Clinical anatomy of the pelvic floor

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Key words:pelvic floor, clinical anatomy

INTRODUCTION

The pelvic floor forms the supportive and caudal border of the human's abdominopelvic cavity. A detailed anatomical understanding of its complex architecture is mandatory for the pelvic floor surgeon (general surgeon, gynaecologist and urologist) and for fundamental mechanisms of anorectal as well as urogenital dysfunctions as different anatomical systems join here. The diagnosis and treatment of complex anorectal disorders, however, require a multidisciplinary approach.

Recent imaging techniques of the pelvic floor (dynamic and conventional magnetic resonance imaging, 3-D reconstruction of CT slices, endoanal and endorectal ultrasound) and plastination histology methods for processing pelvic floor specimens crucially support the pelvic floor surgeon to largely clarify the disposition of the muscular (anal sphincter complex, pelvic diaphragm) and the neurovascular components of the pelvic floor.

Developmental studies have revealed the differentiation of the pelvic connective tissue and the pelvic floor muscles thus jeopardizing the "classical" concepts and functional interpretations of the pelvic floor[1].

PELVIC CONNECTIVE TISSUE COMPARTMENTS

Anatomical preparations of the entire and untouched pelvic region of human fetuses and adults, CT and MRI, static or dynamic, transparent plastinated sections of the adult pelvis, plastination histology of fetal pelves and immunohistochemistry have demonstrated that the pelvic connective tissue can be divided into three compartments: *the anterior, middle and posterior compartment.* The posterior compartment can be subdivided into the presacral subcompartment with the presacral vessels and the perirectal subcompartment or mesorectum, which develops along the rectal vessels, nerves and lymphatics and is enveloped by the mesorectal or rectal fascia. The latter is crucial for rectal resection techniques and a powerful predictor for oncological outcome and local recurrence rate following treatment of rectal cancer. The anterior and middle compartments contain the urogenital organs with the middle only existing in the female. The border between the anterior respectively the middle compartment and the posterior compartment is formed by the perineal body caudally and the rectogenital septum or Denonvilliers' fascia cranially consisting of longitudinal smooth muscle fibres and dense connective tissue which serves as a guiding structure for the cavernous nerves arising from the autonomic inferior hypogastric plexus at the lateral pelvic wall, a borderline for limitation of the spread of malignancy and inflammation and a functional gliding sheath between urogenital organs and rectum enabling shortening and opening of the anal canal during defecation[2]. Recent PET-CT studies of the support system and continence function of the pelvic organs demonstrated the activity of smooth muscle bundles scattered throughout pelvic structural fat tissue and fascial structures like the rectogenital septum[3].

These findings highlight the supportive function of these muscle systems as well as their impact on continence function and defecation and refute the obsolete description of "lateral stalks" of the pelvic organs which definitely do not exist.

The anterior compartment contains the urinary organs like the bladder and the urethra as well as the prostate and the seminal vesicles in the male embedded in the paravisceral fat pad. The pubovesical and the puboprostatic ligaments are considered part of the pelvic fascia originating from the back of the pubic bone which course in dorsocranial direction attached to the capsule of the prostate in the male and the anterior wall of the urinary bladder in the female. Longitudinal smooth muscle bundles also termed the pubovesicalis share the same course towards the neck of the bladder where they intermingle with the longitudinal muscle fibres of the neck of the bladder, bending downwards and forming a ventral coverage of the urethra. We hypothesized a similar function of these muscle fibres in terms of shortening and opening of the urethra during micturition with that of the longitudinal smooth muscle bundles within the rectogenital septum. These originate from the longitudinal layer of the muscle coat of the rectum dividing up at the level of the anorectal junction and coursing downwards in intersphincteric position as the longitudinal anal muscle on the one hand and forming a ventral coverage of the external anal sphincter muscle on the other hand with both terminating at the perineal body. The latter builds up the rectogenital septum and - similar to the pubovesicalis - the muscular components of the rectogenital septum are proposed an active element in shortening and opening of the anal canal during defecation.

