Innervation of the Bladder (fig. 9.2 last lecture)

1- **Pelvic nerves** are the principal nerve supply the bladder, which connect with the spinal cord through the sacral plexus (S-2 and S-3) segments. Pelvic nerves contain both sensory and motor nerve fibers. The sensory fibers detect the degree of stretch in the bladder wall. Stretch signals from the posterior urethra are strong and mainly responsible for initiating the micturition reflex. The motor nerves of this reflex are parasympathetic fibers terminate on ganglion cells located in the wall of the bladder. Short postganglionic nerves then innervate the detrusor muscle.

2- The skeletal (somatic) motor fibers in the **pudendal nerve** that innervate and control the voluntary skeletal muscle of the external bladder sphincter.

3- **hypogastric nerves** are sympathetic fibers pass from L-2 segment of the spinal cord to the sympathetic chain to innervate bladder. They stimulate mainly the blood vessels and have little to do with bladder contraction. Some sensory nerve fibers also pass by way of the sympathetic nerves are important for sensation of fullness and pain.

Transport of urine from the kidney through the ureters and into the bladder

Urine has same composition of fluid flowing out of the collecting ducts. Urine flowing from the collecting ducts into the renal calyces stretches the calyces and increases their inherent pacemaker activity, which in turn initiates peristaltic contractions that spread to the renal pelvis and then downward along the length of the ureter, thereby forcing urine from the renal pelvis toward the bladder. The walls of the ureters contain smooth muscle and are innervated by both sympathetic and parasympathetic nerves as well as by an intramural plexus of neurons and nerve fibers that extends along the entire length of the ureters. The peristaltic contractions in the ureter are enhanced by parasympathetic stimulation and inhibited by sympathetic stimulation (Fig. 9.2). The normal tone of the detrusor muscle in the bladder wall tends to compress the ureter, thereby preventing back flow of urine from the bladder when pressure increase in the bladder during micturition. Each peristaltic wave along the ureter increases the pressure within the ureter so that the region passing through the bladder wall opens and allows urine to flow into the bladder.

The ureterorenal reflex

It is important reflex occur when a ureter becomes blocked (ureteral stone), intense reflex constriction occurs; associated with severe pain (the ureters are well supplied with pain nerve fibers). Also, the pain impulses cause a sympathetic reflex back to the kidney to constrict the renal arterioles, thereby decreasing urine output from the kidney with blocked ureter.

Micturition is the process by which the urinary bladder empties when it becomes filled. This involves two main steps: First, the bladder fills progressively until the tension in its walls rises above a threshold level; this elicits the second step, which is a nervous reflex called the micturition reflex.

The cystometrogram Fig. 10.1

The basal intravesicular pressure is about 0 when there is no urine in the bladder, but by the time 30 to 50 ml of urine has collected, this pressure rises to 5 to 10 cm of water. Collection of urine 200 to 300 ml, only a small rise in basal pressure; this is caused by intrinsic tone of the bladder wall (**plasticity**), so when the bladder fills, the tension increase but the radius increase as well. **Beyond 300 to 400 ml**, collection of more urine in the bladder causes the basal intravesicular pressure to rise rapidly.

The micturition waves (contractions) are the periodic acute superimposed increases in intravesicular pressure that last from a few seconds to more than a minute during filling of the bladder. The micturition waves may rise only a few cm of water up to more than 100 cm of water. The micturition waves caused by the micturition reflex and they are as dashed spikes in the cystometrogram.

