Female Urology, Urogynecology, and Voiding Dysfunction

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Preface

There has been a convergence of the sub-specialties of female urology and urogynecology over the last several years. This development has resulted in improved care for women, as we have had to “escalate” our own knowledge and abilities. Recently, we have even seen fellowship training transcend towards this multidisciplinary goal by the creation of joint accredited fellowship programs in female urology and urogynecology. These programs have as their primary aim to create the thought leaders of tomorrow in women’s health by creating a unique group of physicians who see the “whole” patient and can treat them accordingly. It is evident that there is a strong need for more subspecialization in the field with the aging population and prevalence of incontinence and pelvic floor disorders that is present worldwide. This book speaks to the combined nature of our practices that has emanated from this approach.

We have sought to have some of the top thought leaders and experts from around the world to contribute to this publication. Furthermore, these authors embody some of the exact principles, which establish our sub-specialties as being progressive and forward thinking in their approaches to the various disease processes and disorder that we treat. One of the prevailing undertones of our book speaks to the fact that there are many ways in which to treat any single disorder. We have, therefore, had several chapters written by physicians or subspecialists who may do things differently to present contradictory views. The purpose is more than to be controversial, but rather to give an entrance point for those wishing to advance the field and aim for the utopian dream of literal cures for incontinence and other women’s disorders.

We all have much to learn in this area of urinary incontinence and pelvic floor disorders. It is our hope that this book will help to build on the currently existing framework and provide a platform towards better understanding of the disease processes that affect so many of our patients.

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Introduction

Times have changed and so should our intellectual basis for the management of diseases and conditions. Once thought of as an anatomic structure containing disparate and unrelated viscera, the human pelvis is now appreciated as a functional syncytium as complex as any within the human body. The dysfunctions of urinary, genital, and gastrointestinal elements which constitute this complex functional-anatomic arrangement require comprehensive and inclusive management strategies.

None of us is capable of mastering the vagaries of function and structure of all the elements of the human pelvis and therefore it is requisite that expertise be drawn from collaborative fields of endeavor so that as complete a management schema as is possible be developed. Additionally, the very real superimposition of behavioral, vascular and neurologic dysfunctions further make the inclusive “team” approach concept a mandatory one. This textbook represents a superb example of the inclusive approach for management. The interaction between colorectal (and gastroenterologic), urogynecologic, and urologic specialists can and does produce the best possible outcome for individual patients as well as for entire populations of individuals.

The concept of pelvic medicine remains not only viable, but one that reflects the aforementioned global interaction and collaboration of similarly motivated specialists whose primary concern is the attainment of the best outcome possible for women severely afflicted by conditions which are disruptive and destructive to quality of life and, in some cases, to well being and life expectancy. This book should be viewed in the context of intellectual instruction and exchange which will make the pelvic medicine endeavor that much more successful from both the patient and medical standpoint. The editors of the authors of the text represent the best and their achievement should serve as a model for subsequent efforts in cross specialty collaboration and, possibly more importantly, harmony.

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Introduction

Over the last 10 years, all of you who care for women in your practice have been impressed with the increasing call to provide services for urinary incontinence and pelvic organ prolapse. These pelvic floor disorders are becoming more prevalent within our practices as the number of women in the age groups most affected by these disorders increases. Also, women now coming into these age groups have a more proactive approach to their own health care than did their mothers and their sophistication and expectations demand optimal care.

It is estimated that the demand for pelvic floor disorders care will double in the next 25 years. This increasing demand combined with the remarkable growth in high quality research is both encouraging and intimidating. Intimidating in that as we learn more, we realize how much more we have to learn and encouraging as we watch great strides in both basic science and outcomes research take hold.

This text embraces one of the fundamental concepts that leaders within both female urology and urogynecology have come to understand—that women with pelvic floor disorders are best served by an approach that acknowledges the wisdom and experience of both of these developing subspecialties. Thus, these varied accounts by divergent authors give the reader the opportunity to consider these issues from many points of view. This will inevitably lead to a richness of understanding that a single doctrine could not provide.

