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NERVE SUPPLY OF PELVIC VISCERA — ANATOMICAL NOTES, CLINICAL IMPLICATION ON NERVE STIMULATION

Abstract: Aim: The aim of this study was to present review on pelvic plexuses in males and females with some referrals to clinical practice, specially to the methods including nerve stimulation.
Conclusions: Anatomy of pelvic plexuses is still confusing. Much attention should be paid to further studies on the arrangement of pelvic plexuses specially because of nerve stimulation techniques.

Key words: pelvic plexus, nerve stimulation, anatomy.

An understanding of the detailed anatomy of the pelvic sympathetic and parasympathetic nervous supply to pelvic viscera is essential in any consideration of function. Anatomy of human pelvic nerve plexuses still remains not very clear. The inferior mesenteric plexus is a mixed autonomic plexus which accompanies the inferior mesenteric artery. It receives the sympathetic postganglionic fibers from paravertebral sympathetic chain ganglia, through sacral splanchnic nerves and probably preganglionic sympathetic fibers from cell bodies located in L1–L3 segments of the spinal cord, which enter the plexus through lumbar splanchnic nerves [1]. The nerve plexus makes up two bundles which follow the anterior aspect of abdominal aorta to join up with one another opposite the aortic bifurcation, in front of the promontory to form the superior hypogastric plexus. Immediately opposite or below the level of the promontory the superior hypogastric plexus divides into two hypogastric (or presacral) nerves. The hypogastric nerves run anterior and lateral to the common iliac arteries, immediately on the surface of sacral promontory and outside the anterior (ventral) sacral foramina. They are located in the retroperitoneal fat [2]. On the inside they contact with the sigmoid and then with the rectum and plunge into the inferior hypogastric plexuses.

Inferior hypogastric (pelvic) plexus is a bilateral triangular structure, with a base located opposite the sacrum and the top directed anterior and inferior. You can distinguish three bilateral edges: a cranial edge positioned parallel to the

posterior edge of the internal iliac artery, a dorsal edge positioned at the point of contact with the roots of the sacral plexus, and a caudal edge, which extends from the fourth sacral root to the point of entry of the ureter into the posterior layer of the broad ligament. The inferior hypogastric plexus has also three angles: a superior angle which makes up the origin of the pelvic plexus following on from the unilateral hypogastric nerve, and anterior inferior angle which is located at ureter's point of entry into the posterior layer of the broad ligament, and a posterior inferior angle at the point of contact with the fourth sacral root. The anterior inferior angle of the inferior hypogastric plexus is in all cases at the ureter's point of contact where it perforates the posterior layer of the broad ligament [3]. The position of the inferior hypogastric plexus is variable. In the males it is positioned between the bladder and the rectum in about 73%; in remaining 27% it is placed in perirectal space. In the females the plexus is located mostly in the region of the sacrouterine ligament (in about 57% of cases); in next 30% it is located in the vicinity of the uterus; in 11% between the bladder and the rectum; finally in remaining 2% the plexus is located in the perirectal space [1–3].

Pelvic preganglionic parasympathetic neurons have cell bodies in the sacral spinal cord. Axons leave the spinal cord in ventral roots at levels S2–S4. This is species dependent. The preganglionic parasympathetic pelvic splanchnic nerves (*nervi erigentes*) arise by several rootlets from the anterior rami of the respective sacral segments. They pass forward as visible condensations, expanding into the inferior hypogastric plexus (left and right, also known collectively as the pelvic plexus), which also receives sympathetic component from the hypogastric nerves. In males pelvic plexus is lateral to the rectum, seminal vesicle, prostate, and the posterior part of the bladder; in females, each plexus is lateral to the rectum, uterine cervix, vaginal fornix and the posterior part of the bladder, extending into uterine broad ligament. Both sympathetic and parasympathetic components of the plexus run in a company of the viscerosensory fibers which are mostly derived from adjacent dorsal root ganglia.

