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Sources and streams of multidisciplinary pelvic floor practice: Development and interdisciplinary application of integral theory system (ITS)

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ABSTRACT

Since Professor Petros introduced the Integral Theory in 1990, this framework has evolved continuously, undergoing over three decades of clinical refinement to become a structured, systematic approach. Despite the significant clinical value it has shown in treating pelvic floor disorders, many practitioners in the field still have a limited understanding of its core principles. This article traces the development of integral theory system, examines its interdisciplinary challenges and opportunities, and highlights the central role of ligament repair, muscle balance, and neural regulation in treating pelvic floor disorders. By promoting interdisciplinary collaboration and advancing clinical applications, this article aims to foster the comprehensive development of pelvic floor medicine.

Keywords: Integral theory system; interdisciplinary cooperation; ligament repair; muscle balance; neural modulation

INTRODUCTION

Pelvic floor dysfunction is a complex issue impacting the health of millions of women worldwide. The diversity and intricacies of this condition have drawn considerable research attention over the past few decades. Traditional treatments often focus on addressing individual anatomical structures, frequently overlooking the interconnected and multi-level functionality of the pelvic floor as a whole. In 1990, Professor Petros introduced the Integral Theory, which states, “Prolapse, urinary stress, urge symptoms, abnormal bowel and bladder emptying, and certain forms of pelvic pain primarily arise from vaginal laxity or weakened supporting ligaments due to altered connective tissue”. This theory reframed the understanding of pelvic floor anatomy by emphasizing the synergistic roles of ligaments, muscles, fascia, and nerves. Since then, treatment approaches for pelvic floor disorders have shifted from single-disciplinary interventions to more comprehensive, multidisciplinary collaborations.

However, despite over three decades of development, many practitioners still face limitations in understanding and applying

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integral theory system (ITS). This article explores the evolution of ITS, identifies challenges in multidisciplinary applications, and suggests strategies to strengthen interdisciplinary collaboration, pinpoint blind spots and opportunities, and leverage effective tools to facilitate the widespread clinical adoption of ITS across disciplines in pelvic floor medicine.

1. Evolution and Interdisciplinary Challenges of the ITS

Since its introduction by Professor Petros in 1990, ITS has expanded from a hypothesis to a comprehensive system of practice, providing a robust theoretical foundation for various surgical techniques and achieving notable clinical results.

The author first encountered ITS at a multidisciplinary pelvic floor conference in 2011 and has since pursued in-depth study through continued communication with Professor Petros. Originally published in the Scandinavian Journal of Obstetrics and Gynecology as a supplement in 1990,[1] this framework detailed the origins of ITS, covering biomechanics, static anatomy, clinical imaging, diagnostic strategies, and surgical design. Notably, the mid-urethral sling, developed under this theoretical framework, became a breakthrough gold standard in treating stress urinary incontinence. However, many practitioners, including the author, often focus on specific methods derived from ITS without delving into its comprehensive framework.

Professor Petros's ongoing efforts to improve and apply ITS[2] clinically, as evidenced by the 2024 release of a new supplement published in Annals of Translational Medicine,[3] reinforce its scientific credibility and long-standing clinical value. Nonetheless, despite its widespread application in gynecology, ITS remains underutilized in fields such as urology and colorectal field. This limited interdisciplinary adoption restricts the broader application of effective treatment strategies. Strengthening cross-disciplinary understanding and application of ITS will be crucial for its future development.

2. This Limitation in Understanding Mainly Stems from the Following Aspects

First, in the thinking process, it is often difficult for practitioners to break through the inherent reductionist thinking mode. This makes the transition from static anatomy to functional anatomy and biomechanics quite challenging. Even learning as basic as mastering the terminology of static anatomy and pelvic floor structure anatomy can be a significant challenge for many. This mindset shift takes time and sustained effort.

Second, during the learning process, practitioners face the challenge of integrating knowledge at multiple levels. They not only need to master static anatomy knowledge, but also need to upgrade to the level of functional anatomy, dynamic anatomy and biomechanics, and comprehensively consider muscles, ligaments, nervous system, fascia and their interrelationships. This complex integration of thinking is challenging for many practitioners, resulting in numerous difficulties in learning and application. Overcoming this challenge requires systematic learning and practice.