As we face the challenge of training our residents, fellows and colleagues, we will come to appreciate this text as an excellent resource and frequent reference. These in depth discussions of both basic and complex components of Female Urology, Urogynecology and Voiding Dysfunction offer us an opportunity to both reflect and to look forward. As all involved in research and providing care in this growing field combine forces, the wisdom and philosophy embodied in this work will enable us to expand the foundation of physicians able to join in the process toward the ultimate goal of improving the quality of the care that these women receive.

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Anatomy of Pelvic Support

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I. INTRODUCTION

Female pelvic anatomy is a complex combination of muscles, ligaments, nerves, and blood vessels that act dynamically to provide support for the urethra, bladder, uterus, and rectum. An understanding of normal mechanisms of pelvic support are essential in the evaluation of women with voiding complaints, urinary incontinence, and bowel dysfunction related to pelvic floor relaxation. Thus, the treatment of female urinary incontinence often involves recognition and treatment of concurrent pelvic pathophysiology such as cystocele, uterine prolapse, enterocele, rectocele, and perineal laxity. Identification of the various components of pelvic floor dysfunction is aided by diagnostic tools such as video urodynamics and magnetic resonance imaging of the pelvis. This chapter will focus on normal female pelvic anatomy, including the supporting structures relevant to voiding dysfunction and incontinence, as well as the pathophysiology of pelvic floor relaxation, with a description of the various components of pelvic organ prolapse.

II. PELVIC SUPPORTING STRUCTURES

A. Bone

Passive support of the pelvic floor is provided by the bony structures, which act as anchors for the important muscular and fascial structures comprising the pelvic floor. The pubic rami, ischial spines, and sacrum represent the anchoring points of the true bony pelvis, which is made up of pubis, ilium, ischium, sacrum, and coccyx (1). The pelvic floor is diamond-shaped with the pubic symphysis and sacrum at the anterior and posterior apices while the ischial spines serve as lateral anchors. The pelvic floor can be further subdivided into anterior and posterior compartments by drawing a line between the two ischial spines.

B. Ligaments

The sacrospinous ligaments span the posterior portion of the pelvic floor, from the ischial spines to the anterolateral aspect of the sacrum and coccyx. The coccygeus muscle is found between the

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ischial spines and the lateral aspect of the sacrum and coccyx, overlying the sacrospinous ligament and is an important landmark in vaginal surgery. Above the coccygeus muscle lies the sciatic nerve and its plexus, while the pudendal nerve and vessels lie lateral (Alcock’s canal). Medially, the sacrospinous ligament fuses with the sacrotuberous ligament (2). Anteriorly, the tendinous arc, a curvilinear condensation of pelvic fascia arising from the obturator internus muscle, runs between the ischial spines and the lower portion of the pubic symphysis. This crucial structure provides a musculofascial origin for the majority of the anterior pelvic diaphragm, allowing its attachment to the bony pelvis. The arcus tendinous flanks the urethra and bladder neck anteriorly and rectum posteriorly, providing lateral attachment of the pelvic diaphragm and its ligaments (1).

The perineal body is a tendinous structure located in the midline of the perineum between the anus and the vaginal introitus, which provides a central point of fixation for the transverse perineal musculature (3). This anchoring site provides a second level of pelvic support to the posterior vaginal wall and rectum, incorporating the levator ani and transverse perineal musculature as well as the external anal sphincter.

