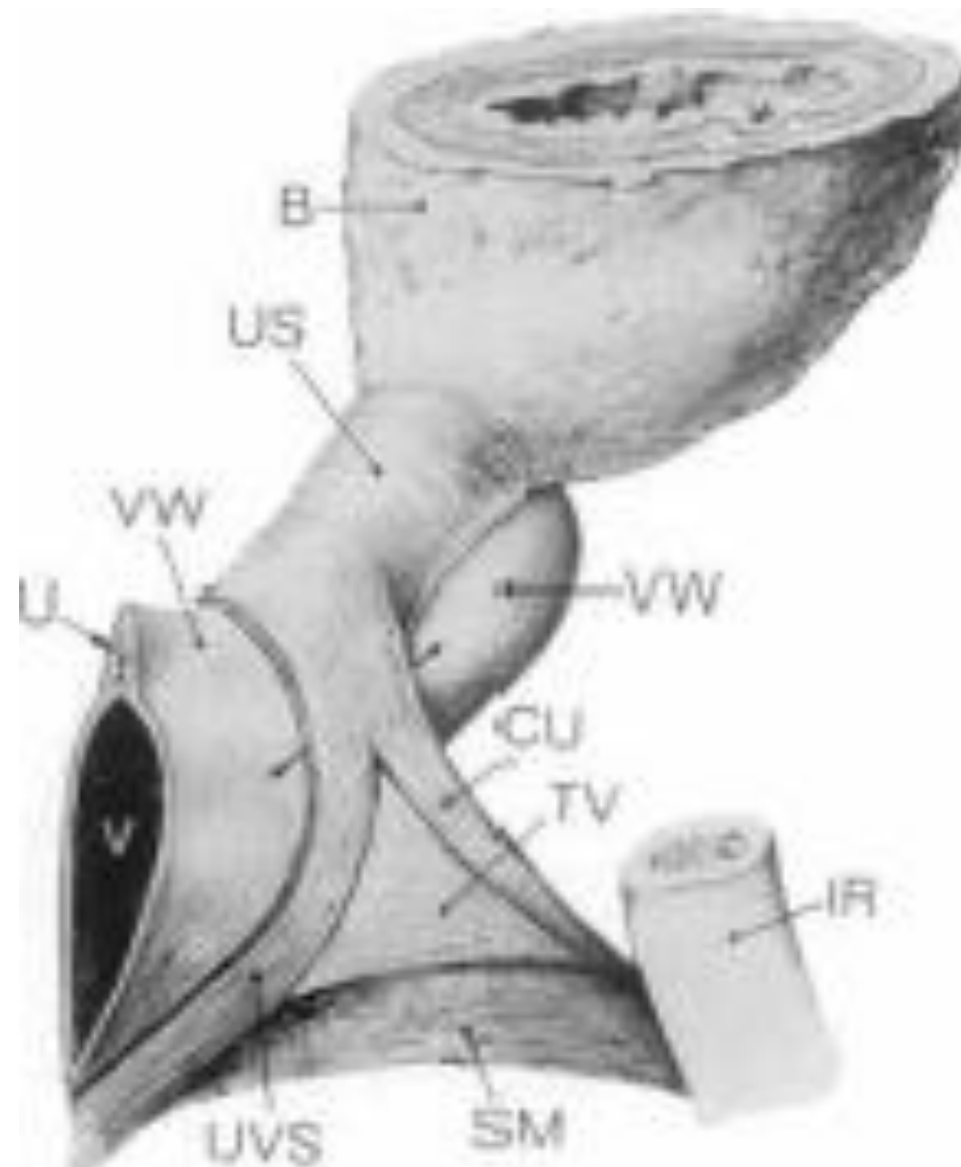
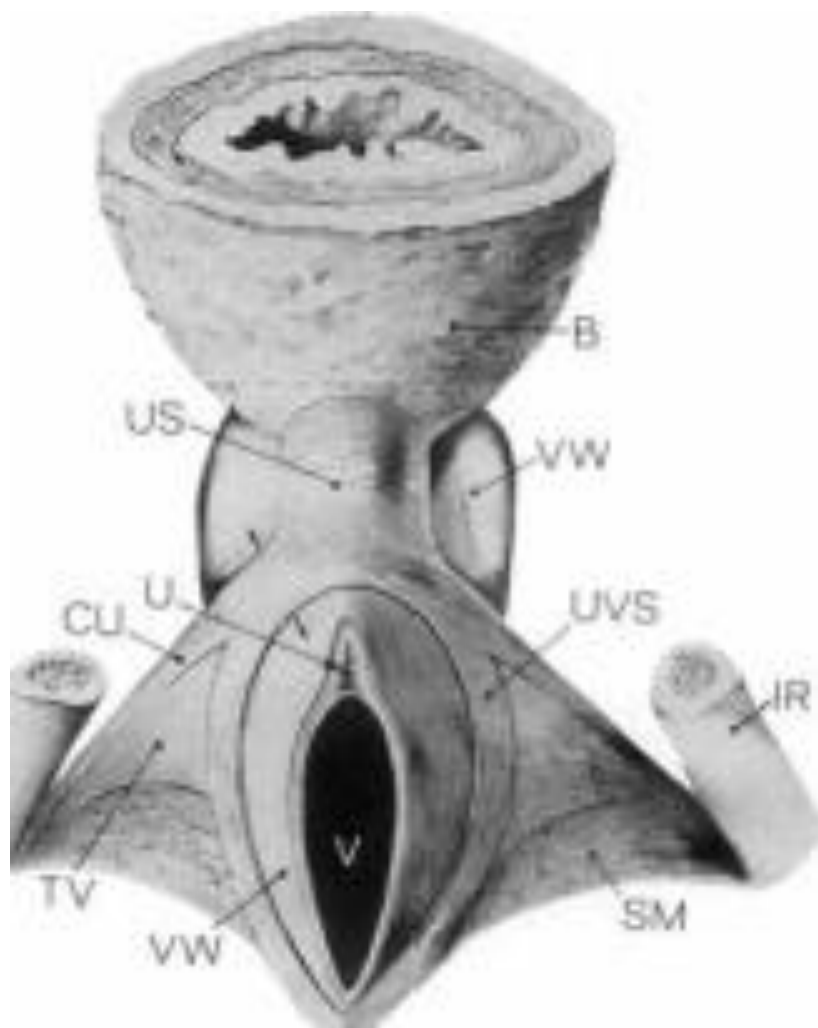
4 year old