In addition, because the integral theory originated from the field of gynecology, other related disciplines such as urology and colorectal field have not yet fully understood and applied. These disciplines may not fully appreciate the importance and impact of this theory on pelvic floor multidisciplinary practice and their own disciplines. This limitation of interdisciplinary application not only hinders the comprehensive promotion of the theory, but may also lead to missing some effective treatments in clinical practice. Therefore, strengthening exchanges and cooperation between different disciplines and promoting the application of theory in a wider range of fields will be an important direction for future development.

3. Perspectives on Ligament Repair, Muscle Balance, and Neural Regulation in ITS

3.1 The importance of ligament repair

In ITS, ligaments play a key role in pelvic floor structures repair deserves special attention. This emphasis is not meant to downplay the importance of muscles, fascia, and other structures but is based on the efficiency of anatomical repair. Biomechanically, ligaments, composed primarily of type I collagen, provide greater strength than muscles and fascia, making them crucial in addressing pelvic floor issues such as anterior rectal wall intussusception and prolapse.

(1) The relationship between collagen, vagina and ligaments

Collagen is a major component of human structures such as ligaments, fascia and muscles. Different tissues have different functional needs and therefore the composition and properties of their collagen.

Ligaments are mainly composed of type I collagen, accounting for approximately 70-80% of their total collagen. This collagen gives the ligament extremely high tensile strength and structural stability, allowing it to provide strong anatomical support. The breaking strain of the ligament is as high as 300 mg/mm^2, demonstrating its excellent strength.

In contrast, vaginal tissue is primarily composed of type III collagen, which gives the vagina its unique physiological properties. Type III collagen gives the vagina good ductility and elasticity while maintaining a certain tensile strength. Although

the vagina is not as strong as ligaments, its breaking strain is still 60 mg/mm², which is much higher than the 5 mg/mm² of the pelvic floor muscles. This structural characteristic is ideally suited to the physiological and functional needs of the vagina: It maintains sufficient strength while possessing the necessary elasticity to adapt to the birth process. More importantly, this property enables the vagina to effectively transmit the force generated by pelvic floor muscle contraction, playing a key role in pelvic floor function.

The unique structure of the vagina allows it to act as a "hammock" in the pelvic floor musculature. This structure can be compared to the elastic surface of a trampoline or the surface of a drum. It must have both strength and elasticity, and become the key link to transmit the force between muscles. If the drum surface is too hard, the sound of the drum will not travel far; if the trampoline is too hard, it will not bounce high. Similarly, the vagina needs to support the pelvic organs while effectively transmitting force during muscle contraction, thereby participating in the control of important physiological functions such as urination and defecation.

It is precisely because of these differences in structure and strength between the ligaments and the vagina that they can play their own unique and complementary roles in pelvic floor function and jointly maintain the normal physiological functions of the pelvic floor.

(2) Rethinking Surgical Approaches

This deeper understanding of ligament and vaginal structure calls for reevaluation of certain surgical techniques. For example, the practice of avoiding vaginal removal or mesh placement is based on this understanding.

When dealing with anterior rectal intussusception and prolapse, we should focus on the main source of the problem—the laxity of the uterosacral ligaments—rather than just the anterior rectal wall itself. Ligament damage can lead to passive elongation of the anterior rectal wall, leading to anterior rectal wall intussusception, prolapse, and enterocele. Therefore, the correct approach is to repair the uterosacral ligaments rather than placing a mesh in the rectovaginal septum or resecting the anterior rectal wall. Paying attention to strengthening or shortening the uterosacral ligaments during vaginal vault apex suspension surgery is an effective repair solution. Regardless of whether the transvaginal, transperineal or transabdominal approach is chosen, the purpose of repairing the ligaments can be achieved, thereby solving the prolapse problem. This approach not only restores the structural integrity of the pelvic floor, but also prevents prolapse of other organs, reducing the patient's need for future surgery.

Additionally, we should not overlook the important role of the perineal body as the third level of pelvic floor support. Perineal body laxity and dysfunction are closely related to the occurrence of rectocele and descending perineal syndrome. Therefore, when treating this type of pelvic floor disease, we can effectively improve the function of the perineal body by shortening and strengthening the suspensory deep transverse perineal ligament. This idea for the perineal body solves the problem of the anchor point for muscle contraction, relaxation and force generation, and is an indispensable part of the overall treatment strategy.

