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LOWER URINARY TRACT FUNCTION; A CONTROLLED AUTONOMIC FUNCTION; THE REFLEX HAMMER, THE AGONIST AND THE ANTAGONIST AND THE 13TH CRANIAL NERVE.

Hypothesis / aims of study
Lower urinary tract function depends on somatosensory control as well as on autonomic nerves innervating striated and smooth muscles. Lower urinary tract function and dysfunction are not easily explained and frequently incompletely- or misunderstood. A clearer concept that nevertheless includes normal and common neurology as well as standard physiology will be of great help in the education of professionals and as the basis for interventions to improve lower urinary tract dysfunction. The principle of controlled autonomic reflex activity is introduced here.

Study design, materials and methods
Anatomy, neuroanatomy, neurophysiology and muscle physiology are integrated to explain lower urinary tract normal storage and voiding function.

Results
Children are born with an autonomic reflex bladder function (that existed already before birth). When the bladder is filled with urine from the kidneys to a certain volume, the detrusor dome contracts and the bladder empties. This reflex becomes socialized by will as the result of potty training.
When the kidneys fill the bladder, its lumen distends and this causes the detrusor muscle to become stretched starting a from a certain volume. When the muscle stretches the muscle stretch sensors register this and signal to the brain. This is proprioception like in all other muscles. This detrusor proprioception is gradually recognised as bladder filling sensation during childhood and is the basis for maturation of voiding function and urinary continence.
The detrusor dome is kept relaxed through parasympathetic inhibition in the autonomic reflex and the potty training upgrades this reflex to higher volumes. While parasympathetic activity is inhibited, sympathetic dominance to the bladder base results in closure (contraction). Urinary bladder filling results in detrusor muscle stretch increment and the conscious brain becomes aware of this. At a socially acceptable moment the sympathetic dominance is released and parasympathetic detrusor dome contraction empties the bladder. The bladder base (bladder neck) relaxes however, some longitudinal fibres should contract to ensure funnelling of the outlet. Detrusor dome and base are antagonists and innervated as a reflex. The detrusor dome contraction is necessary to open the relaxed outlet; the circular bladder base relaxes but can only open when counter pressure of the abdominal content and detrusor contraction provide the energy for this opening. The autonomic switch from sympathetic dominance to parasympathetic dominance is initiated by pelvic floor muscle relaxation. And normally the usual pelvic activity tone is sufficient to keep the bladder in storage function and prevents switching to voiding. The pelvic muscles act, with relaxation, as the reflex-hammer for the initiation of the autonomic voiding reflex.
A voluntary controlled or inhibited autonomic reflex is not unique for lower urinary tract function. The cornea- blink reflex is a brainstem reflex that can be somewhat inhibited. Eye-blinking can be initiated by will, and the blinking reflex is up -regulated when somebody uses (gets used to) contact lenses. The gasp reflex and the cough and crying reflex are adapted to vocalizing and speaking. The cough reflex can also be inhibited to a certain extend.
Onuf's nucleus in the sacral levels of the end of the spinal cord relays the autonomic reflex and coordinates this with voluntary pelvic striated muscle relaxation (or contraction). The activity of Onuf's nucleus depends on the excitation signals from the pontine micturition centre and in this regard the lower urinary tract innervation is basically very similar to the cranial nerves; originating in the brain and exerting its actions in a peripheral organ. Almost all cranial nerves integrate somatosensory with autonomic activity and are a combination of sensory and motoric functions. The lower urinary tract is controlled by the 13th cranial nerve.
The detrusor dome and the base are antagonists and should alternately but synergic contract and relax. The pelvic muscles are the initiator of the voiding reflex at adult life. Some children are faster than others to control the autonomic lower urinary tract but eventually almost all neurologically normal children manage to do so. When the pelvic muscles relax the detrusor dome is the driver of the urine flow. Higher than normal outlet resistance drives the detrusor to higher pressures and the muscle becomes hypertrophic. Man (boys) have already a higher detrusor voiding pressure at birth and the continuing growth of the prostate is a continuing challenge for the detrusor muscle. Women have a lesser fixed bladder outlet and lower outlet resistance and funnelling at the initiation of the voiding is relatively of more importance. The weight of the abdominal content -in women- may however provide enough energy for the voiding and the detrusor is contracting at (only) high velocity without being able to build any pressure. Women have fast contracting detrusors with little power and men have high poser slower contraction.
The detrusor contracts to zero bladder content at the end of filling. No muscle fibre can contract to zero length and therefore the outer layer has to squeeze the inner layer at small intravesical volume to ensure complete emptying. Bladder sensation begins when the innermost layer becomes stretched when the bladder is filling again.

Interpretation of results
Normal adult human lower urinary tract function (and lower bowel function) depends on controlled autonomic reflex activity. The detrusor dome and detrusor base are antagonists and the switch from storage to voiding is initiated by the reflex hammer activity of the pelvic floor. The system is innervated by the 13th cranial nerve from the pontine micturition centre (nucleus XIII). The detrusor dome drives the voiding and contracts with high velocity when the outlet resistance is low.

Concluding message

Integration of physiology and neurology has provided a simple, sound and practical basis for the understanding of lower urinary tract function.

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