21 year old

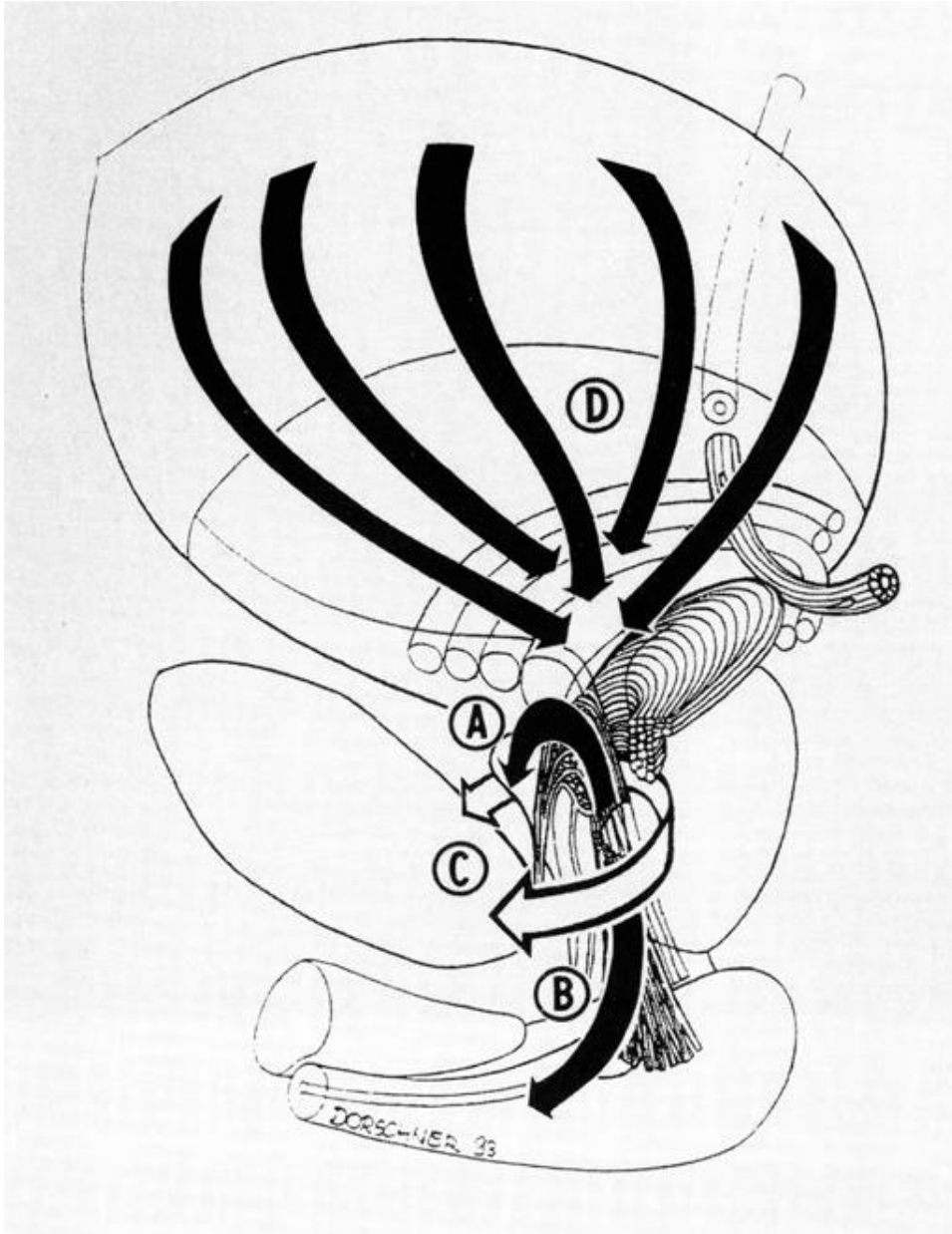
Oelrich TM, Am J Anat 158: 229-246, 1980

