Micturition

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Abstract

The lower urinary tract function is to store and void urine (micturition) that is produced by the kidneys and transferred via the ureters. The lower urinary tract consists of the bladder, urethra and (in males) the prostate. A complex interaction of central, autonomic and somatic innervation enables micturition to be under voluntary control. Common disorders of micturition include bladder outflow obstruction and overactive bladder syndrome, and management of these disorders may include conservative, pharmacological or surgical interventions.

Keywords Bladder; bladder outflow obstruction; lower urinary tract; micturition; stress incontinence; urge incontinence

Royal College of Anaesthetists CPD Matrix: 1A01

Learning objectives

After reading this article, you should be able to:

- describe the anatomy and neurological control of the lower urinary tract
- describe the common disorders that may affect the lower urinary tract
- outline the initial assessment and management of common causes of urinary tract dysfunction
- list five red flag indicators of serious pathology of the lower urinary tract

Micturition (also known as voiding and urination) is the release of urine from the urinary bladder via the urethra. The function of the lower urinary tract is the storage and voiding of urine.

Anatomy (Figure 1)

The lower urinary tract consists of the urinary bladder and the urethra. In males it also includes the prostate.

The bladder wall has three layers:

- transitional epithelium with associated submucosa containing sensory nerves and blood vessels
- detrusor muscle arranged in interlocking and over lapping bundles
- adventitial or serosal layer.

Towards the base of the bladder the two ureters transverse the bladder wall obliquely. The area between the two ureters and the bladder neck is known as the 'trigone' and has a distinct layer of adrenergic smooth muscle.

In men this adrenergic smooth muscle merges with the capsule and smooth muscle component of the prostate to form the bladder neck sphincter. The sphincter is important in sexual function as it prevents retrograde ejaculation; however, it is less important in the control of continence.

In the males, the control of continence is dependent upon the distal urethral sphincter or rhabdosphincter. This is a horseshoe-shaped structure of smooth muscle, deficient posteriorly, that lies around the urethra distal to the apex of the prostate. Outside the urethra at this level there is a sling of striated muscle, the pubourethral sling. This forms part of the pelvic floor. In the female, the bladder neck is less developed and the rhabdosphincter lies in the mid urethra.

Neurological control of the lower urinary tract (Figure 2)

The lower urinary tract is controlled by local reflexes in the sacral spinal cord, the sacral micturition centre and Onuf's nucleus within the spinal cord. These reflexes are modulated by descending tracts from the pontine micturition centre and the cerebral cortex. The complex interaction between central, autonomic and somatic innervation enables micturition to be under voluntary control.

Afferent nerves

A plexus of free nerve endings in the urothelium and submucosa provide the primary source of sensory information from the bladder. The nerve endings are sensitive to bladder stretching during filling. They send axons via the pelvic nerves to S2–S4. Sensory fibres from the trigone convey urgency and pain via the hypogastric nerves to T10–L2. Additional sensory fibres from the urethra travel via the pudendal nerve to T10–L2.

Efferent nerves

The lower urinary tract receives somatic, sympathetic and parasympathetic innervation.

- *Parasympathetic innervation* is the most important with regard to control of the lower urinary tract function. It arises from S2–S4. Preganglionic fibres run in the nervi erigentes (pelvic splanchnic nerves). They synapse in the ganglia of the pelvic plexus located in the adventitial layer of the bladder wall and base. The postganglionic fibres go on to supply the detrusor muscle and the urethra, enabling smooth muscle contraction and bladder emptying.
- *Sympathetic innervation* arises from T10–L2. The fibres run in the hypogastric nerves to supply the trigone, the bladder base and (in men) the prostate. Fibres also reach the pelvic plexus ganglia. They are responsible for bladder relaxation and thereby contributing to urinary continence.
- *Somatic innervation* comes from S2–S4. The axons join the pudendal nerve to supply the muscles of the pelvic floor and the urethra. Other axons go on to supply the intrinsic rhabdosphincter.

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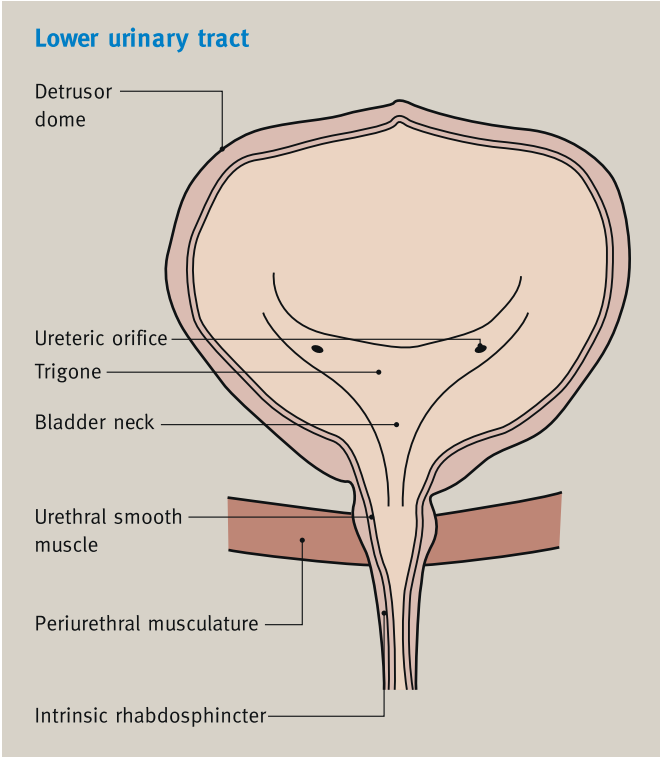

