Urodynamics, Neurourology and Pelvic Floor Dysfunctions

Antonio Carbone
Giovanni Palleschi
Antonio Luigi Pastore
Aurel Messas *Editors*

Functional Urologic Surgery in Neurogenic and Oncologic Diseases

Role of Advanced Minimally Invasive Surgery

Springer

Urodynamics, Neurourology and Pelvic Floor Dysfunctions

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“To our beloved lifelong companions and children, whose love, patience and constant support make every of our efforts a success”

Foreword

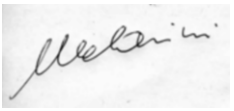
Functional surgery in oncologic and neuro-urological patients is one of the hardest tasks for urologists. The search for the ideal bladder replacement began as early as 1855 when Tuffier reported his experience with ureterosigmoidostomy. The use of isolated bowel segments started to be investigated in the 1950s. In the following decades, detubularization and reconfiguration optimized functional results in terms of low-pressure reservoir with good neo-bladder capacity. Open surgery is routinely adopted. In this book, authors report advanced minimally invasive surgical options using laparoscopy or robotics. Such new approaches have been shown efficacy with low risk of adverse events in the short and medium follow-up. These promising outcomes should be confirmed in the long term and possibly improved by means of further technological innovations and surgical experience.

Despite the amelioration of surgical techniques, stress urinary incontinence (SUI) is still a prevalent complication after radical prostatectomy or radical hysterectomy. This issue is taken into account by authors reporting mini-invasive solutions in both genders.

An overview of neurogenic dysfunctions and their specific treatment also in complicated clinical patterns such as the presence of pelvic floor pain and concomitant anatomical bladder outlet obstruction in chronic or progressive neurological disease is described in detail.

Bladder augmentation is the last option in the management of neurological patients with high risk of upper urinary tract deterioration. In neurological population, the primary aim is to achieve a low-filling-pressure high-capacity reservoir, as the voiding phase is obtained by self-intermittent catheterization. Entero-cystoplasty remains the gold standard despite being associated with multiple complications, such as metabolic disorders, calculus formation, mucus production, enteric fistulas, and potential for secondary malignancy. Clearly, this is an area of unmet needs and search for novel solutions.

Editors and authors are to be commended for their efforts to outline contemporary reconstructive functional urologic surgery.



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Preface

This second book of the Italian Urodynamic Society (SIUD) addresses functional aspects of the lower urinary tract. In particular, this manuscript presents preventive measures in oncological patients who have undergone demolitive surgery with the use of new robotic and/or laparoscopic technology, as well as new minimally invasive techniques for reconstruction or functional recovery. Interestingly, for some aspects, the approach for recovering micturition control is similar in oncological and neurological patients as reported in the second part of the book. On behalf of SIUD, we believe to have provided a precious contribution, thanks to the editors and all authors who are internationally known as experts on this field, to interested readers who want to understand more functional urological surgery and who want to get ideas for implementing their knowledge about current or developing minimally invasive surgical procedures in functional urology. In closing, special thanks go to all coauthors who contributed to the fulfillment of this project.

I hope you will enjoy reading.

Florence, Italy — Giulio Del Popolo

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Part I

Functional Urologic Surgery in Oncologic Patients

Functional Anatomy of Pelvic Organs

1

Guido Carpino, Vincenzo Petrozza,
and Samer Fathi Al-Rawashdah

1.1 Pelvic Cavity

The abdominopelvic cavity consists of the circular true (lesser) pelvis, wherein the urogenital organs lie, and the false (greater) pelvis which corresponds to the iliac fossae and is largely in contact with intraperitoneal contents.

The limit between true and false pelvis is represented by the pelvic inlet, a plane passing through the promontory of the sacrum, the arcuate line on the ilium, the iliopectineal line, and the posterior surface of the pubic crest [1].

The walls of the true pelvic cavity consist of sacrum and bony pelvis, ligaments interconnecting these bones, and the muscles lining their inner surfaces. Inferiorly, the pelvic outlet of the true pelvis is closed by the pelvic diaphragm (floor) which is a muscular partition formed by the levator ani and coccygei muscles. The lateral walls of the true pelvis are composed of the bony pelvis and the obturator internus and piriformis muscles.