Female Urethral Sphincter



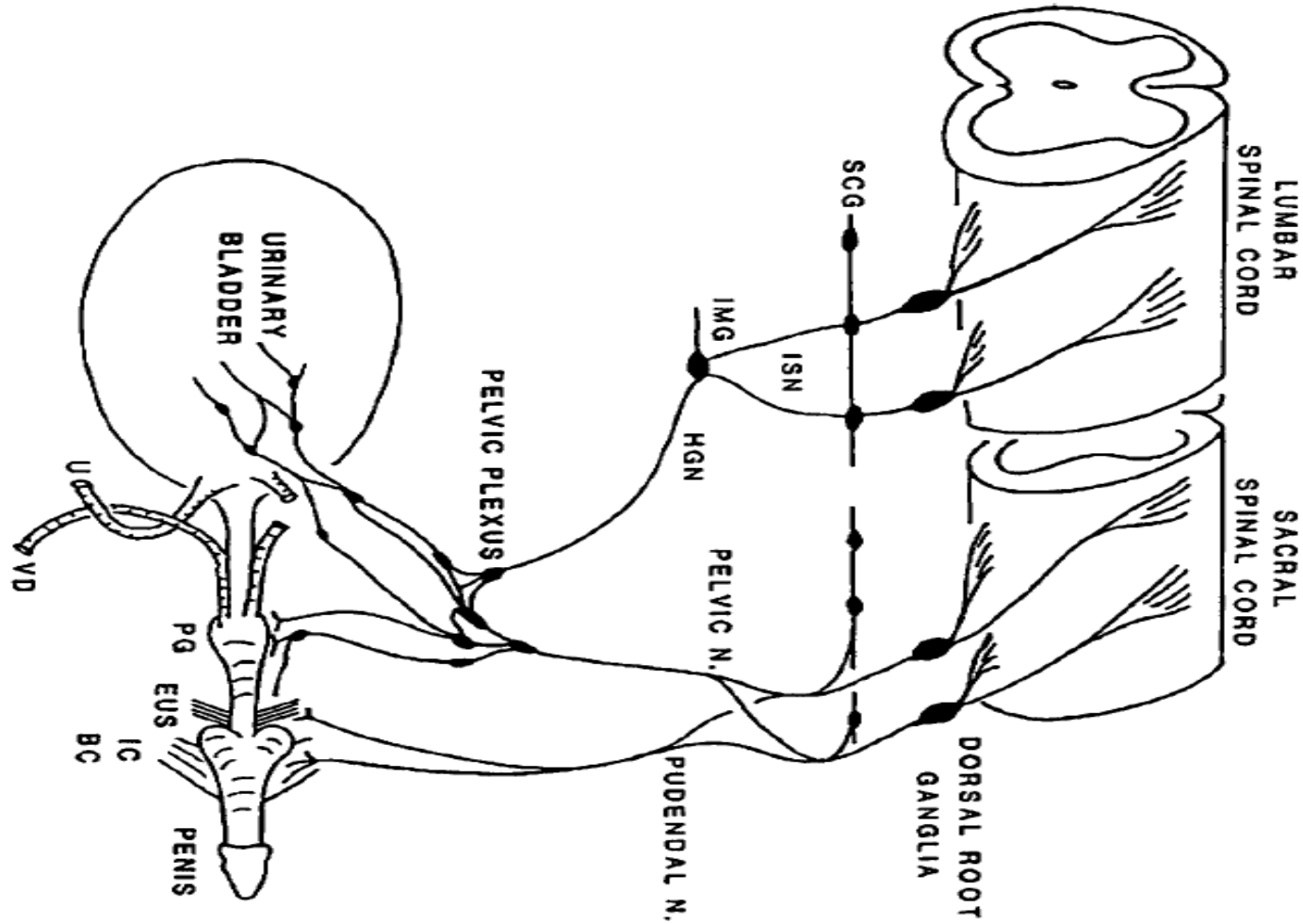
DeLancey, JOL, *Neurourology & Urodynamics* 1988 7:509-519.

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.

