

Bladder

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1. Introduction

Bladder is a hollow visceral organ serving as a reservoir for collecting urine and its wall is composed of 3 distinct structural layers - mucosa, muscularis, and serosa. Bladder structure is built to accommodate filling, storage and emptying functions.

2. Embryology

Bladder is derived embryologically from urogenital sinus, endodermal structure. Trigone arises from mesonephric ducts, mesodermal structure. Ureteral bud, which is also derived from mesonephric duct, gives rise to ureter, renal pelvis and collecting ducts.

3. Histology

3.1 Urothelium

Superficial layer of urothelium is composed of umbrella cells, large hexagonal cells forming a watertight boundary between urine and tissue under normal conditions. This boundary maybe disrupted under pathological conditions. This urothelium is usually six cells thick and rests on a thin basement membrane. Deep to this, the lamina propria forms a relatively thick layer of fibroelastic connective tissue that allows considerable distention.

This layer is traversed by numerous blood vessels and contains smooth muscle fibers collected into a poorly defined muscularis mucosa.¹

The presence of cholinergic, purinergic, and other receptors on urothelial cells and the non-neuronal release of neurotransmitters, including ACh and ATP, implicate the urothelium in the sensory process.^{2,3}

3.2 Muscularis

Muscularis is composed of 3 layer of smooth muscle arranged in intertwined spiral and circular bundles, collagen, and elastin.

The cells of the outer and inner layers tend to be oriented longitudinally, and those of the middle layer

circularly. In the human detrusor, bundles of muscle cells of varying size are surrounded by connective tissue rich in collagen.⁴

Near the bladder neck, the detrusor muscle is clearly separable into the three layers described earlier. Here, the smooth muscle is morphologically and pharmacologically distinct from the remainder of the bladder because the large-diameter muscle fascicles are replaced by much finer fibers. The structure of the bladder neck appears to differ between men and women.

In men, radially oriented inner longitudinal fibers pass through the internal meatus to become continuous with the inner longitudinal layer of smooth muscle in the urethra.

At the female bladder neck, the inner longitudinal fibers converge radially to pass downward as the inner longitudinal layer of the urethra, as described earlier. The middle circular layer does not appear to be as robust as that of the male. The female bladder neck differs strikingly from the male in possessing little adrenergic innervation.¹