The anterior and posterior iliac spines, the iliac crests, the pubic tubercles, and the ischial tuberosities are palpable landmarks that orient the pelvic surgeon [2].

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1.2 Pelvic Muscles

The pelvic muscles form two groups: the first group is represented by piriformis and obturator internus which are also considered lower limb muscles and form the lateral wall of true pelvis; the second group is represented by levator ani and coccygeus which form the pelvic diaphragm and outline the lower limit of the true pelvis.

Piriformis forms part of the posterolateral wall of the true pelvis [1]: proximally, it is attached to the anterior surface of the sacrum, then passes out of the pelvis through the greater sciatic foramen, and attaches to the greater trochanter of the femur. The anterior surface of piriformis is related, inside the pelvis, to the rectum and to the sacral plexus of nerves and branches of the internal iliac vessels, while the posterior surface lies against the sacrum. *Obturator internus* forms part of the anterolateral wall of the true pelvis [1]. It is attached to the structures surrounding the obturator foramen and to the medial part of the pelvic surface of the obturator membrane; it leaves the pelvis through the lesser sciatic foramen and attaches to the trochanteric fossa of the femur. Ischiococcygeus (or coccygeus) represents the most posterosuperior portion of pelvic floor and arises as a triangular musculotendinous sheet with its base attached to the lateral margins of the coccyx and sacrum and its apex to the ischial spine and sacrospinous ligament. *Levator ani* forms a large portion of the pelvic floor and is attached to the internal surface of the true pelvis. The muscle is subdivided into iliococcygeus, pubococcygeus, and puborectalis. Levator ani arises from each pelvic sidewall along the tendinous arch of levator ani (the condensation of the fascia of the obturator internus). *Iliococcygeus* forms the lateral portion of the levator ani attached to the inner surface of the ischial spine and to the tendinous arch of levator ani while, medially, it is attached to the lateral margins of the coccyx and to the anococcygeal ligament. *Pubococcygeus* represents the medial portion of the levator ani and is attached to the back of the body of the pubis and passes back almost horizontally. The most medial fibers run directly lateral to the urethra and its sphincter as it passes through the pelvic floor; here the muscle is named the puboperinealis, although due to its close relationship to the upper half of the urethra in both sexes it is often referred to as pubourethralis. The muscle fibers from both sides form part of the urethral sphincter complex together with the intrinsic striated and smooth musculature of the urethra where fibers intersect across the midline directly behind the urethra. Then, the medial fibers run posteriorly and reach the anorectal junction and the deep part of the external anal sphincter, thus forming the puborectalis muscle. Posterior to the rectum, the fiber of the pubococcygeus crosses the midline forming a fibrous raphe, the anococcygeal ligament, which is attached to the coccyx.

1.3 Pelvic Fascias

The pelvic fascia is divided into the parietal pelvic fascia, which forms the coverings of the pelvic muscles, and the visceral pelvic fascia, which forms the coverings of the pelvic viscera and their vessels and nerves [1].

Parietal pelvic (endopelvic) fascia consists of the obturator fascia, the piriformis fascia, the levator ani fascia (superior fascia of pelvic diaphragm), and the presacral fascia. The *obturator fascia* is connected above to the posterior part of the arcuate line of the ilium and is continuous with iliac fascia. Anterior to this, as it follows the line of origin of obturator internus, it is gradually separated from the attachment of the iliac fascia and a portion of the periosteum of the ilium and pubis spans between them. It arches below the obturator vessels and nerve, investing the obturator canal, and is attached anteriorly to the back of the pubis. Behind the obturator canal, the fascia is markedly aponeurotic and gives a firm attachment to levator ani, called the tendinous arch of levator ani. *Piriformis fascia* fuses with the periosteum on the front of the sacrum at the margins of the anterior sacral foramina where it enchases the sacral anterior primary rami. *Levator ani fascia (superior and inferior fascia of pelvic diaphragm)* covers both the surfaces of the pelvic diaphragm. On the lower surface, the thin inferior fascia is continuous with the obturator fascia laterally below the tendinous arch of levator ani. It covers medially the wall of the ischioanal fossa and extends below to give fasciae on the urethral sphincter and external anal sphincter. On the upper surface, it is attached anteriorly to the back of the body of the pubis and extends laterally across the superior ramus of the pubis, blending with the obturator fascia and continuing to the spine of the ischium. *Presacral fascia* forms a hammock-like structure behind the posterior portion of the rectal fascia and extends laterally to the origin of the piriformis and levator ani fasciae. Inferiorly, it reaches the anorectal junction, fusing with the posterior aspect of the rectal fascia and the anococcygeal ligament at the anorectal junction level. Superiorly, it can be followed to the origin of the superior hypogastric plexus.