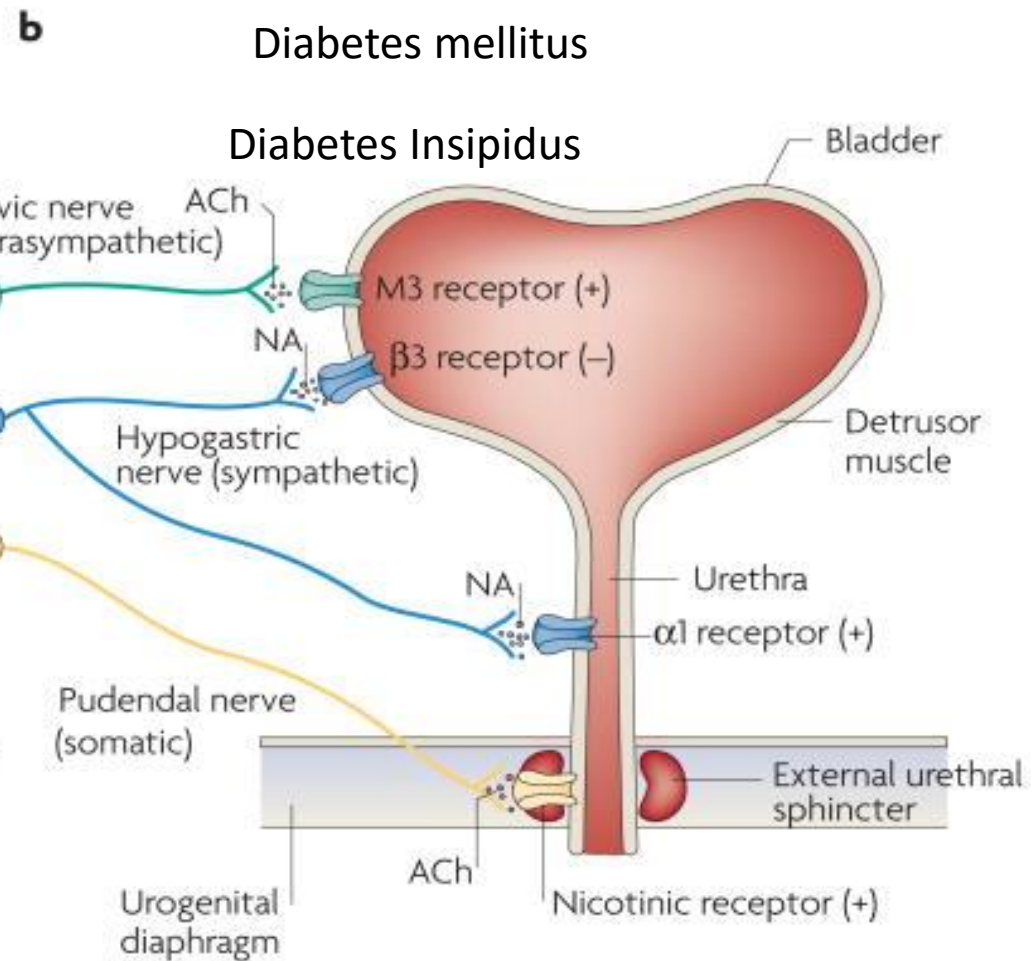
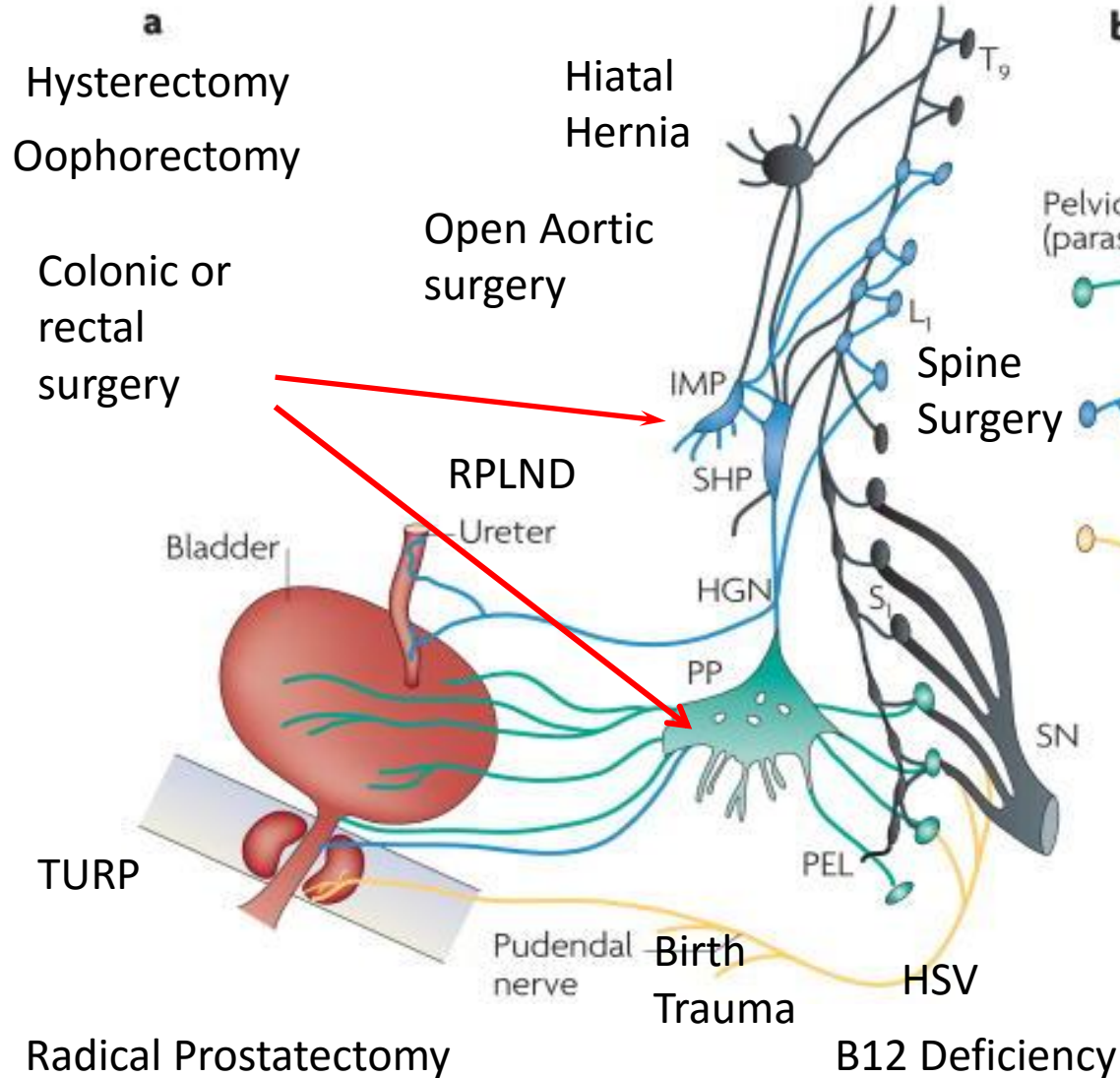
Innervation of pelvic organs. (CAT)