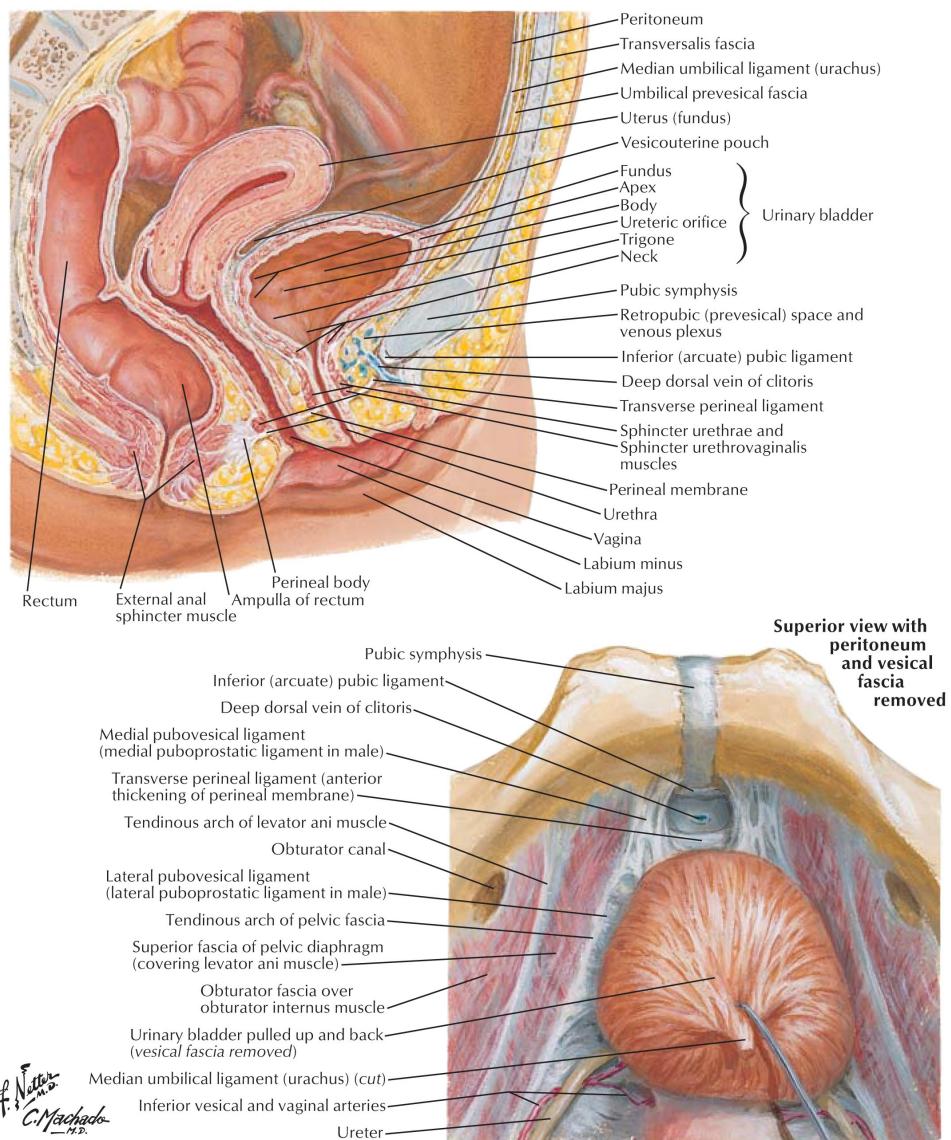
3.3 Serosa

The dome of the bladder is covered by parietal peritoneum as it reflects off the anterior and lateral abdominal walls.

In females this layer becomes contiguous with the anterior surface of the uterus (medially) and the anterior leaf of the broad ligament on either side of the uterus. The remainder of the bladder exterior surfaces are extraperitoneal.⁵

4. Gross Anatomy

Female: midsagittal section



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Figure 1: Female Bladder

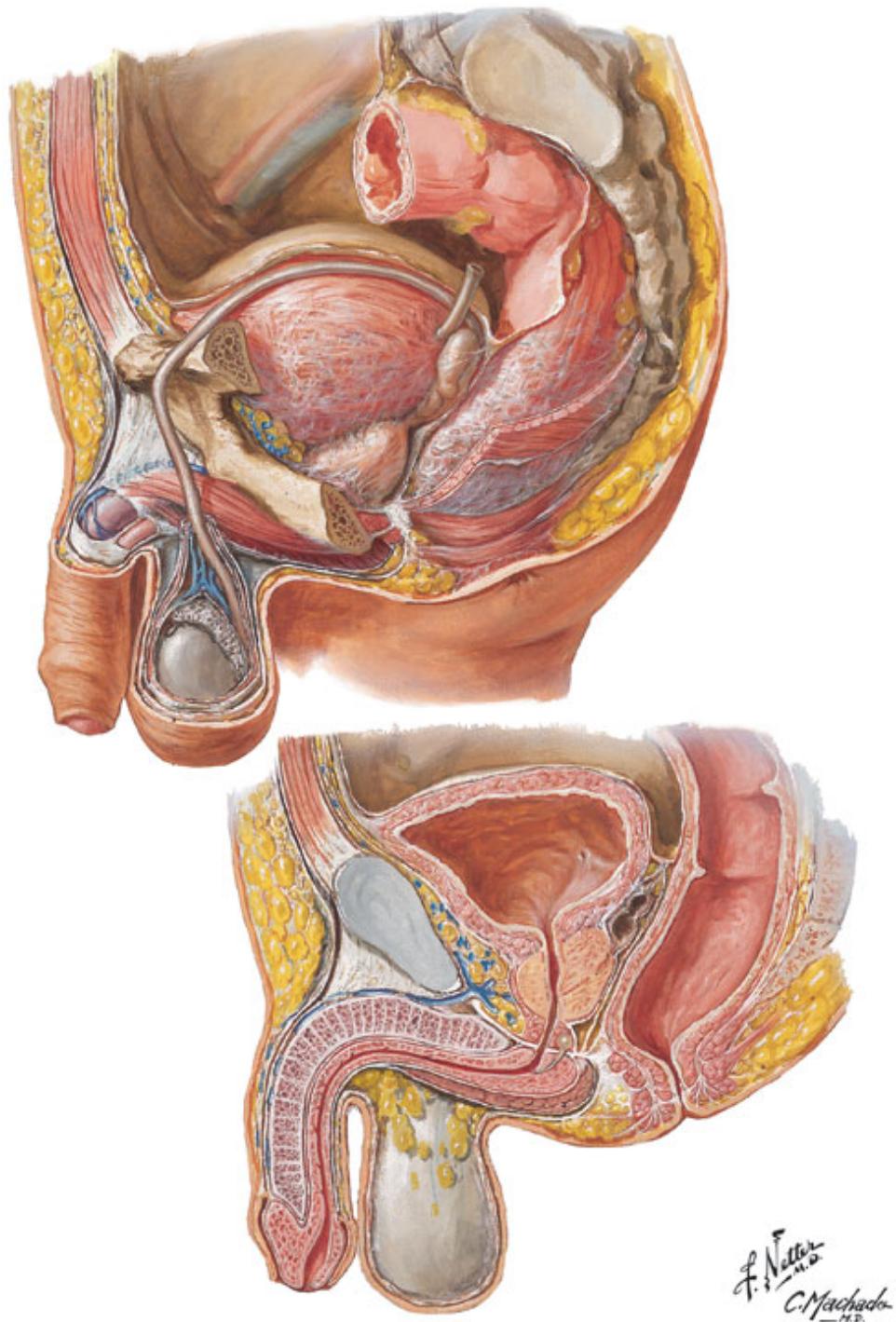


Figure 2: Male Bladder

When empty, the adult bladder lies behind the pubic symphysis and is largely a pelvic organ with approximate volume of 50 ml. In infants and children, it is situated higher. When it is full, it rises well above the symphysis and can readily be palpated or percussed. Average adult bladder capacity is about 500 ml, pediatric bladder capacity is calculated by following formula- $(\text{age}+2) \times 30 \text{ ml}$. When overdistended, as in acute or chronic urinary retention, it may cause the lower abdomen to bulge visibly.⁶

Extending from the dome of the bladder to the umbilicus is a fibrous cord, the median umbilical ligament, which represents the obliterated urachus. The ureters enter the bladder posteroinferiorly in an oblique manner with orifices situated at ureteric ridge. Ureteric ridge is semi-lunar in shape forming a proximal trigone border. The trigone occupies the area between the ridge and the bladder neck.