Visceral pelvic fascia is formed from thickenings of connective tissue, which are closely associated with the pelvic viscera to which it relates and with the neurovascular structures related to those organs. In its most inferior and lateral extent, the visceral pelvic fascia is closely related to, and derives from, the superior fascia over the attachment of levator ani, whereas, more superiorly and posteriorly, it is derived from part of the piriformis fascia [1].

The visceral pelvic fascia covers the pelvic organs including prostate, bladder, and rectum. Therefore, visceral pelvic fascias composed of individual organ fasciae (e.g., rectal fascia, prostatic fascia) and connective sheets between pelvic organs (e.g., rectoprostatic or rectovaginal fasciae) or linking pelvic organs with pelvic walls (e.g., pubovesical ligaments). The pubovesical (or puboprostatic) ligaments are paired fibrous bands originating from visceral fascia, stretching from the posterior surface of the pubic bone adjacent, to the urethral sphincter, and to the ventral prostate. They stabilize the prostate, urethra, and urinary bladder representing a part of the "suspensory system" of the continence mechanisms.

On the lateral sidewalls of the pelvis, the parietal and the visceral pelvic fascia are fused at the level of the prostate and bladder; this fusion is named the fascial tendinous arch of the pelvis and extends from the pubovesical ligaments to the ischial spine. During surgery, access to the prostate may be gained by incision of the pelvic fascia either medial or lateral to this fusion. The incision of the pelvic fascia lateral to the tendinous arch of the pelvis leaves levator ani fascia adherent to the

prostate and the levator ani muscle bare. Differently, when the pelvic fascia is incised medial to the tendinous arch, the levator ani fascia is not separated from the levator ani muscle fibers and the prostate remains covered only by its visceral (prostatic) fascia.

1.4 Perineum

The perineum is a diamond-shaped region located below the pelvic floor, between the inner aspects of the thighs and anterior to the sacrum and coccyx [1]. It is bounded anteriorly by the pubic symphysis and its arcuate ligament, posteriorly by the coccyx, anterolaterally by the ischiopubic rami and the ischial tuberosities, and posterolaterally by the sacrotuberous ligaments. The deep limit of the perineum is the inferior surface of the pelvic diaphragm and its superficial limit is the skin. A line drawn through the ischial tuberosities divides the perineum into an anal triangle, which faces downwards and backwards, and a urogenital triangle, that faces downwards and forwards.

Anal triangle is similar in males and females where the main difference is the wider transverse dimension of the triangle in females as a result of the larger size of the pelvic outlet. The anal triangle contains the anal canal with its sphincters and the ischioanal fossa with its contained nerves and vessels.

Urogenital triangle is posteriorly delimited by the interischial line which overlaps the posterior border of the transverse perineal muscles. Anteriorly and laterally, it is delimited by the symphysis pubis and ischiopubic rami. In males, the urogenital triangle expands superficially to the scrotum and to the root of the penis. In females, it extends to the lower limit of the labia and mons pubis. The urogenital triangle is divided into two parts by the perineal membrane, a triangular membrane attached laterally to the ischiopubic rami with its apex attached to the arcuate ligament of the pubis. *Deep perineal pouch* is bounded deeply by the inferior fascia of the pelvic floor and superficially by the perineal membrane. Between these two layers lie the deep transverse perinei, superficial to the urethral sphincter mechanism and puborethralis, and in females superficial to the compressor urethrae and sphincter urethrovaginalis.

1.5 Pelvic Circulation (Arteries, Veins, Lymphatics)

1.5.1 Arteries

Common iliac arteries separate at the level of the sacroiliac joint into external and internal iliac arteries. *Internal iliac arteries* divide into an anterior trunk and a posterior trunk. Anterior to the artery is located the ureter and, in females, the ovary and fimbriated end of the uterine tube, while posterior to it are the internal iliac vein, the lumbosacral trunk, and the sacroiliac joint.