THE ANAL SPHINCTER COMPLEX

The anal sphincter complex consists of the striated puborectalis muscle sling and the external anal sphincter which is divided into a deep, anorectal and a superficial, subcutaneous portion and the smooth internal anal sphincter and the longitudinal anal muscles. The latter form continuations of the circular and the longitudinal layers of the muscle coat of the rectum. From a developmental point of view it is crucial to notice that the dentate line does not indicate the strict borderline between the hindgut as part of the embryological entoderm and the anal canal which forms a kind of inversion of the surface ectoderm. Both the longitudinal anal and the internal anal sphincter muscles course downwards to the perineal level far beyond the dentate line, where the subcutaneous portion of the mesodermal external anal sphincter muscle turns inwards and forms a muscular continuum with the smooth longitudinal anal muscle. The bilaterally organized somatic external anal sphincter muscle can be best studied in 3-D reconstructions of histological sections as demonstrated by Fritsch et al.[4]. At the anorectal level above the perineum this muscle is continuous with the puborectalis muscle dorsally, but is not a completely circular muscle in ventral position. This is the explanation for the higher risk of internal anal sphincter tears during vaginal child birth with consecutive incontinence episodes due to the missing external anal sphincter in midline position.

ARTERIAL BLOOD SUPPLY OF THE ANORECTUM

The anal sphincter complex is rounded off by the corpus cavernosum recti (CCR), an arteriovenous network without interposition of a capillary system, being located in the anorectal submucosa above the dentate line at about 3 to 5 cm from the anal verge. The arterial blood supply of the CCR originates from the terminal branches of the superior rectal artery. Some course longitudinally in the submucosa downward to the CCR. Others pierce the rectal wall nearly in a horizontal plane to reach the CCR. These vessels can be demonstrated with color Doppler ultrasonography. On the one hand these transmural branches of the superior rectal artery play an essential role for the blood supply of the CCR and consequently suggest an additional effect on the pathogenesis of hemorrhoids. We could detect morphological changes of the terminal branches in patients with hemorrhoids[5]. Our morphological data provide strong evidence that the hyperplasia of the arterial branches of the CCR might be an explanation for the remarkable recurrent rate and postoperative hemorrhage following hemorrhoidopexy procedures. On the other hand these arterial branches seem impossible to be reached by submucous hemorrhoidal artery ligation techniques (like HAL) due to their course.

In general the subdivision of male and female pelvic connective tissue is identical, an endopelvic visceral fascia does not exist, striated as well as smooth muscles are supportive elements of the pelvic floor and sexual difference in the morphology of the muscular components already exist in early fetal stages. Thorough knowledge of the topographical relationships between the different organ systems, neurovascular structures and connective tissue compartments of the pelvic floor is therefore indispensable for clinical application to improve and optimize surgical treatment both for benign and malignant conditions.

SUMMARY

KLINIČKA ANATOMIJA PELVIČNOG PODA

Pelvični pod predstavlja kaudalnu granicu abdominopelvične duplje. Detaljno znanje i razumevanje kompleksne gradje i funkcije pelvičnog poda je neophodno za sve hirurge koji se bave pelvičnim podom (opšti hirurzi, ginekolozi i urolozi).

Za postavljanje dijagnoze i za adekvatno lečenje kompleksnih anorektalnih oboljenja neophodan je multidisciplinarni pristup. Nove imaging dijagnostičke procedure (dinamična i konvencionalna magnetna rezonanca, CT sa 3-D rekonstrukcijom, endoanalni i endorektalni ultrazvuk) i nove histološke metode za ispitivanje operativnih preparata pružaju hirurzima veliku pomoć u nastojanju da se prezerviraju analni sfinkteri, mišići i neurovaskularni elementi pelvičnog poda.

Savremene studije o razvoju tkiva su pružile nova saznanja o razvoju vezivnog tkiva i mišića pelvičnog poda ugroavajući klasične koncepte shvatanja anatomije i funkcije mišića pelvičnog poda.

Key words: pelvični pod, klinička anatomija, funkcionalno ispitivanje

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