C. Musculature

The striated musculature comprising the pelvic floor acts as a supporting structure for the visceral contents of the abdominopelvic cavity as well as a dynamic organ involved in maintenance of urinary and fecal continence. The pelvic diaphragm is composed of the levator ani and coccygeus muscles. The levator ani muscle group and its fascia provide the most critical support for the pelvic viscera, acting as the true muscular pelvic floor. The levator ani group is composed of the pubococcygeus, ischiococcygeus, and iliococcygeus, named according to their origin from the pelvic sidewall (4). This broad sheet of muscular tissue extends from the undersurface of the pubic symphysis to the pelvic surface of the ischial spines, taking origin from the tendinous arc laterally. The anterior muscle group, primarily made up of pubococcygeus (puborectalis) with its overlying endopelvic fascia, directly attaches to the bladder, urethra, vagina, uterus, and rectum, actively contributing to visceral control (Fig. 1). This important muscular support mechanism is crucial during times of suddenly increased intra-abdominal pressure (1).

The posterior muscle group consists of the posterior portion of the levator ani and the coccygeus muscle. Their points of origin include the more posterior portions of the tendinous arc and the ischial spines. The two sides fuse in the midline posterior to the rectum and attach to the coccyx. This plate of horizontal musculature spans from the rectal hiatus to the coccyx and allows maintenance of the normal vaginal and uterine axis. The upper vagina and uterine cervix lie on this horizontal plane created by the levator plate. This posterior muscle group is active at rest and contracts further during rectus abdominis contraction, maintaining proper vaginal axis (1).

Midline apertures in the levator ani group, collectively referred to as the levator hiatus, allow passage of the urethra, vagina, and rectum. Adjacent fascial attachments provide support to these pelvic viscera as they exit the pelvis, fashioning a “hammock” of horizontal support (5). The bladder, proximal vagina, and rectum rest on the levator floor and become coapted against it during periods of increased intra-abdominal pressure. Resting tone of the levator muscle, as well as reflex and voluntary contraction, acts to pull the vagina and rectum forward, thereby preventing incontinence of both urine and stool. These active mechanisms of pelvic floor support maintain both urinary and fecal continence.
III. ANTERIOR VAGINAL SUPPORT

The fascia overlying the pelvic floor musculature plays a critical role in pelvic support. The abdominal portion of the fascia is referred to as endopelvic fascia and represents a continuation of the abdominal transversalis fascia (1). The levator ani muscle is covered superiorly and inferiorly by a fascial layer (Fig. 2). The two fascial layers split at the levator hiatus to cover the pelvic organs that traverse it. The superior or intra-abdominal segment (endopelvic fascia) and the inferior or vaginal side of the levator fascia together constitute the pubocervical fascia in the classical anatomic descriptions. This levator fascia is divided into discrete areas of specialization, depending on the associated organ it supports. The specialization of levator fascia around the urethra, the pubourethral ligament, represents a fusion of the perirethral fascia and endopelvic fascia attaching to the tendinous arc. The levator fascia associated with the bladder, the vesicocervical ligament or fascia, represents the fusion of perivesical and endopelvic fascia attached to the tendinous arc. Such condensations of the endopelvic fascia create “ligamentous” structures that support the pelvic viscera, such as the pubourethral ligaments, urethropelvic ligaments, pubocervical fascia, and cardinal and uterosacral ligaments (Fig. 3). These represent discrete supportive structures that are part of a continuum of connective tissue surrounding the pelvic organs and serve as important surgical and physiologic landmarks. An understanding of their individual contribution to pelvic visceral support is essential in reconstructive surgery. Therefore, these four fascial structures will be discussed in detail as a basis for understanding the pathophysiology of pelvic organ prolapse.
A. Pubourethral Ligaments

The pubourethral ligaments are a condensation of levator fascia connecting the inner surface of the inferior pubis to the midportion of the urethra. They provide support and stability to the urethra and its associated anterior vaginal wall. These ligaments divide the urethra into proximal and distal halves; the proximal or intra-abdominal portion is responsible for passive or involuntary continence. The striated external urethral sphincter is located just distal to the pubourethral ligaments so that the midurethra becomes primarily responsible for active or
voluntary continence. The distal one-third of urethra is simply a conduit and does not significantly change continence when damaged or resected. Weakening or detachment of the pubourethral ligament causes separation of the urethra from the inferior ramus of the pubic symphysis. This pathologic process has an unclear role in continence.