The efferences of the inferior hypogastric plexus in the females lead into the vesicovaginal septum and the rectovaginal septum. The vaginal efferences come out at the top of the inferior hypogastric plexus, through branches leading to the bladder, the vagina, the uterus and the rectum [4], which originate in two trunks exactly underneath the crossing point of the ureter and the uterine artery. A lateral trunk, leading to the bladder, is located outside and underneath the ureter. At the point where the ureter leads into the wall of the bladder [5], it divides into two groups: a lateral group spreads out over the lateral and inferior wall of the bladder; a medial trigonal group heads towards the posterior lateral angle of the trigone and perforates the muscularis without ever directly reaching the vesical sphincter. The linear and medial distribution of these efferences towards the vesical trigone gives them an intimate relationship with the septum located between the bladder and the vagina, which separates it from the vaginal

ferences. The medial trunk leading to the vagina runs along the inferior edge of the uterine artery. At the point of contact with the superior part of the lateral edge of the vagina, it divides into two groups: anterior thin and posterior voluminous. The anterior group is distributed across the whole height of the vagina in a "fan" shape. It provides the innervation of the anterior 2/3 of the vagina.

The posterior group is located inside and underneath the ureter. Its branches perforate the posterior wall of the vagina and are distributed to the rectovaginal septum in a tooth comb pattern. Branches located further down, emerging from the inferior edge of the inferior hypogastric plexus, reach the rectum directly [6].

The efferences of the inferior hypogastric plexus in the males include three main pathways. They consist of fibers following bilaterally along the lateral aspect of seminal vesicles which supply the urinary bladder; rami which run lateral to the prostate and finally so called neurovascular bundle covered with Denonvillier's fascia [2, 7, 8] which runs posterior to the seminal vesicles, between the rectum and posterolateral surface of the prostate. Neurovascular bundle contains nerves which supply levator ani muscle, prostate and cavernous bodies of penis (cavernous nerves causing penile erection) [9].

CONCLUSIONS

In the males majority (73%) of positions of the inferior hypogastric plexus considers the space between the bladder and the rectum. The remaining 27% of inferior hypogastric plexuses are found within the perirectal space. Sympathetic postganglionic and preganglionic fibers are derived from hypogastric nerves and sacral and lumbar splanchnic nerves [10]. If we wish to stimulate:

a. rectum (or internal anal sphincter) the stimulator should be placed bilaterally at least at the level immediately below the sacral promontorium, on the ventral aspect of sacrum, immediately medial and below the level of aortic bifurcation. It should overlap then the hypogastric nerves or the bundles which run more centrally.

b. bladder (vesical trigone = internal urethral sphincter) the stimulator should be placed bilaterally at least at the level of the sacral midpoint, since through the respective ventral sacral foramina the nerves emerge from sacral canal which next join the hypogastric plexus and go lateral to the seminal vesicles. If possible one can place the stimulator immediately anterior to the rectum, lateral to the seminal vesicles, because in this position there are rising the efferences of the inferior hypogastric plexus which stimulate the bladder directly.

c. cavernous bodies of penis (causing erection) — the stimulator should be placed between the rectum and the posterolateral surface of the prostate.

In the females the distribution of the nerve fibers forming the inferior hypogastric plexus is more dispersed, however the most of the plexuses are located in the vicinity of the sacrouterine ligament, which is located in the rectouterine

pouch and extends between the ventral aspect and lateral borders of sacrum and the supravaginal portion of the uterine cervix. Remaining positions include regions in the vicinity of the uterus, space between the bladder and uterus, and the perirectal space.

To cause stimulation of the bladder one should place the stimulator at the point where ureter crosses the uterine artery (which is marked by the point of entrance of the uterine into the posterior lamina of the broad ligament).

However the rectal efferences of the plexus are poor defined. The rectal innervation in the females probably goes together with the fibers which innervate posterior wall of vagina. This is why we suggest an implantation of the stimulator as low as possible in the rectouterine pouch, posterior to the mesorectum or to place the stimulators similar to those described in the males.

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