

Anatomy of the lower urinary tract

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Abstract

For descriptive purposes the urinary tract is divided into two parts: the upper urinary tract and the lower urinary tract. The former comprises the kidneys and ureters, while the lower urinary tract consists of the urinary bladder and the urethra. In this article, a detailed description of the surgical and functional anatomy of the urinary bladder is followed by a description of the clinical anatomy of the female and male urethra. There then follows a brief description of the relevant anatomy of the prostate and seminal vesicles. While not strictly involved in the conduction of urine from the bladder to the exterior, the prostate and seminal vesicles are so intimately related (both topographically and functionally) to the urethra and bladder that no account of the lower urinary tract in the male would be complete without them. It is conventional therefore to regard the prostate and seminal vesicles as part of the lower urinary tract.

Keywords detrusor; parasympathetic nerves; prostate; seminal vesicle; trigone; urachus; urethra; urinary bladder; urothelium

The urinary bladder

The urinary bladder is a distensible and hollow viscus which functions as a temporary reservoir for the urine that is conveyed to it continuously by the two ureters. It is wholly extraperitoneal. The muscular wall of the bladder confers an impressive degree of contractility to the bladder. The size, shape and position of the bladder and the relationship of the bladder to nearby structures are determined by the degree to which the bladder is distended by the contained urine and also by the state of the adjacent viscera. In the adult, the *empty* urinary bladder lies entirely within the true pelvic cavity, occupying the anterior part of the pelvic cavity, behind the pubic symphysis and pubic bones. As the bladder distends it ascends above the level of the pelvic brim and thus into the abdomen.

It is important, however, to emphasize that in the neonate and infant, the bladder, even when empty, is an abdominal viscus. The explanation for this lies in the fact that at birth there is practically no depth or volume to the pelvic cavity. The bladder neck at this stage lies level with the upper edge of the pubic symphysis. The bladder is almost tubular in shape and lies in contact with the posterior surface of the lower part of the anterior abdominal wall. This anatomical feature is a very important surgical consideration when performing lower abdominal laparotomy incisions in infants. It is only by the age of 7 or 8 years that the pelvic cavity acquires sufficient depth to accommodate the bladder, and it is only at about the time of puberty that the

bladder becomes truly intra-pelvic in location, and then only when the bladder is empty! When empty the bladder appears flattened from above downwards by the pressure of neighbouring viscera, but as it fills with urine, it assumes an ovoid shape. The empty, contracted adult bladder has a somewhat tetrahedral shape (Figures 1 and 2) and presents externally, four surfaces which are demarcated from each other by indistinct borders: a superior surface, a posterior surface (also referred to as the base of the bladder) and two inferolateral surfaces (right and left) which meet anteriorly. The anterior angle of the superior surface (where the superior surface meets the two inferolateral surfaces) is the apex of the bladder. Running antero-superiorly from the apex of the bladder to the umbilicus is the median umbilical ligament. The latter is a fibrous, cord-like remnant of the embryological urachus. The bladder neck refers to the lowest part of the bladder where the posterior and inferolateral surfaces of the bladder meet. Within the bladder neck lies the internal urethral orifice through which the bladder lumen is continuous with the urethra. In the male the bladder neck lies immediately above the upper surface (or base) of the prostate. In the female, the bladder neck is related to the pelvic floor and the pelvic fascia surrounding the upper urethra. Posteriorly, the bladder neck is related to the anterior vaginal wall and fornix. With the inflow of urine and progressive distension of the bladder, the vague demarcations between the surfaces of the bladder gradually disappear and the surfaces merge one with another as the bladder assumes a globoid or ovoid shape.