Central innervation of the urinary sphincter

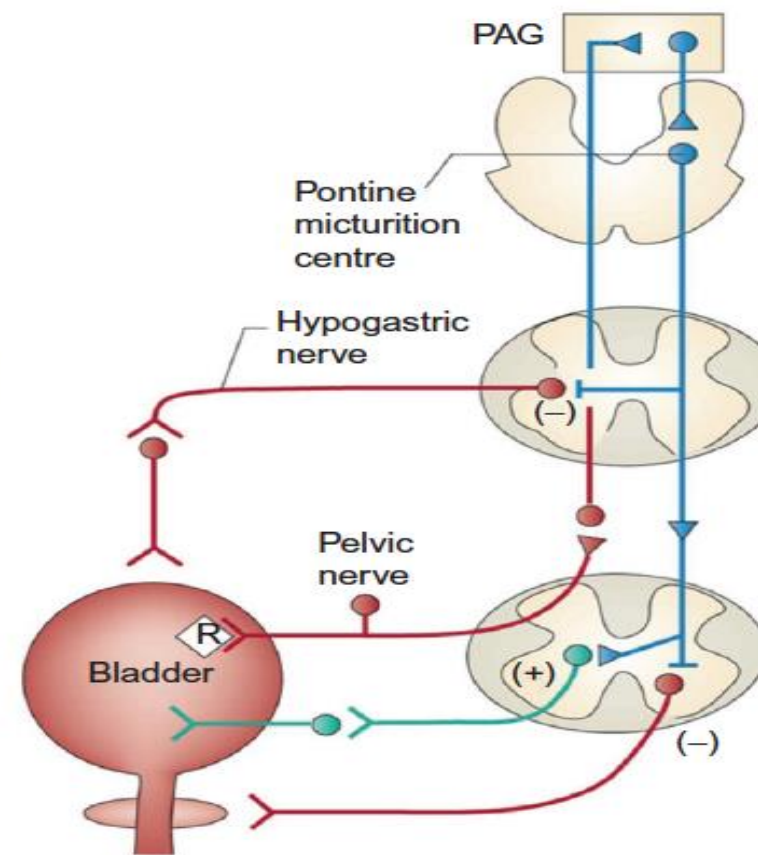
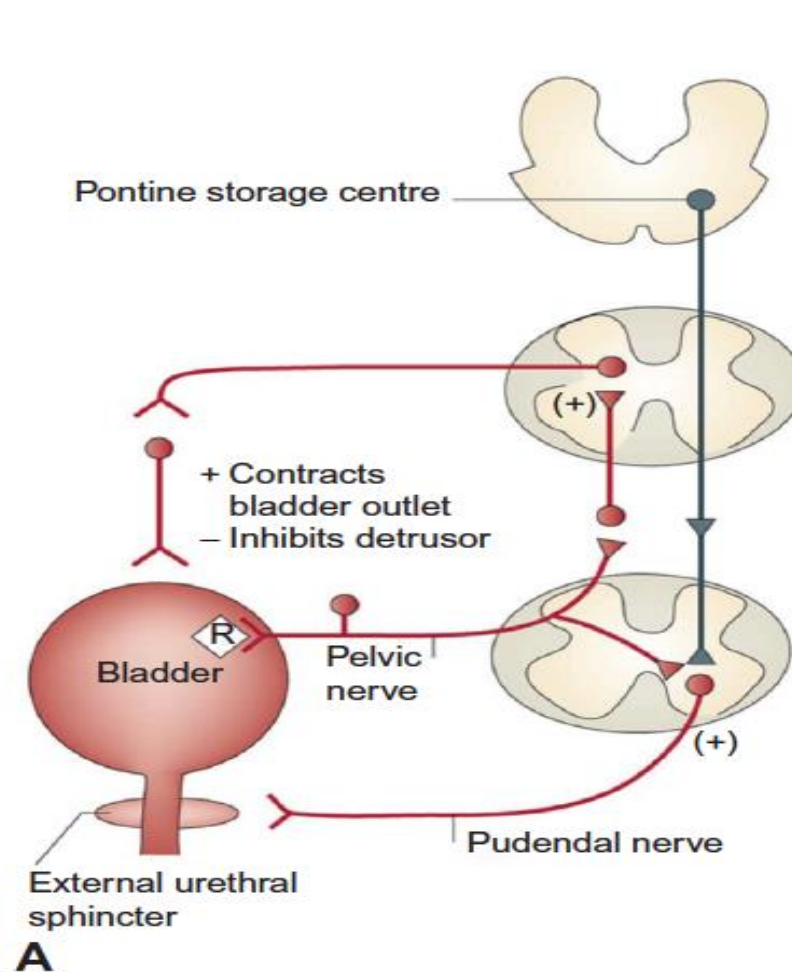
- Pudendal nerve has mixed contributions:
 - Somatic
 - Parasympathetic
 - Sympathetic
- There are cross connections between the pelvic nerves and pudendal.
- Interconnections in the Spinal cord at Sacral & Thoracic levels.