Figure 1

Central control

Bladder filling occurs when the bladder wall relaxes and intravesical pressure is low, thereby accommodating the increase in bladder contents. This is known as 'receptive relaxation'. It is possible due to suppression of the micturition reflex. Descending signals from the pontine micturition centre and ascending signals from the sympathetic innervation work together to inhibit activity in the pelvic plexus via a gating mechanism. Consequently low threshold afferent activity does not result in detrusor muscle contraction. Simultaneously the tone in the rhabdospincter (internal sphincter) increases as the bladder volume rises. This is known as the 'guarding reflex'.

Bladder voiding occurs when detrusor muscle contraction and sphincter relaxation are synchronized. Both processes occur due to spinal reflexes. However, the synchronization is dependent upon descending signals from the pontine micturition centre, which in turn receives afferent input from all components of the lower urinary tract and the cerebral cortex.

Disorders of micturition (Figure 3)

Lower urinary tract dysfunction is common in both males and females, often resulting in irritating and embarrassing symptoms that impact on quality of life. It may also progress to urinary incontinence and renal impairment.

Lower urinary tract symptoms (LUTS) is an umbrella term used to describe symptoms of dysfunctional micturition such as poor flow and hesitancy. LUTS can arise due to pathology in the bladder, ureter, prostate and other pelvic organs. Occasionally there may be a neurological cause.

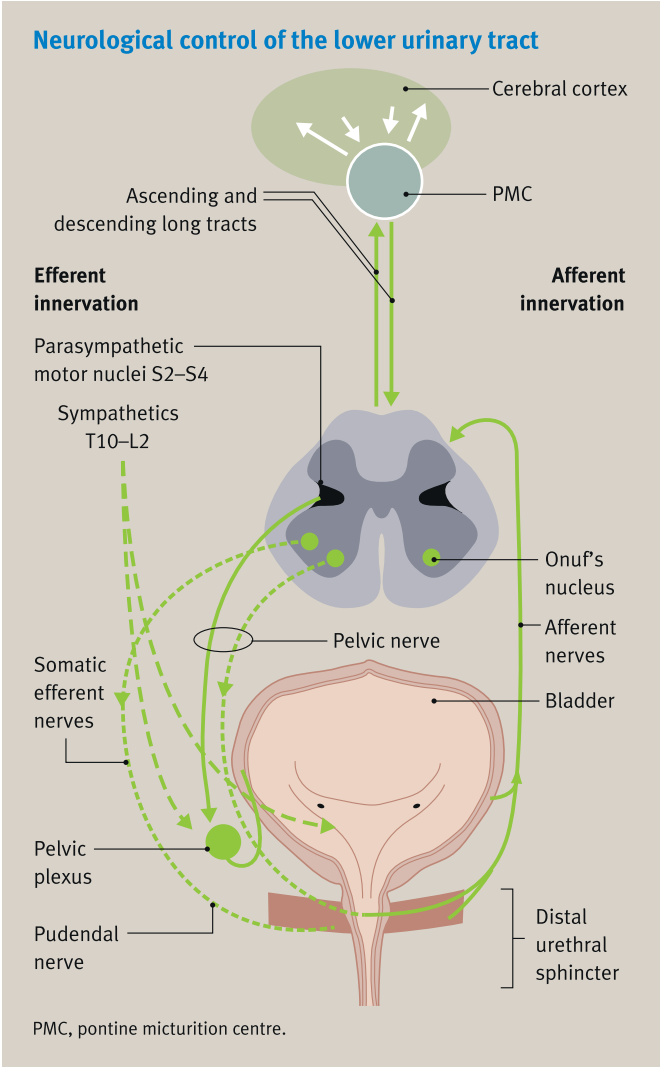

Figure 2

The most common lower urinary tract problems are bladder outflow obstruction and the overactive bladder.

Bladder outflow obstruction (BOO) due to urethral strictures, phimosis, or more frequently prostatic enlargement causes LUTS. It may lead to incomplete bladder emptying. Slow onset BOO may result in chronic urinary retention, however rapid onset can result in painful acute urinary retention.

If catheterization following acute urinary retention reveals a residual volume of less than 1 litre, the renal function is normally unaffected. In contrast, chronic urinary retention is less painful, and on catheterization the residual volume often exceeds 1 litre. During urinary retention, if the detrusor muscle is compliant the bladder wall stretches, enabling the intravesical pressure to remain normal. If the bladder cannot adequately stretch, an increase in intravesical pressure results causing dilatation of the upper urinary tract and subsequent renal impairment.

Overactive bladder syndrome is characterized by storage symptoms such as urgency of micturition and urge incontinence. It can also include symptoms such as frequency and nocturia. Often it is due to detrusor overactivity (i.e. spontaneous detrusor

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