The relationship of the bladder to the peritoneum (Figures 1 and 2) is of considerable surgical and clinical importance. The superior surface of the bladder (also known as the dome of the bladder) is covered completely by peritoneum; the peritoneum being densely attached to this surface. Anteriorly the peritoneum leaves the superior surface of the bladder and stretches upwards to reach the posterior surface of the anterior abdominal wall where it blends with the fascia transversalis. The level at which the peritoneum meets the fascia transversalis lies 4–5 cm superior to the upper edge of the pubic symphysis. Three longitudinal folds, all directed towards the umbilicus, are seen in the peritoneum that sweeps superiorly from the dome of the bladder to the anterior abdominal wall. The central fold is the median umbilical fold. It is produced by the underlying cord-like median umbilical ligament, the obliterated remnant of the urachus. On each side of the median umbilical fold is the corresponding medial umbilical fold produced by the underlying medial umbilical ligament which is the obliterated remnant of the umbilical artery (Figure 3). Laterally on either side, the peritoneum leaves the superior surface of the bladder to reach the obturator fascia (the fascia covering the inner surface of the obturator internus) on the lateral pelvic wall. (Figure 3). Posteriorly, in the male, the peritoneum descends from the superior surface of the bladder on to the posterior surface (base of the bladder) for a very short distance before it turns posteriorly to reach the ventral surface of the rectum. The shallow fold of peritoneum thus produced is termed the rectovesical pouch. In the female the peritoneum extends directly backwards onto the uterine isthmus without dipping down the posterior surface of the bladder (see Figure 1).

As the bladder distends with urine it becomes progressively rounded and rises above the pelvic brim into the abdominal

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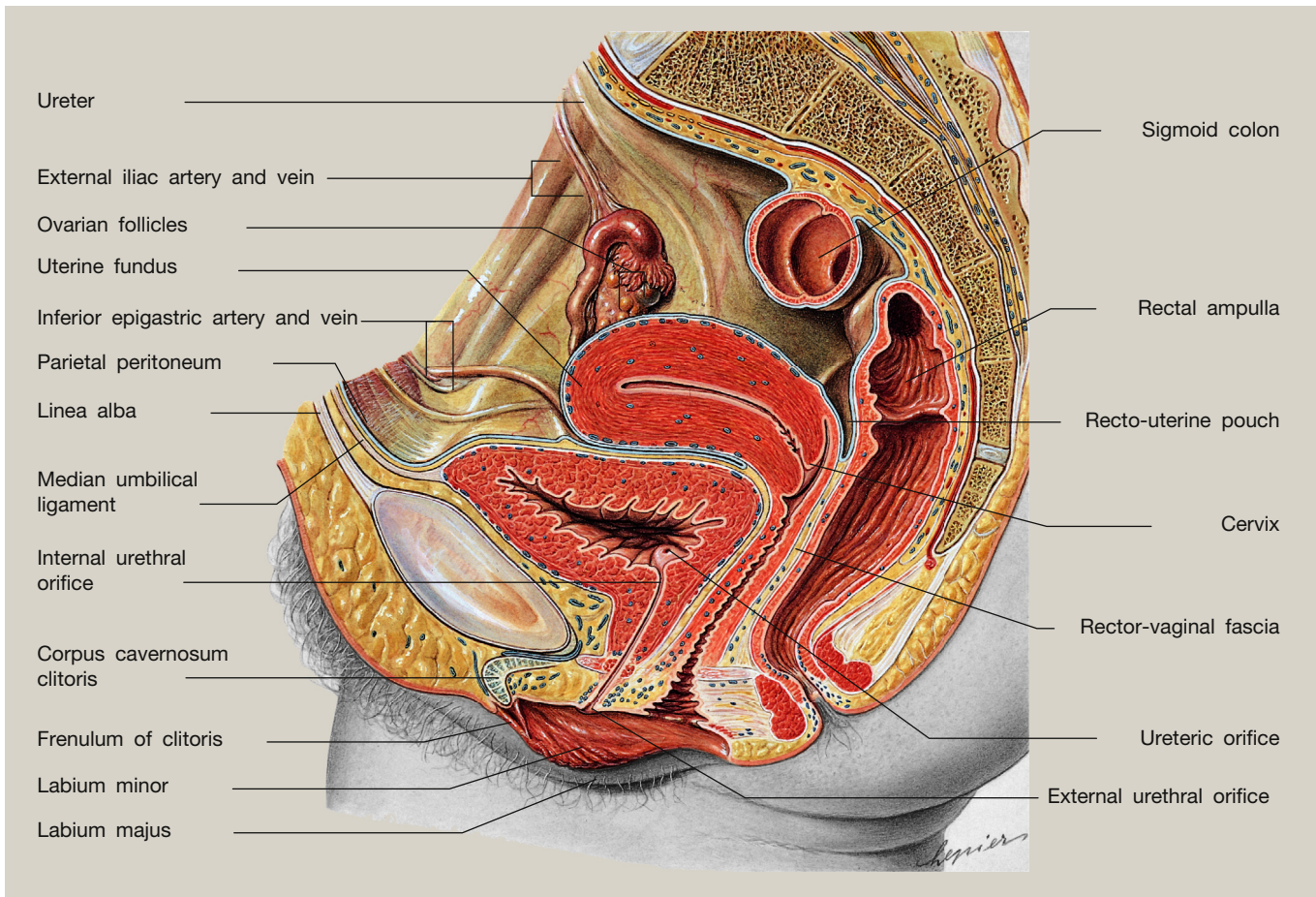