Peripheral Nerves Involved.



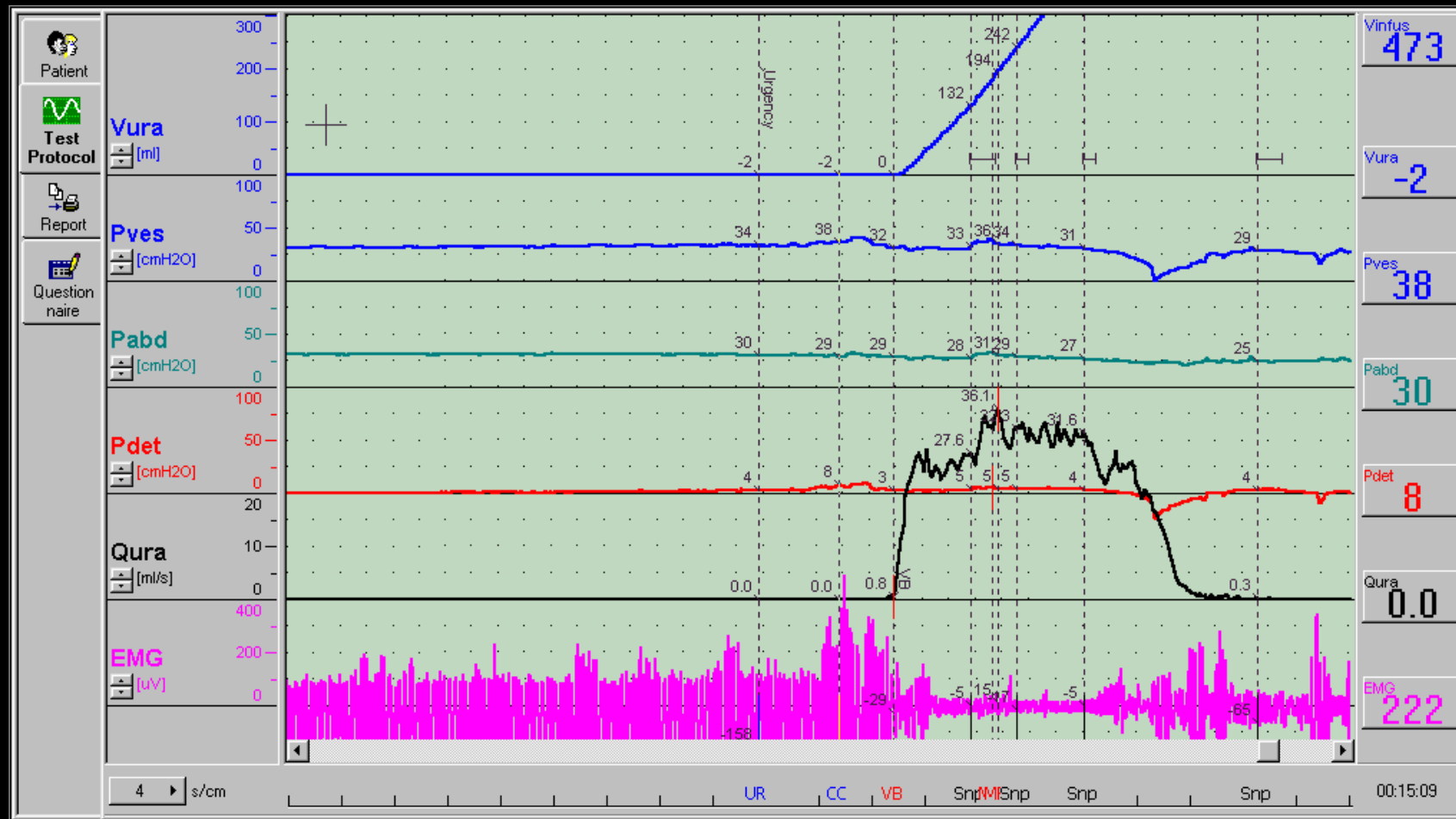
Fowler CJ, Griffiths D, deGroat WC. Nat Rev Neurosci. 2008 Jun; 9(6): 453–466. doi: [10.1038/nrn2401](https://doi.org/10.1038/nrn2401)