The internal sphincter, or bladder neck, is not a true circular sphincter but a thickening formed by interlaced and converging muscle fibers of the detrusor as they pass distally to become the smooth musculature of the urethra.⁶

4.1 Blood Supply

The vessels are primarily located laterally along the base of the bladder and urethra along the endopelvic fascia.

4.1.1 Arterial

Main arterial supply to the bladder is provided by superior and inferior vesical pedicles which arise from the anterior trunk of the internal iliac artery and by smaller branches from the obturator and inferior gluteal arteries. In females, the uterine and vaginal arteries also send branches to the bladder.

The superior vesical pedicle is primarily supplied by the superior vesical artery. The superior vesical artery and the obliterated umbilical artery are derived from the same umbilical artery branch.

The inferior vesical pedicle is supplied by the inferior vesical artery which usually comes directly off of the internal iliac artery, but may, in some cases, be a branch of the internal pudendal artery.^{1,5}

4.1.2 Venous

Surrounding the bladder is a rich plexus of veins that ultimately empties into the internal iliac (hypogastric) veins.

4.1.3 Lymphatics

Majority of lymphatic drainage passes to the external iliac lymph nodes. Some anterior and lateral drainage may go through the obturator and internal iliac nodes, whereas portions of the bladder base and trigone may drain into the internal and common iliac groups.¹

4.2 Surrounding Organs

Male: Posteriorly: seminal vesicles (SVs), ureters, rectum and vasa deferens.

Female: Posteriorly: posterior wall and dome are invaginated by the uterus. Vagina is located posterior to the bladder. Rectum is located posterior to vagina and uterus thus uterus and vagina are positioned between bladder and rectum.

Anteriorly Male and Female: pubic symphysis, and, when distended, it is in contact with the lower

abdominal wall.⁶ (see **Figure 1** and **Figure 2**)

5. Bladder Innervation

See **Table 1**

The bladder receives innervation from sympathetic and parasympathetic nervous systems. The sensory afferent of the bladder originates from both subepithelial nerve endings and nerve fibers between detrusor muscle bundles.^{3,4}

Autonomic **efferent** fibers from the anterior portion of the pelvic plexus (the vesical plexus) pass up the lateral and posterior ligaments to innervate the bladder. The bladder wall is richly supplied with parasympathetic cholinergic nerve endings and has abundant postganglionic cell bodies.

Afferent innervation from the bladder travels with both sympathetic (via the hypogastric nerves) and parasympathetic nerves to reach cell bodies in the dorsal root ganglia located at thoracolumbar and sacral levels.

Sympathetic innervation. The sympathetic innervation originates from the intermediolateral nuclei in the thoracolumbar region (T10-L2) of the spinal cord. The axons leave the spinal cord via the splanchnic nerves and travel either through the inferior mesenteric ganglia (IMF) and the hypogastric nerve or pass through the paravertebral chain to the lumbosacral sympathetic chain ganglia and enter the pelvic nerve. Thus, sympathetic signals are conveyed in both the hypogastric nerve and the pelvic nerve.⁷

The male bladder neck receives abundant sympathetic innervation and expresses α_1 -adrenergic receptors. The female bladder neck has little adrenergic innervation.¹

Parasympathetic innervation. The sacral parasympathetic pathways mediate contraction of the detrusor smooth muscle and relaxation of the outflow region. The preganglionic parasympathetic neurons are located to the sacral parasympathetic nucleus (SPN) in the spinal cord at the level of S2-S4. The axons pass through the pelvic nerves and synapse with the postganglionic nerves either in the pelvic plexus, in ganglia on the surface of the bladder (vesical ganglia), or within the walls of the bladder and urethra (intramural ganglia).⁷

Somatic innervation. Pudendal nerve provides somatic innervation to urethral skeletal sphincter. These fibers originate from sphincter motor neurons located in the ventral horn of the sacral spinal cord (levels S2-S4) in a region called Onuf's nucleus.⁸

Table 1: Summary of Bladder Innervation

Nervous System	Neurotransmitter	Spinal Level	Nerve	Innervated Structure
Sympathetic	Acetylcholine (ganglia) Norepinephrine (effector sites)	T10-L2	Hypogastric nerve	Trigone, bladder neck
Parasympathetic	Acetylcholine	S 2,3,4	Pelvic nerve	Bladder
Somatic	Acetylcholine	Mainly S 2	Pudendal nerve Pelvic Nerve	External sphincter Bladder

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