Bladder Volume Sensation and Sensory Processing

Phillip P. Smith MD
Department of Surgery
UConn Center on Aging
CT Institute for the Brain and Cognitive Sciences
Uconn/JAX Institute for Systems Genomics
UConn, School of Medicine
Farmington CT
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Significance

What’s in there?

Renal Output

Brain

STORAGE Vs. VOIDING

LUT
Muscle and Structure

Genetics

Aging

Disease

Lifestyle

DO

DU

ISD

OAB

UAB

SUI

Incontinence
Retention
Frequency
Urgency
Nocturia
Significance

Mature Adult

SUI

Genetics

Aging

Disease

Lifestyle

LUT Muscle and Structure

DO

DU

ISD

OAB

UAB

SUI

Old Adult


Krause, et al., Drugs Aging. 2010 Sep 1;27(9):697-713

Smith et al., Int Urol Nephrol. 2014 Sep;46 Suppl 1:S35-44.

Frail Adult

Incontinence

Retention

Frequency

Urgency

Nocturia
Significance

MODEL CALCULATIONS
"Garbage In-garbage Out" Paradigm

Brain

What’s in there?

Bladder
Knowledge

• Older asymptomatic patients less sensitive to bladder content. 

• Ex-Vivo bladder sensitivity to volume might increase with aging. 
  Daly et al., J Physiol 2013.

• Brain areas relevant to sensory signaling become less responsive to bladder volume. 

• OAB can be considered as a syndrome of impaired volume perception.

• UAB is a syndrome of volume hyposensitivity. 
  Smith et al., Bladder 2015;2:e17.

• Incontinence can also be viewed as an impaired content response. 
Knowledge


Bladder wall stiffness vs. volume is the result of diffuse smooth muscle activity interacting with the extracellular matrix *Coolsaet B, Neurourol Urodyn* 1985; 4, 263-273.

Hypothetical curves illustrating aging and the relationship of pressure/volume, The Problem of “Compliance”, and how the P/V relationship can affect volume sensitivity.

Micromotions are modulated by autonomic transmitters Gillespie JI. BJU Int 2004;93:393-400; Gillespie et al., BJU Int 2012;110:E132-142; Gillespie et al., Naunyn-Schmiedeberg's archives of pharmacology 2015;388:719-726.

Modulation of micromotions drives changes in afferent activity Heppner et al., J Gen Physiol. 2016 Apr;147(4):323-35

Knowledge


• Suppression of the voiding reflex increases bladder stiffness and reduces spectral content (mouse) Smith et al., Neurourol Urodyn 2012;31:30-35.

• Spectral content and stiffening effect of voiding suppression increase with aging (mouse) Smith et al., BJU Int 2015;115:322-329.
Bladder Volume Transduction

- UE derived EPs
- Myocytes
- Sympathetic
- Collagen
- Mass
- Micromotions
- ExtraCellular Matrix
- Tension
- Afferent Activity
- Bladder content-induced stretch
- Perceptions
- PAG/Insula
- PMC/Locus Coeruleus
Knowledge

• The outer hair cells of the organ of Corti are the target of abundant efferent projections from the olivocochlear system.

• Thought to be modulated by central activity via corticofugal descending auditory system, and to modulate active cochlear micromechanics.

• May be involved in ear protection against noise damage and auditory perception, especially in the presence of background noise.

• Mounting evidence that its activity is modulated by auditory and visual attention.

• Differences in olivocochlear function might reflect differences in peripheral auditory function, or in more central factors such as top–down attentional modulation.

Perrot and Collet, Hear Res. 2014 Feb;308:27-40
STRESSORS
STRESSORS
Research Opportunities

Perception of Bladder

Brain

The Sum of All Physiologic
Stressors, Memories, Emotions

STORAGE

VOIDING
Research Opportunities

• What is “normal adaptive response” vs pathology (phenotyping)?

• How do adjustable sensors function and what is the impact of aging and disease?

• What are the mechanisms of central control over centrifugal processing?

• What is the impact of aging on central (integrative) mechanisms?

• Where are potential points of intervention?
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