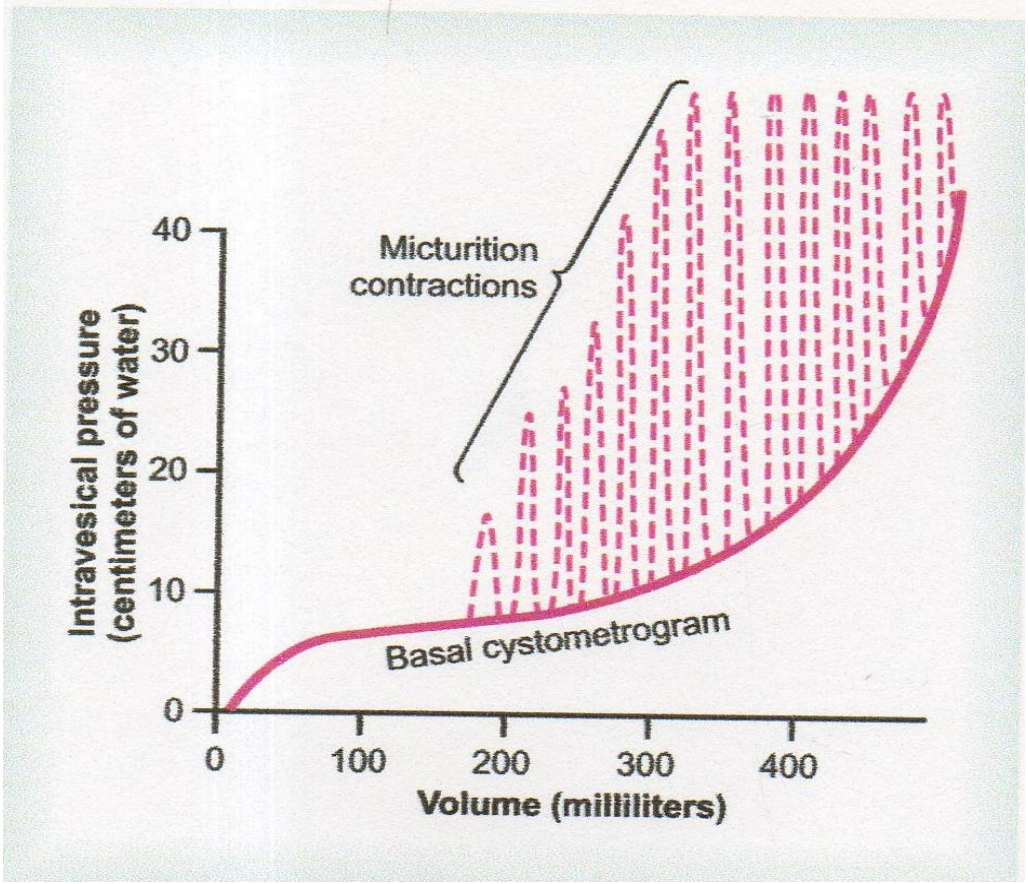

Figure 10.1 Normal cystometrogram, showing basal intravesical pressure & the micturition waves (dashed spikes)

Micturition Reflex

It is detrusor muscles contractions (micturition waves) due to a stretch reflex initiated by sensory stretch receptors in the bladder wall, especially by the receptors in the posterior urethra when this area begins to fill with urine at the higher bladder pressures. **The first urge** to void is felt at a bladder volume of about **150** ml and a **marked sense of fullness** at about **400** ml.

When the bladder is partially filled, these micturition contractions cease spontaneously & the bladder relax after a fraction of a minute and pressure falls back to the baseline. Once a micturition reflex begins, it is **"self-regenerative".**

Once a micturition reflex has occurred but has not succeeded in emptying the bladder, the nervous elements of this reflex usually remain in an inhibited state for a few minutes to 1 hour or more before another micturition reflex occurs. As the bladder continues to fill, the micturition reflexes become **more frequent** and cause **greater** contractions.

Once the micturition reflex becomes powerful enough, it causes another reflex, which passes through the pudendal nerves to the external sphincter to inhibit it. If this inhibition is more potent in the brain than the voluntary constrictor signals to the external sphincter, urination will occur. If not, urination will not occur until the bladder fills still further and the micturition reflex becomes more powerful.

Facilitation or inhibition of micturition by the brain

The micturition reflex is a **completely autonomic spinal cord reflex**, but it can be inhibited or facilitated by centers in the brain (pons & cerebral cortex).

Voluntary urination is usually initiated in the following way: First, a person voluntarily contracts his or her abdominal muscles, which increases the pressure in the bladder and allows extra urine to enter the bladder neck and posterior urethra under pressure, thus stretching their walls. This stimulates the stretch receptors, which excites the micturition reflex and simultaneously inhibits the external urethral sphincter. Ordinarily, all the urine will be emptied, with rarely more than 5 to 10 milliliters left in the bladder.