1.1 Functional Anatomy of the Pelvic Floor and Lower Urinary Tract

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Key Message
Pelvic floor rehabilitation is dependent on a meticulous insight into relevant anatomy. Therefore, this chapter describes not only the anatomy of the organs and muscles involved but also their topography and innervation. Predominantly its focus is on functional anatomy. Besides other issues, the following questions, which are necessary for understanding pelvic floor function, are extensively discussed:

- How is the pelvic floor muscle (PFM) able to empower the urethral closure mechanism?
- What are the anatomical deficiencies related to the prevention of successful pelvic floor re-education?
- How are the pelvic organs kept in place?
- What is the anatomical deficit when stress urinary incontinence (SUI) or prolapse occurs?
- What is the mechanism of the anal sphincter unit?

Introduction
The bony pelvis lies in the middle of the human body. It supports the spinal column, which attaches to it posteriorly, and provides the points of articulation for the femur and the lower extremities. It cradles the abdominopelvic organs that rest above and within it; however, because the bony pelvis is only a hollow ring, its contents would plummet to the ground unless it had a bottom. The “pelvic floor” is the bottom of this pelvic container and includes all of the structures that lie between the pelvic peritoneum and the vulvar skin (Fig. 1.1.1).

Pelvic floor disorders are common, affecting one in nine women. They include pelvic organ prolapse, urinary incontinence, and anal incontinence. These are debilitating conditions that not only lead to medical problems and costs but are also associated with embarrassment that can lead to isolation, loss of independence, and diminished quality of life.

The levator ani muscles are the primary source of support for the pelvic organs. These muscles close off the pelvic floor, allowing structures that lie above them to rest on the upper surface of the muscle. This closure is usually remarkably effective; however, because of injuries and deterioration of the muscles, as well as of the nerves and connective tissue that support and control normal function, urinary incontinence, fecal incontinence, and pelvic organ prolapse can result.

Female incontinence is strongly associated with pregnancy, childbirth, and ageing. However, there is universal consensus that the pathophysiology of urinary incontinence and pelvic organ prolapse is multifactorial and incompletely understood. Incompetence of the sphincter mechanism, weakness of the muscles that support the urethra and bladder neck, overactive detrusor muscle, neurological disorders, injury during childbirth or other trauma, age-related changes in structural integrity, nervous control, hormone balance, and systemic disease have all been implicated as causative agents.
Increasing Age

A consensus also exists that the continence mechanism deteriorates over time. The prevalence of prolapse increases with age, and vaginal birth confers a 4–11 fold increase in the risk of developing pelvic organ prolapse that increases with higher parity. The deterioration of pelvic floor function may be acute, as with vaginal delivery. There may be recovery after that acute injury occurs, or there may be a gradual decline in function, especially with age. As graphically depicted in Figure 1.1.2, despite a repeatedly damaged continence mechanism, a patient is able to retain continence and compensate for the damage (blue line). Compensation is possible because the damage to the pelvic floor and the continence control system remain above the continence threshold.

An individual may begin with far less reserve (red line), and although the number and magnitude of the insults she suffers over time are no greater than in a women who remains continent, her initial low reserve level leads to incontinence over her lifespan.

Pregnancy and devastating damage to the pelvic floor because of a difficult delivery can lead to the loss of continence early in life, even if an individual was born with a “good” continence mechanism (black line). Little is known about the individual risk factors for incontinence and prolapse; therefore, it is difficult to identify women who are at risk.

Nulliparous women without known damage to the pelvic floor may also leak urine. In a series of studies, approximately 30% of young, nulliparous, healthy, athletic women experienced problems with incontinence. The sports producing the highest percentage of incontinence occurrence were gymnastics (67%) and basketball (66%). This suggests that there is a continence threshold that when exceeded can result in urine loss, even in the absence of known risk factors for incontinence.

**Figure 1.1.1.** Overview of pelvic anatomy. The pelvic floor extends between the two red areas (peritoneum and levator ani muscle). re = rectum, ut = uterus, bl = bladder, sy = pubic symphysis, va = vagina, and la = levator ani muscles.

**Figure 1.1.2.** Deterioration of pelvic floor function over a lifetime. Continence is achieved if the sum of all continence factors remains over the (imaginary) continence threshold (blue area). Events A and B (pregnancy/delivery) and ageing contribute to the deterioration of the continence mechanism (pelvic floor). Various scenarios are possible:

- **Blue line:** Despite the fact that the continence mechanism is repeatedly damaged, a patient is able to remain continent and compensate the damage.
- **Red line:** An individual may start with far less reserve initially, even though the number and magnitude of the insults she suffers over time are no greater than in women who remain continent. She has less reserve and, therefore, becomes incontinent during her life.
- **Black line:** Devastating damage as consequence of an acute insult (event A) can lead to loss of continence early in life, even if an individual was born with good continence factors.