Figure 1 Sagittal view of female pelvic cavity showing relations of urinary bladder and relationship of peritoneum to bladder.

cavity, stripping the peritoneum away from the posterior surface of the anterior abdominal wall. The inferolateral surfaces of the bladder now rest directly against the posterior surface of the abdominal wall without any intervening peritoneum. At this stage the distended bladder may be palpable or may be identified and defined by percussion. A needle or cannula advanced perpendicular to the anterior abdominal wall in the anterior midline just above the pubic symphysis will enter the distended bladder without traversing the peritoneal cavity. This is the anatomical basis to suprapubic puncture of bladder, suprapubic catheterization and suprapubic cystostomy. The dome of the urinary bladder is the most mobile and least well-supported of the walls of the bladder. A powerful blunt injury to the lower abdomen in a subject with a tense and distended bladder, may well result in a rupture of the bladder dome. The ensuing leak of urine will inevitably be into the peritoneal cavity on account of the relationship of the peritoneum to the dome. A rupture through any of the other walls of the bladder is likely to result in an extraperitoneal leak of urine. The management of bladder perforations will differ significantly depending on whether the perforation is intra or extraperitoneal.

Interior of the bladder

The inner aspect of the lower part of the posterior wall of the bladder features a triangular area called the trigone. The outline

of the trigone is that of an inverted triangle, with the internal urethral orifice at the apex of the triangle and the right and left ureteric orifices marking the other two angles (Figure 4). The two ureteric orifices appear as oblique slits and are about 3 cm apart, in the empty bladder. However when the bladder is fully distended the distance between the two orifices may be up to 5 cm. Running transversely between the two ureteric orifices is a sub-mucosal ridge termed the interureteric bar (Mercier's bar). The outer wall of the bladder corresponding to trigonal region is firmly fixed to the upper surface of the prostate (in the male) and to the anterior vaginal wall (in the female). This makes the trigone the least mobile part of the bladder. The mucous membrane of the empty bladder is rugose but this rugosity disappears when the bladder is distended with fluid, as is readily observed during cystoscopy. Over the trigone which is the least distensible part of the bladder, the mucous membrane is always smooth. The vesical mucosa is only loosely adherent to the subjacent detrusor muscle. However, in the region of the trigone, the mucosa is more densely adherent to the subjacent muscle. The entire urinary bladder is lined on the inside by a specialized epithelium termed urothelium (synonymous with transitional epithelium). This epithelium is unique to the conducting part of the urinary tract and forms an uninterrupted and complete inner lining of the entire pelvicalyceal system of the kidneys, the ureters, the urinary bladder and the proximal urethra.

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