Brain centers / Nuclei involved

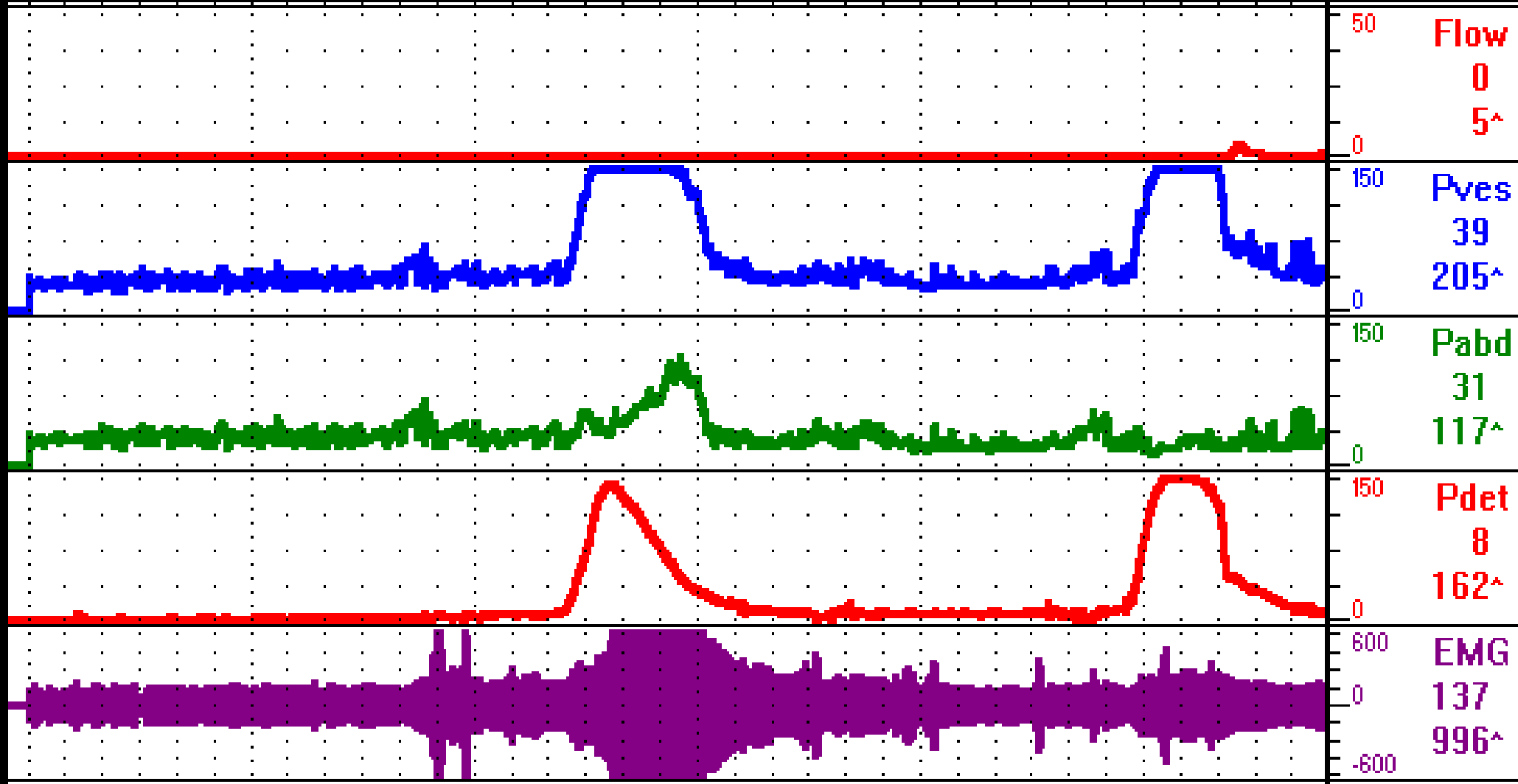


B deGroat, Wc & Yoshimura N, Handbook of Clinical Neurology 2015 vol 130 61-

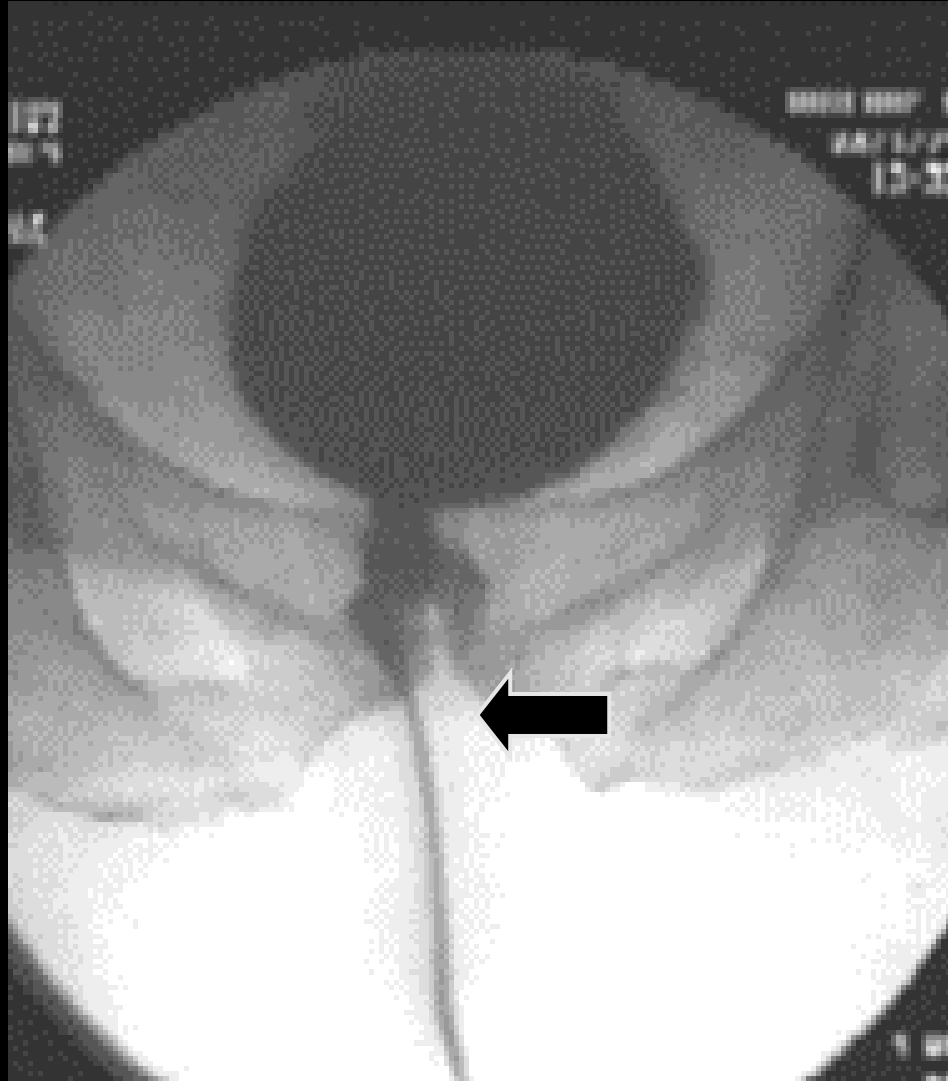
Normal voiding pattern



DSD



Courtesy C. Smith



Courtesy C. Smith

Potential Relief of DSD for SCI patients.

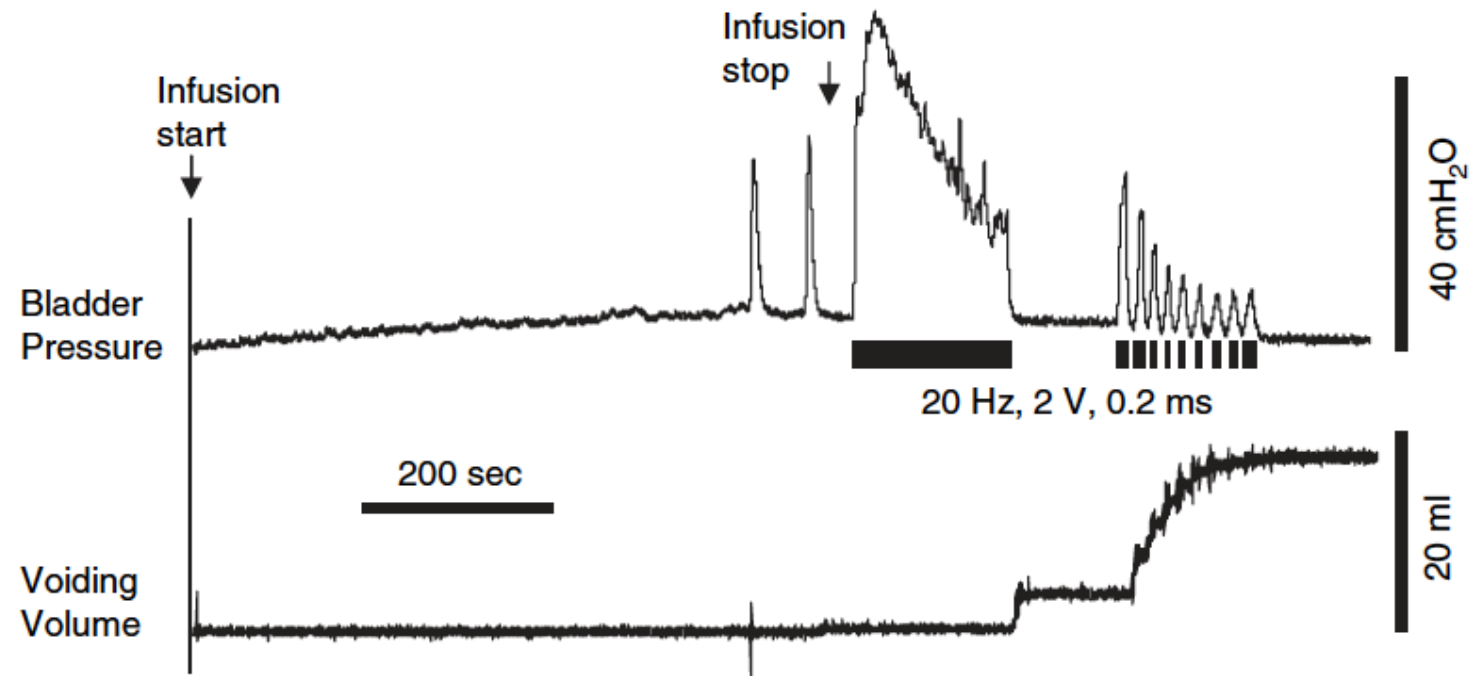


Fig. 3. Voiding induced by 20-Hz stimulation of the pudendal nerve in a chronic SCI cat (9 months). Total 23 ml was infused into the bladder and 18 ml was voided. The black bars under the bladder pressure trace indicate stimulation durations. Stimulation: 20-Hz frequency, 2 V intensity, 0.2 msec pulse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