B. Urethropelvic Ligaments

The urethropelvic ligaments are composed of a two-layer condensation of levator fascia, which provides the most important anatomic support of the bladder neck and proximal urethra to the lateral pelvic wall (Fig. 4). The first layer is known as the periurethral fascia (vaginal side) and is located immediately beneath the vaginal epithelium, apparent as a glistening white layer surrounding the urethra. The second layer of the urethropelvic ligament consists of the levator fascia covering the abdominal side of the urethra (endopelvic fascia), which fuses with the periurethral fascia. The two layers attach as a unit to the tendinous arc of the obturator fascia along the pelvic sidewall (Fig. 5). These lateral fusions of the levator and periurethral fascia provide important, elastic musculofascial support to the bladder outlet, thereby maintaining passive continence in women. Voluntary or reflex contractions of the levator or obturator musculature increase the tensile forces across these ligaments, increasing outlet resistance and continence. Thus, these ligamentous structures are critically important in the surgical correction of stress incontinence.

C. Pubocervical Fascia (Vesicopelvic Ligament)

The pubocervical fascia is a continuous sheet of connective tissue support from pubic symphysis to cervix, including the periurethral, perivesical, and endopelvic fascia, which fuse to support the bladder to the lateral pelvic wall (Fig. 6). It is formed by the fusion of fascia from the bladder wall and anterior vaginal wall in the region of the bladder base. It is continuous distally with the periurethral fascia and proximally with the uterine cervix and cardinal ligament complex. This fascial condensation, sometimes referred to as the vesicopelvic ligament, fuses laterally with the

Figure 4  Schematic diagram demonstrating the urethropelvic ligaments, a two-layer condensation of levator fascia which envelops the urethra and surrounding neurovascular structures and attaches to the lateral side wall.
endopelvic fascia, attaching to the pelvic sidewall at the tendinous arc and supporting the bladder base and anterior vaginal wall (Fig. 7). Attenuation of this lateral bladder support results in a lateral cystocele defect (paravaginal).

IV. UTERINE AND VAGINAL VAULT SUPPORT

The cardinal ligaments are thick, triangular condensations of pelvic fascia that originate from the region of the greater sciatic foramen. They insert into the lateral aspects of a fascial ring encircling the uterine cervix and isthmus as well as the adjacent vaginal wall, providing important uterine and apical vaginal support. In addition, the cardinal ligaments are an important mechanism of support for the bladder base and can be seen extending to the perivesical fascia. It is often difficult to differentiate the two structures surgically, and sharp dissection is required. These ligaments contain numerous blood vessels branching from the hypogastrics that supply the uterus and upper vagina (1). The cardinal ligaments fuse posteriorly with the uterosacral ligaments (sacrouterine), which stabilize the uterus, cervix, and upper vagina posteriorly toward the sacrum. They originate from the second, third, and fourth sacral vertebrae and insert into the posterolateral aspect of the pericervical fascia and lateral vaginal fornices (6). The fascial unit comprising cardinal ligaments, uterosacral ligaments, and pubocervical fascia spreads out posterolaterally on each side of the vaginal apex, uterus, and cervix to the pelvis (7).

The broad ligaments provide additional uterine support and are located more superiorly, covered by anterior and posterior sheets of peritoneum. They attach the lateral walls of the uterine body to the pelvic sidewall and contain the Fallopian tubes, round and ovarian ligaments, and uterine and ovarian vessels.
Figure 6  Schematic diagram of the vaginal fascial condensations from the pubic symphysis to the cervix, including the periurethral fascia, perivesical fascia, and cardinal ligaments. This continuous sheet of fascial support is also known as the pubocervical fascia.

Figure 7  Schematic diagram of the vesicopelvic ligament, the fascial condensation providing lateral support to the bladder base and anterior vaginal wall.