

Anatomy and Physiology of the Urinary Tract

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Fact Sheet

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Overview

The urinary tract consists of the upper urinary tract (kidneys and ureters) and the lower urinary tract (bladder, and urethra).¹ These organs cooperate to carry out urine production, storage and elimination. Spinal cord injury (SCI) can disrupt the coordination of the urinary system, resulting in problems with the storage and elimination of urine.^{2,3} To understand the impact of SCI on the urinary system, it is important to understand the basic anatomy and physiology of the urinary tract.

Components of the Urinary Tract

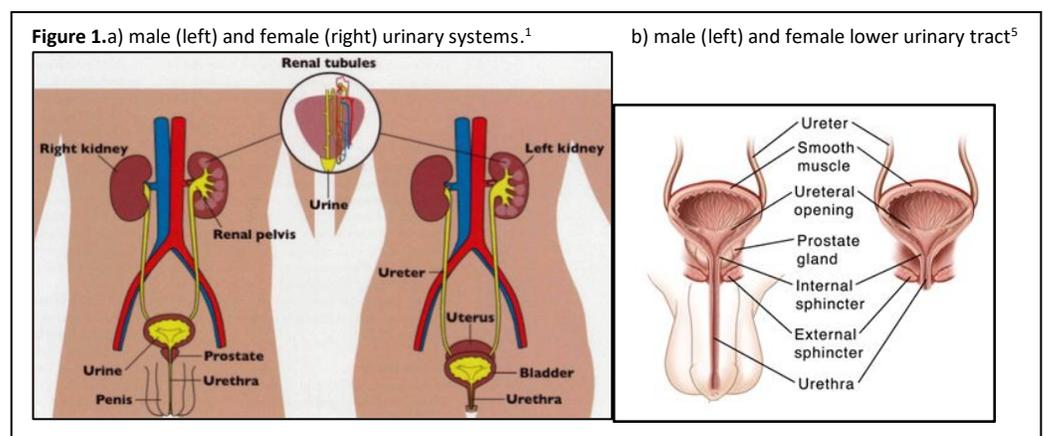
Kidneys: The kidney filters the blood of solutes and then secretes, concentrates and excretes urine into the lower urinary tract via the ureters.

Ureters: The ureters carry urine approximately 22-30cm from the kidneys to the bladder for elimination. Gravity and peristaltic waves within the ureters propel urine from one end to the other.^{1,3}

Bladder: The bladder is composed of smooth muscle fibers. Urine fills the bladder at low pressures causing it to distend, up to a normal capacity of about 500mL of urine in adults.¹ Near the neck of the bladder at the inferior base, the smooth muscle is organized in a circular fashion, allowing it to serve as a function sphincter.⁵ Urine is emptied from the bladder to the urethra via the internal urethral orifice.

Urethra: The urethra carries urine from the bladder to the external environment.

- **Internal urethral sphincter (IUS):** The IUS is positioned at the junction between the bladder neck and the proximal urethra. The IUS is composed of smooth muscle and connective tissue in a circular arrangement, and it is considered a functional sphincter because its tone increases progressively with bladder filling resulting in greater pressure within the urethra than within the bladder.⁵
- **External urethral sphincter (EUS):** The EUS is composed of skeletal muscle fibers that circle the membranous part of the urethra in males and the upper two-thirds of the urethra in females.³



Neural Control of the Urinary Tract

During storage of urine in the bladder, the smooth muscle of the bladder relaxes while the IUS and EUS remain closed. During bladder emptying, the smooth muscle of the bladder contracts while the IUS and EUS open.

Storage and emptying of the bladder are controlled by the parasympathetic, sympathetic, and somatic innervation of lower urinary tract structures with some modulation from the central nervous system.³

- Parasympathetic efferent supply to the bladder originates from the spinal cord at S2-4 with stimulation leading to contraction of smooth muscle in the bladder.
- Sympathetic efferent supply to the bladder and urethra originates from the spinal cord at T11-L2 with stimulation leading to relaxation of smooth muscle in the superior portion of the bladder and smooth muscle contractions of the IUS and prostate (in males), facilitating bladder storage.
- Innervation of the EUS is from the S2-S4 levels of the spinal cord via the pudendal nerve, allowing for voluntary closure of the EUS and facilitating bladder storage.
- There are three main voiding centers in the central nervous system:³
 - Sacral micturition center (S2-S4): a reflex center that provides feedback about bladder fullness via efferent parasympathetic impulses to cause bladder contraction with corresponding afferent impulses.
 - Pontine micturition center: coordinates relaxation of the IUS when the bladder contracts.
 - Cerebral cortex: has an overall effect of inhibiting the sacral micturition center.

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Patient Resources

Bladder Management Following Spinal Cord Injury: What You Should Know, a guide for people with Spinal Cord Injury from the Consortium for Spinal Cord Medicine/Paralyzed Veterans of America:

<https://pva.org/research-resources/publications/>

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