By fully considering all components of the pelvic floor support system, including ligaments, muscles, and the perineal body, we are able to tailor a more comprehensive and effective treatment plan for our patients.

3.2 Muscle strength and functional balance in pelvic floor

Muscle relaxation, tension, and mechanical balance are fundamental to pelvic floor function. For instance, in pelvic floor dyssynergic defecation sydrome, the internal anal sphincter and the pelvic floor muscle group are often typically tense, reflecting the inability of the visceral smooth muscle and pelvic floor striated muscle systems to effectively relax.

The striated muscles of the pelvic floor differ from striated muscles elsewhere in the body. They are mainly composed of type 1 muscle fibers that can tolerate sustained tension contraction, between smooth muscles and voluntary skeletal muscles. At the same time, the contractile force of the external anal sphincter and longitudinal muscle of anus acts downward. Additionally, the puborectalis and levator ani plates form a pair of interacting forces: one pulls the posterior rectal wall anteriorly and the other posteriorly. These forces, together with the pull-down force of the external sphincter and longitudinal muscle of anus, form a rotational resultant force. This torque is the key to closing the rectum. When this force cannot be relaxed in time, the anus will not open properly.

Based on this understanding, the ITS provides a new perspective on muscle balance and neural function regulation. Traditional methods mainly directly relax the internal anal sphincter, external sphincter, puborectalis muscle or levator ani muscle through rehabilitation training, botulinum toxin injection or surgical cutting. However, could we take another approach? That is, starting from the ITS, focusing on the relaxation and tension of the corresponding anterior pelvic antagonist muscles and ligaments, so as to achieve a more comprehensive rehabilitation?

3.3 Bidirectional neuromodulation

ITS introduces the idea that neuromodulation can be applied from a "top-down" or "bottom-up" perspective.Urge incontinence may be caused by premature excitation of the receptors, which may be caused by problems with the receptors themselves or by abnormalities in structures such as the ligaments, fascia, or vagina that support the receptors.

Modulation through the pudendal nerve, sacral nerve plexus, brain and central nervous system, and even the enteric nervous system are all possible intervention routes. This bidirectional regulation method is particularly important in the ITS of the pelvic floor because it not only focuses on local pathophysiological changes, but also emphasizes the impact of the systemic nervous system on local functions.

ITS provides us with a more whole picture perspective, allowing us to better understand and treat pelvic floor disorders. This holistic understanding helps us expand the ideas of treatment methods, so that when treating defecation problems, we can not only start from the posterior compartment, but also from the anterior compartment. For example, when treating fecal incontinence, both urinary and fecal incontinence problems may improve after repairing the pubourethral ligament. Likewise, posterior compartment symptoms may improve when urinary incontinence is treated, and anterior pelvic symptoms may decrease when constipation is treated. This cross-regional linkage effect shows that the ITS not only provides a direct treatment method, but also puts forward the idea of achieving therapeutic effects by dealing with opposing muscles or antagonist muscles.

CONCLUSION

The proposal of the ITS provides new ideas and methods for the treatment of pelvic floor diseases. By considering the overall function of ligaments, muscles, and nerves, this theory has not only been widely used in the field of gynecology, but also provided a solid theoretical foundation for interdisciplinary cooperation.

However, the promotion and application of theory still faces many challenges, especially in terms of cooperation and understanding between different disciplines. This article emphasizes the importance of ligament repair in clinical practice, especially when dealing with problems such as anterior rectal wall intussusception and prolapse and vaginal apical suspension, while noting the role of the perineal body in rectocele and descending perineal syndrome. Additionally, this article explores ways to improve pelvic floor disorders by modulating muscle balance and nerve function.

Through in-depth study and application of the ITS, we can deepen our understanding of anatomy and expand treatment strategies, providing patients with more comprehensive and effective care. Promoting interdisciplinary applications in future clinical practice will advance the field of pelvic floor medicine and enhance patients' quality of life.

FOOTNOTES

DISCLOSURES

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